Tanana Chiefs Conference

Priority Climate Action Plan

Village of Alatna

Alatna, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
ATTC	Alatna Traditional Tribal Council
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	CO_2 equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Ton
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Alatna, a rural and predominantly Alaska Native community in Interior Alaska. Alatna lies on the north bank of the Koyukuk River directly across from the neighboring village of Allakaket on the river's south bank. The two neighboring communities have a combined population of approximately 173 residents, with 80% living in Allakaket and 20% living in Alatna. Electricity is produced in the larger community of Allakaket and provided to both communities. This PCAP identifies sources of greenhouse gas (GHG) emissions in the community of Alatna and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Alatna. GHG production levels and energy costs for Alatna were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024). A single PCE report was generated by AEA for both communities of Allakaket and Alatna; therefore, the 80%-20% split in population, respectively, is applied to the PCE data for these community PCAPs to arrive at approximate individual community values for energy usage, cost, and GHG emissions.

Based on the available data, diesel was the primary energy source for power and resulting GHG emissions in both communities in 2022 (AEA 2023). Their combined 62 residential customers, 18 community facility customers, and 16 other customers required 648,000 kWh in diesel-generated power (approximately 129,600 kWh for Alatna). A total of 53,364 gallons of diesel fuel were consumed by Allakaket and Alatna by customers in 2022 (approximately 10,673 gallons in Alatna) at a cost of $281,323 for both communities (approximately $56,265 in Alatna), averaging $5.27 per gallon. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Allakaket and Alatna jointly accounted for approximately 1,194,286 lbs of CO_2 (541.7 MT of CO_2) produced in FY2022. About 20% of this combined total, or 238,857 lbs CO_2 (108.3 MT CO_2), can be attributed to Alatna alone.

The average fuel cost per kWh for Alatna in 2022 was $0.48. The annual non-fuel expenses associated with power generation for both communities totaled $134,140 in FY22 (about $26,828 for Alatna), resulting in an additional cost of $0.23 per kWh sold. Thus, the combined fuel and non-fuel expenses in Alatna were $0.71 per kWh sold in FY22. The electric rates in Allakaket and Alatna were nearly 4.5 times the national average of $0.16 per kWh. They were PCE eligible for 58.1% of their total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to the two communities in the amount of $202,413 (approximately $40,483 to Alatna) to offset high energy costs. The average annual subsidized PCE payment per eligible customer in these communities combined was $2,530 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Alatna. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Alatna:

- Residential Sector
  - Residual Fuel Oil No. 5 = 66.00 MT CO_2e
  - Wood and Residuals = 0.36 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 38.05 MT CO_2e
  - Propane = 29.0 MT CO_2e
  - Wood and Wood Residuals = 0.11 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Alatna was also modeled. The analysis indicated that approximately 110.44 MWh electricity is used in this capacity in Alatna, resulting in emissions all stemming from diesel in the amount of 31.81 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software (UL Solutions 2024) for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs. Following a review of this information preferred options for cleaner, lower cost energy in Alatna are:

- Solar PV + BESS array (may reduce fuel consumption and CO_2 production by up to 20%);
- Weatherization of residences, tribal / city buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

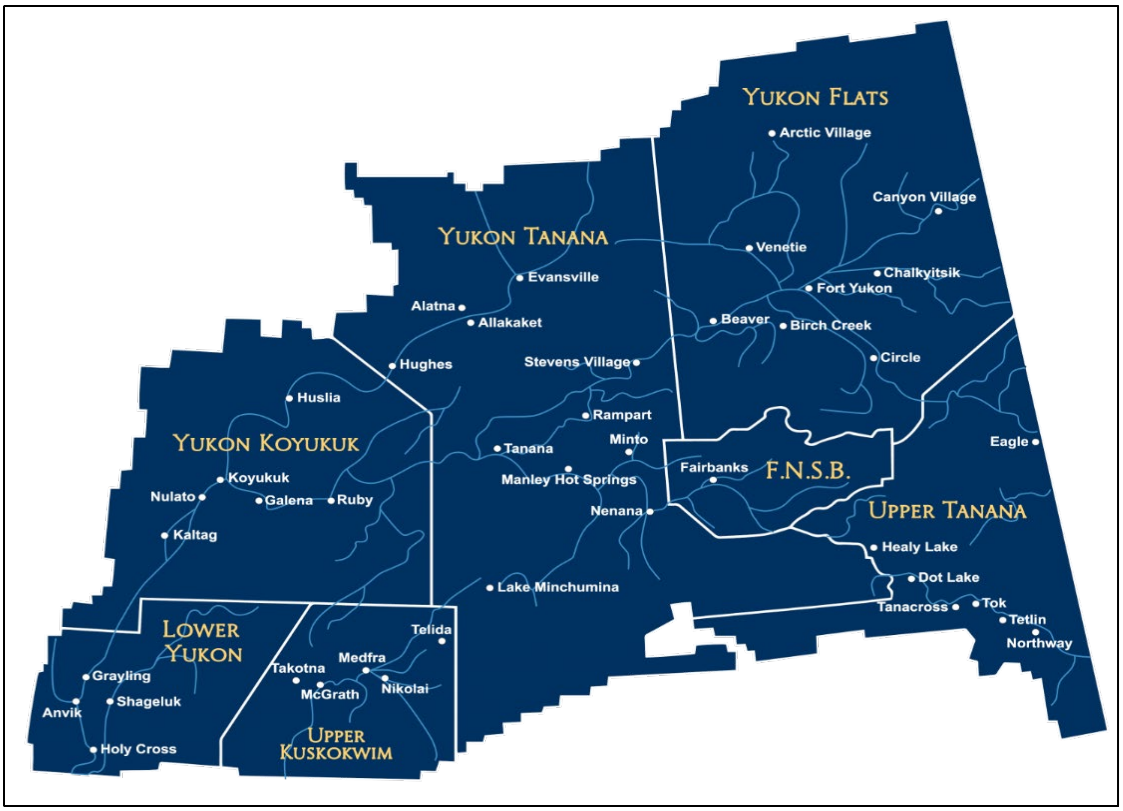
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison

- Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

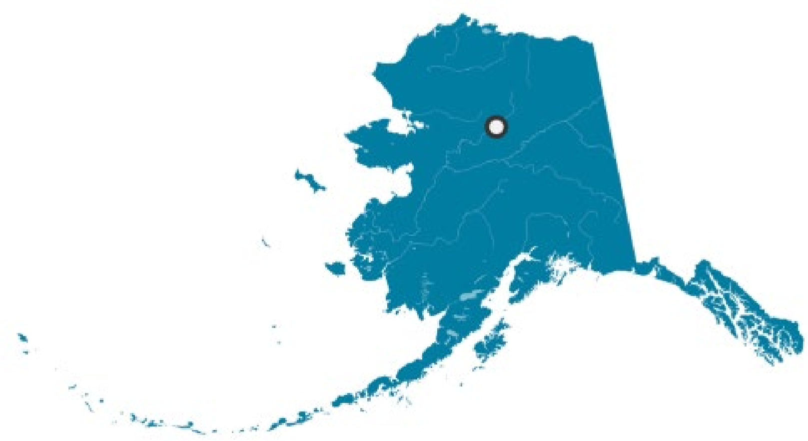
1.4 Scope of this PCAP: The Community of Alatna

Alatna is a traditional Upper Yukon Tanana Athabascan village that is home to approximately 173 residents. Alatna is located on the north bank of the Koyukuk River, Southwest of its junction with the Alatna River, approximately 190 air miles northwest of Fairbanks and 57 miles upriver from Hughes. Alatna is just west of the city of Allakaket. (Figure 2). It lies south of the Tanana River. Alatna's power is supplied by The Alaska Power & Telephone Company (AP&T).

Alatna is located in the continental climatic zone, where winters are cold, and summers are warm. In winter, cool air settles in the valley, and ice fog and smoke conditions are common. The average low temperature during December, January, and February is -40 °F. The average high temperature during June, July, and August is 75 °F. Extreme temperatures ranging from a low of -75 to a high of 94 °F have been measured. Average annual precipitation is 13 inches, and annual snowfall averages 36 inches.

The U.S. EPA indicates that Alatna's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Alatna as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 92% of Allakaket / Alatna tribal area residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Alatna, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, tribal communities requires specific considerations for PCAPs, including:

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[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Alatna. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north and west of Alatna and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat. If they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Alatna's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote

Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. There are a number of areas around the village that may be suitable.

As noted above, Alatna's power is generated at the AP&T facility in Allakaket and is transferred to Alatna via underground cables. Upgrades to the power grid would need to be made in order to incorporate solar power in Alatna.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are the highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed Alatna is estimated to be 5.6 mph which is a Class 2 (light breeze) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a small community, turbines turned by even a Class 2 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter. The high initial capital cost can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Alatna and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Alatna because of the number of moving parts that must continue operating at very cold temperatures. Should Alatna decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed

by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [3]

A wood-fired boiler is used to heat a number of homes in Alatna, but may have included some initial design flaws, such as buried pipes that were damaged. Funding is needed for maintenance and to potentially expand the number of homes served by this project.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

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[3] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Alatna, the transmission lines from Allakaket and switch gear are likely due for upgrade, along with any transformers and other hardware required to maintain the power grid. Grid component upgrades may be needed to accommodate new projects, including alternative means of electrical generation.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Alatna does not have an operating airport at this time and relies on Allakaket for this service.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Alatna does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Alatna is located on the north bank of the Koyukuk River, southwest of its junction with the Alatna River. However, they currently do not have plans to pursue a hydropower project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In Alatna, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of residential housing and tribal or city building components in Alatna would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

The Village of Alatna completed a community survey that was issued by TCC in late 2023. This survey provided the Tribe with an opportunity to comment on their energy priorities and challenges, weatherization and electrical needs, and interest in renewable energy systems.

The survey completed by the community of Alatna indicated they do not currently have an energy / economic development plan but would like assistance in developing one. Their three top energy priorities are to reduce the cost of electricity, improve reliability of power generation (i.e., reduce power outages), and acquire a local generator. Because Alatna uses the Allakaket powerplant via AP&T, Alatna is reliant on AP&T's Allakaket's powerplant and there is no back up energy available in Alatna.

Alatna indicated that it does not have a heat recovery system and does not have any renewable energy projects in their future. Alatna is interested in the following type of projects for the future:

- Community-scale solar photovoltaic systems

- Wind turbines
- Run-of-river hydroelectric systems
- Battery energy storage systems
- Diesel back-up generator for Village of Alatna residents

The highest priority for Alatna is to acquire funding for a back-up generator for the entire Village of Alatna, along with acquiring funding to pursue renewable energy such as solar power generation. The Village of Alatna's population and geographic size should allow for the community to provide a high percentage of renewable energy. Residential homes in Alatna are currently being upgraded with energy efficiency improvements, including LED lighting upgrades, new doors, windows, and Toyo stoves. The community would be interested in additional weatherization as recommended. Forty percent of the homes are older and lacking basic utilities, including power, water and sewer. They would also be interested in weatherization retrofits for their community buildings. Over half of their community buildings do not have basic utilities, including power, water and sewer.

Alatna is interested in applying for EPA CPRGs. They intend to apply for energy efficient upgrades along with solar power + BESS to power the community and relieve the reliance on higher cost power. The Village of Alatna continues to have power outages throughout the year, and the lack of a back-up generator located in Alatna causes continued concern and frustration.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Alatna (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source for power and resulting GHG emissions in both communities in 2022 (AEA 2023). Their combined 62 residential customers, 18 community facility customers, and 16 other customers required 648,000 kWh in diesel-generated power (approximately 129,600 kWh for Alatna). A total of 53,364 gallons of diesel fuel were consumed by Allakaket and Alatna by customers in 2022 (approximately 10,673 gallons in Alatna) at a cost of $281,323 for both communities (approximately $56,265 in Alatna), averaging $5.27 per gallon. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Allakaket and Alatna jointly accounted for approximately 1,194,286 lbs of CO_2 (541.7 MT of CO_2) produced in FY2022. About 20% of this combined total, or 238,857 lbs CO_2 (108.3 MT CO_2), can be attributed to Alatna alone.

The average fuel cost per kWh for Alatna in 2022 was $0.48. The annual non-fuel expenses associated with power generation for both communities totaled $134,140 in FY22 (about $26,828 for Alatna), resulting in an additional cost of $0.23 per kWh sold. Thus, the combined fuel and non-fuel expenses in Alatna were $0.71 per kWh sold in FY22. The electric rates in Allakaket and Alatna were nearly 4.5 times the national average of $0.16 per kWh. They were PCE eligible for 58.1% of their total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to the two communities in the amount of $202,413 (approximately $40,483 to Alatna) to offset high energy costs. The average annual subsidized PCE payment per eligible customer in these communities combined was $2,530 (AEA 2023).

PCE data for both communities are summarized in Tables 1 and 2, below.

Table 1. Alatna and Allakaket Combined Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
173	62	18	16

Source: AEA 2023; Approximately 20% of values can be attributed to Alatna alone.

Table 2. Alatna and Allakaket Combined Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ Gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
648,000	0	90%	12.5	615,866	53,364	2,384

Source: AEA 2023; Approximately 20% of values can be attributed to Alatna alone.

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Alatna (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to Scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion

leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Alatna. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Alatna:

- Residential Sector
    - Residual Fuel Oil No. 5 = 66.00 MT CO_2e
    - Wood and Residuals = 0.36 MT CO_2e
- Commercial Sector
    - Distillate Fuel Oil No. 1 = 38.05 MT CO_2e
    - Propane = 29.0 MT CO_2e
    - Wood and Wood Residuals = 0.11 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Alatna was also modeled. The analysis indicated that approximately 110.44 MWh electricity is used in this capacity in Alatna, resulting in emissions all stemming from diesel in the amount of 31.81 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Alatna may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;

- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** The community should consider applying for funding for a solar array and BESS project.
2. **Weatherization of Residential and Public Structures.** The community should apply for funding for weatherization of residences and tribal / city buildings.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 45% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power for Allakaket and Alatna combined. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 450 kW Renewable Solar + 800kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal.)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
450 kW PV 800 kWh BESS	2.82	1.00	45%	32,018	21,346	80,802	216,549	217

Source: HOMER Pro Software; Table is for Allakaket and Alatna, combined.
* = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the communities of Allakaket and Alatna, coupled with reduced greenhouse gas emissions.

Alatna is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC and AP&T's chief concerns around the region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Alatna Traditional Tribal Council (ATTC) is the governing body for Alatna Village, a federally recognized tribe. The ATTC has the authority to implement GHG reduction measures through resolutions passed in ATTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, DLTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Funding Mechanisms

TCC recommends the following projects should be pursued by Alatna to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should apply for funding for a 2MW solar array project along with 3MW BESS.
2. **Weatherization of Residential and Public Structures.** The community should apply for funding for additional weatherization of residences and tribal / city buildings. It is likely that the several homes, and tribal / city buildings in Alatna have not had energy efficiency improvements beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** The wood-fired boiler that is used to heat a number of homes in Alatna had some initial design flaws, including buried pipes that were easily damaged. Alatna should consider applying for funds for maintenance and to potentially expand the number of homes this project serves.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide

additional fuel savings, including during winter. However, the wind source around Alatna is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** A backup diesel generator is desperately needed for the community; this would not reduce GHGs but would benefit community resilience to outages. The community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed.

5 References

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Alatna (FY2022)

Allakaket; Alatna PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	173
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	62
Community Facility Customers	18
Other Customers (Non-PCE)	16
Fiscal Year PCE Payments	**$202,413**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	203,170	Average Annual PCE Payment per Eligible Customer	$2,530
PCE Eligible kWh - Community Facility Customers	135,930	Average PCE Payment per Eligible kWh	$0.60
Total PCE Eligible kWh	339,100	Last Reported Residential Rate Charged (based on 500 kWh)	$1.02
Average Monthly PCE Eligible kWh per Residential Customer	273	Last Reported PCE Level (per kWh)	$0.68
Average Monthly PCE Eligible kWh per Community Facility Customer	629	Effective Residential Rate (per kWh)	$0.33
Average Monthly PCE Eligible Community Facility kWh per Person	65	PCE Eligible kWh vs Total kWh Sold	58.1%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	648,000	Fuel Used (Gallons)	53,364
Non-Diesel kWh Generated	0	Fuel Cost	$281,323
Purchased kWh	0	Average Price of Fuel	$5.27
Total Purchased & Generated	648,000	Fuel Cost per kWh sold	$0.48
		Annual Non-Fuel Expenses	$134,140
		Non-Fuel Expense per kWh Sold	$0.23
		Total Expense per kWh Sold	$0.71

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	222,813	Consumed vs Generated (kWh Sold vs Generated-Purchased)	90.1%
Community Facility kWh Sold	167,796	Line Loss (%)	5.0%
Other kWh Sold (Non-PCE)	193,209	Fuel Efficiency (kWh per Gallon of Diesel)	12.14
Total kWh Sold	583,818	PH Consumption as % of Generation	4.9%
Powerhouse (PH) Consumption kWh	32,048		
Total kWh Sold & PH Consumption	615,866		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Allakaket Village
Allakaket, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
ATC	Allakaket Tribal Council
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Allakaket, a rural and predominantly Alaska Native community in Interior Alaska. Allakaket lies on the south bank of the Koyukuk River directly across from the neighboring village of Alatna on the river's north bank. The two neighboring communities have a combined population of approximately 173 residents, with 80% living in Allakaket and 20% living in Alatna. Electricity is produced in the larger community of Allakaket and provided to both communities. This PCAP identifies sources of greenhouse gas (GHG) emissions in the community of Allakaket and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Allakaket. GHG production levels and energy costs for Allakaket were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024). A single PCE report was generated by AEA for both communities of Allakaket and Alatna; therefore, the 80%-20% split in population, respectively, is applied to the PCE data for these community PCAPs to arrive at approximate individual community values for energy usage, cost, and GHG emissions.

Based on the available data, diesel was the primary energy source for power and resulting GHG emissions in both communities in 2022 (AEA 2023). Their combined 62 residential customers, 18 community facility customers, and 16 other customers required 648,000 kWh in diesel-generated power (approximately 518,400 kWh for Allakaket). A total of 53,364 gallons of diesel fuel were consumed by Allakaket and Alatna customers in 2022 (approximately 42,691 gallons in Allakaket) at a cost of $281,323 for both communities (approximately $225,058 in Allakaket), averaging $5.27 per gallon. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Allakaket and Alatna jointly accounted for approximately 1,194,286 lbs of CO_2 (541.7 MT of CO_2) produced in FY2022. About 80% of this combined total, or 955,429 lbs CO_2 (433.4 MT CO_2), can be attributed to Allakaket alone.

The average fuel cost per kWh for Allakaket in 2022 was $0.48. The annual non-fuel expenses associated with power generation for both communities totaled $134,140 in FY22 (about $107,312 for Allakaket), resulting in an additional cost of $0.23 per kWh sold. Thus, the combined fuel and non-fuel expenses in Allakaket were $0.71 per kWh sold in FY22. The electric rates in Allakaket and Alatna were nearly 4.5 times the national average of $0.16 per kWh. They were PCE eligible for 58.1% of their total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to the two communities in the amount of $202,413 (approximately $161,930 to Allakaket) to offset high energy costs. The average annual subsidized PCE payment per eligible customer in these communities combined was $2,530 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Allakaket. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Allakaket:

- Residential Sector
  - Residual Fuel Oil No. 5 = 409.18 MT CO_2e
  - Wood and Residuals = 7.48 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 161.46 MT CO_2e
  - Propane = 12.33 MT CO_2e
  - Wood and Wood Residuals = 0.45 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Allakaket was modeled. The analysis indicated that approximately 468.71 MWh electricity is used in this capacity and that the resulting emissions all come from diesel in the amount of 134.99 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Alatna and Allakaket, the maximum fraction of existing energy production that could be replaced by renewables is 45%, represented by a 450 kw solar PV and an 800 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software (UL Solutions 2024) for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs. Following a review of this information preferred options for cleaner, lower cost energy in Allakaket are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

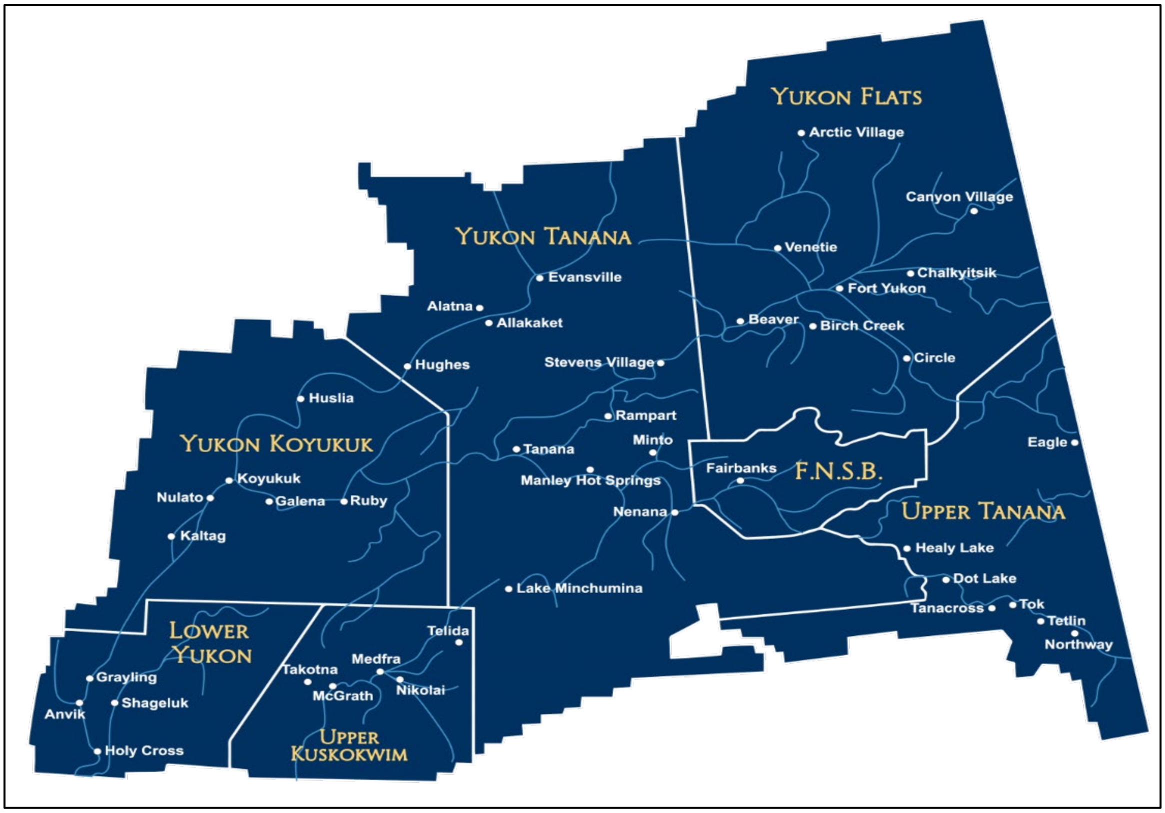
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
    - Dave Messier – Infrastructure Director
    - Jason Paskvan – Project Manager and Community Liaison
    - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Allakaket

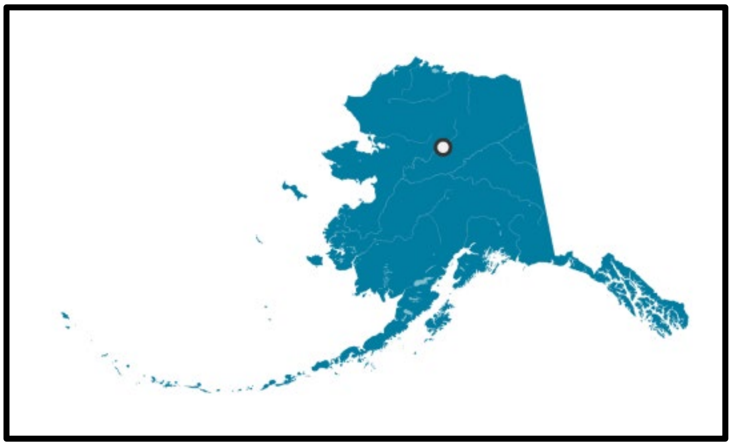
Allakaket is a traditional Upper Yukon Tanana Athabascan village that is home to approximately 173 residents. Allakaket is on the south bank of the Koyukuk River, southwest of its junction with the Alatna River, approximately 190 miles (310 km) northwest of Fairbanks and 57 miles (92 km) upriver from Hughes (Figure 2). Allakaket's power is supplied by The Alaska Power & Telephone Company (AP&T).

Allakaket is located in the continental climatic zone, where winters are cold, and summers are warm. In winter, cool air settles in the valley, and ice fog and smoke conditions are common.

The area experiences a cold, continental climate with extreme temperature differences. The average high temperature during July is 70 °F. The average low during January is well below zero, and extended periods of -40 °F are common. The highest temperature ever recorded was 94 °F and the lowest temperature ever recorded was -75 °F. Average annual precipitation is 13 inches, and average annual snowfall is 72 inches. The Koyukuk River is ice-free from June through October.

The U.S. EPA indicates that Allakaket's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Allakaket as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 92% of Allakaket / Alatna tribal area residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Allakaket, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Allaket. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies northwest of Allakaket and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Allakaket's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many

remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. There are a number of areas around the village that may be suitable.

As noted above, Allakaket's power is generated from a facility operated by AP&T to produce power for the community, as well as the neighboring community of Alatna via underground cables. Upgrades to the power grid would need to be made in order to incorporate solar power or other renewable energy systems in Allakaket.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed Allakaket is estimated to 5.6 mph) which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 173 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter. The high initial capital cost can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource. If capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Allakaket and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Allakaket because of the number of moving parts that must continue operating at very cold temperatures. Should Allakaket decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable

example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future.[3]

The use of biomass systems in Allakaket is unknown, although neighboring Alatna does use a wood-fired boiler to heat some homes.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community’s transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

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[3] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

In Allakaket, the transmission lines and switch gear are likely due for upgrade, along with any transformers and other hardware required to maintain the power grid. Grid component upgrades may be needed to accommodate new projects, including alternative means of electrical generation.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Allakaket has an operating airport that is state-owned and has a 4,000 ft by 100 ft gravel runway that is accessible year-round. A $6 million airport improvement began construction in 1997. There are currently no plans to integrate renewable energy systems or electrification into the airport. While river barges dock at Allakaket, there is no small port infrastructure.

2.1.6 EV’s & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.

- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Allakaket does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Allakaket is located on the south bank of the Koyukuk River, southwest of its junction with the Alatna River. However, there are no plans to pursue a hydropower project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

The Allakaket Water Treatment Plant and Washeteria received funding from the Environmental Protection Agency and the Indian Health Service to install a heat recovery system from the local power plant to the water treatment plant for the purpose of heating the facilities. The system was installed in September 2011 by ANTHC. The heat recovery system in the water treatment plant provides heat from the local power plant for water heating and hydronic heat purposes. The system extracts heat from 10 cooling loops in the power plant's generators through a glycol line and transports the heated glycol line to transfer the heat to the water treatment plant through a heat exchanger. The system produces an average of approximately 400,000 BTU/hr.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of housing and building components in Allakaket would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

The Village of Allakaket completed a community survey that was issued to the Tribe by TCC in late 2023. This survey provided the Tribe with an opportunity to comment on their energy priorities and challenges, weatherization and electrical needs, and interest in renewable energy systems.

The survey completed by the community of Allakaket indicated they do not currently have an energy/economic development plan but would like help writing one. Their three top energy priorities are to reduce the cost of electricity, reduce energy costs of public buildings and facilities, and improve training for the energy workforce. Allakaket currently uses the powerplant via AP&T. Allakaket is reliant on AP&T's powerplant; there is no back up energy available in Allakaket, and power outages can occur throughout the year.

Allakaket indicated that it does not have a heat recovery system and does not have any renewable energy projects in their future. Allakaket is interested in the following type of projects for the future:

- Community-scale solar photovoltaic systems
- Wind Turbines
- Solar Panels

The highest priorities for Allakaket are to acquire funding for a back-up generator and for renewable energy systems, such as solar PVs. The Village of Allaket's population and geographic size should allow for the community to provide a high percentage of renewable energy.

Over 80% percent of all the residential homes in Allakaket are in need of being weatherized, including LED lighting upgrades, doors, windows, Toyo stoves, and heating monitors. More than 80% percent of the homes are older and lacking basic utilities including power, water and sewer. The Village of Allakaket is interested in weatherization retrofits for their community buildings. Over seventy percent of their community buildings do not have basic utilities, including power, water and sewer.

Allakaket might be interested in applying for EPA Climate Pollution Reduction Grants. They intend to apply for energy efficiency upgrades, along with solar PV + BESS, to power the community and reduce their reliance on higher cost power.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Allakaket (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source for power and resulting GHG emissions in both communities in 2022 (AEA 2023). Their combined 62 residential customers, 18 community facility customers, and 16 other customers required 648,000 kWh in diesel-generated power (approximately 518,400 kWh for Allakaket). A total of 53,364 gallons of diesel fuel were consumed by Allakaket and Alatna customers in 2022 (approximately 42,691 gallons in Allakaket) at a cost of $281,323 for both communities (approximately $225,058 in Allakaket), averaging \$5.27 per gallon. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Allakaket and Alatna jointly accounted for approximately 1,194,286 lbs of CO_2 (541.7 MT of CO_2) produced in FY2022. About 80% of this combined total, or 955,429 lbs CO_2 (433.4 MT CO_2), can be attributed to Allakaket alone.

The average fuel cost per kWh for Allakaket in 2022 was \$0.48. The annual non-fuel expenses associated with power generation for both communities totaled \$134,140 in FY22 (about \$107,312 for Allakaket), resulting in an additional cost of \$0.23 per kWh sold. Thus, the combined fuel and non-fuel expenses in Allakaket were \$0.71 per kWh sold in FY22. The electric rates in Allakaket and Alatna were nearly 4.5 times the national average of \$0.16 per kWh. They were PCE eligible for 58.1% of their total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to the two communities in the amount of \$202,413 (approximately \$161,930 to Allakaket) to offset high energy costs. The average annual subsidized PCE payment per eligible customer in these communities combined was \$2,530 (AEA 2023).

PCE data for both communities are summarized in Tables 1 and 2, below.

Table 1. Alatna and Allakaket Combined Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
173	62	18	16

Source: AEA 2023; Approximately 20% of values can be attributed to Alatna alone.

Table 2. Alatna and Allakaket Combined Fuel Consumption and CO2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ Gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal.)	CO_2 produced[4] (lbs)
648,000	0	90%	12.5	615,866	53,364	2,384

Source: AEA 2023; Approximately 20% of values can be attributed to Alatna alone.

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Allakaket (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to Scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Allakaket. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Allakaket:

- Residential Sector
  - Residual Fuel Oil No. 5 = 409.18 MT CO_2e
  - Wood and Residuals = 7.48 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 161.46 MT CO_2e
  - Propane = 12.33 MT CO_2e
  - Wood and Wood Residuals = 0.45 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Allakaket was modeled. The analysis indicated that approximately 468.71 MWh electricity is used in this capacity and that the resulting emissions all come from diesel in the amount of 134.99 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Allakaket may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** The community should consider applying for funding for a solar array and BESS project to reduce diesel fuel consumption and GHG emissions.

2. **Weatherization of Residential and Public Structures.** The community should consider applying for funding for weatherization of residences and tribal / city buildings to reduce the use of heating oil and wood and lower GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 45% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power for Allakaket and Alatna combined. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 450 kWh Renewable Solar + 800 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Mill. $)	Utility Improvements (Mill. $)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal.)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
450 kWh PV; 800 kWh BESS	2.82	1.00	45%	32,018	21,346	80,802	216,549	217

Source: HOMER Pro Software; Table is for Allakaket and Alatna, combined.

* = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

Allakaket is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC and AP&T's chief concerns around Upper Tanana region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Allakaket Tribal Council (ATC) is the governing body for Allakaket Village, a federally recognized tribe. The ATC has the authority to implement GHG reduction measures through resolutions passed in ATC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, ATC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Allakaket to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should consider applying for funding for a solar array and BESS project to reduce diesel fuel consumption and GHG emissions.

2. **Weatherization of Residential and Public Structures.** The community should apply for funding for additional weatherization of residences and tribal / city buildings. It is likely that the several homes, and tribal / city buildings in Allakaket have not had energy efficiency improvements beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.

3. **Biomass Project(s):** The wood-fired boiler that is used to heat a number of homes in Allakaket had some initial design flaws, including buried pipes that were easily damaged. Allakaket should consider applying for funds for maintenance and to potentially expand the number of homes this project serves.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide

additional fuel savings, including during winter. However, the wind source around Allakaket is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** A backup diesel generator is desperately needed for the community; this would not reduce GHGs but would benefit community resilience to outages. The community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Allakaket (FY2022)

Allakaket; Alatna PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	173
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	62
Community Facility Customers	18
Other Customers (Non-PCE)	16
Fiscal Year PCE Payments	**$202,413**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	203,170	Average Annual PCE Payment per Eligible Customer	$2,530
PCE Eligible kWh - Community Facility Customers	135,930	Average PCE Payment per Eligible kWh	$0.60
Total PCE Eligible kWh	339,100	Last Reported Residential Rate Charged (based on 500 kWh)	$1.02
Average Monthly PCE Eligible kWh per Residential Customer	273	Last Reported PCE Level (per kWh)	$0.68
Average Monthly PCE Eligible kWh per Community Facility Customer	629	Effective Residential Rate (per kWh)	$0.33
Average Monthly PCE Eligible Community Facility kWh per Person	65	PCE Eligible kWh vs Total kWh Sold	58.1%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	648,000	Fuel Used (Gallons)	53,364
Non-Diesel kWh Generated	0	Fuel Cost	$281,323
Purchased kWh	0	Average Price of Fuel	$5.27
Total Purchased & Generated	648,000	Fuel Cost per kWh sold	$0.48
		Annual Non-Fuel Expenses	$134,140
		Non-Fuel Expense per kWh Sold	$0.23
		Total Expense per kWh Sold	$0.71

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	222,813	Consumed vs Generated (kWh Sold vs Generated-Purchased)	90.1%
Community Facility kWh Sold	167,796	Line Loss (%)	5.0%
Other kWh Sold (Non-PCE)	193,209	Fuel Efficiency (kWh per Gallon of Diesel)	12.14
Total kWh Sold	583,818	PH Consumption as % of Generation	4.9%
Powerhouse (PH) Consumption kWh	32,048		
Total kWh Sold & PH Consumption	615,866		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Arctic Village

Arctic Village, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
AVC	Arctic Village Council
BESS	Battery Energy Storage System
BIL	Bipartisan Infrastructure Law
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Arctic Village, a rural and predominantly Alaska Native community of approximately 189 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Arctic Village. GHG production levels and energy costs for Arctic Village were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Arctic Village in 2022 (AEA 2023). Arctic Village's 84 residential customers, 6 community facility customers, and 19 other customers required 154,287 kWh in diesel-generated power. A total of 45,618 gallons of fuel were consumed by Arctic Village customers in 2022 at a cost of $318,738 ($6.99 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that Arctic Village accounted for approximately 1,020,931 lbs of CO_2 produced in FY2022.

The average fuel cost per kWh in Arctic Village in 2022 was $0.75. The annual non-fuel expenses associated with power generation totaled $16,500 in FY22, resulting in an additional cost of $0.04 per kWh sold. Thus, the combined fuel and non-fuel expenses in Arctic Village were $0.78 per kWh sold in FY22. Arctic Village's electric rate is over 4.5 times the national average of $0.16 per kWh. Arctic Village was PCE eligible for 48.6% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Arctic Village in the amount of $139,944 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,555 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Arctic Village. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Arctic Village:

- Residential Sector
  - Residual Fuel Oil No. 5 = 13.20 MT CO_2e
  - Wood and Residuals = 24.59 MT CO_2e
- Commercial Sector

- Distillate Fuel Oil No. 1 = 208.79 MT CO_2e
- Propane = 15.94 MT CO_2e
- Wood and Wood Residuals = 0.58 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Arctic Village was modeled. The analysis indicated that approximately 491.07 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (38.19 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Arctic Village are:

- Solar PV + BESS array (may reduce fuel consumption and CO_2 production by up to 20%);
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

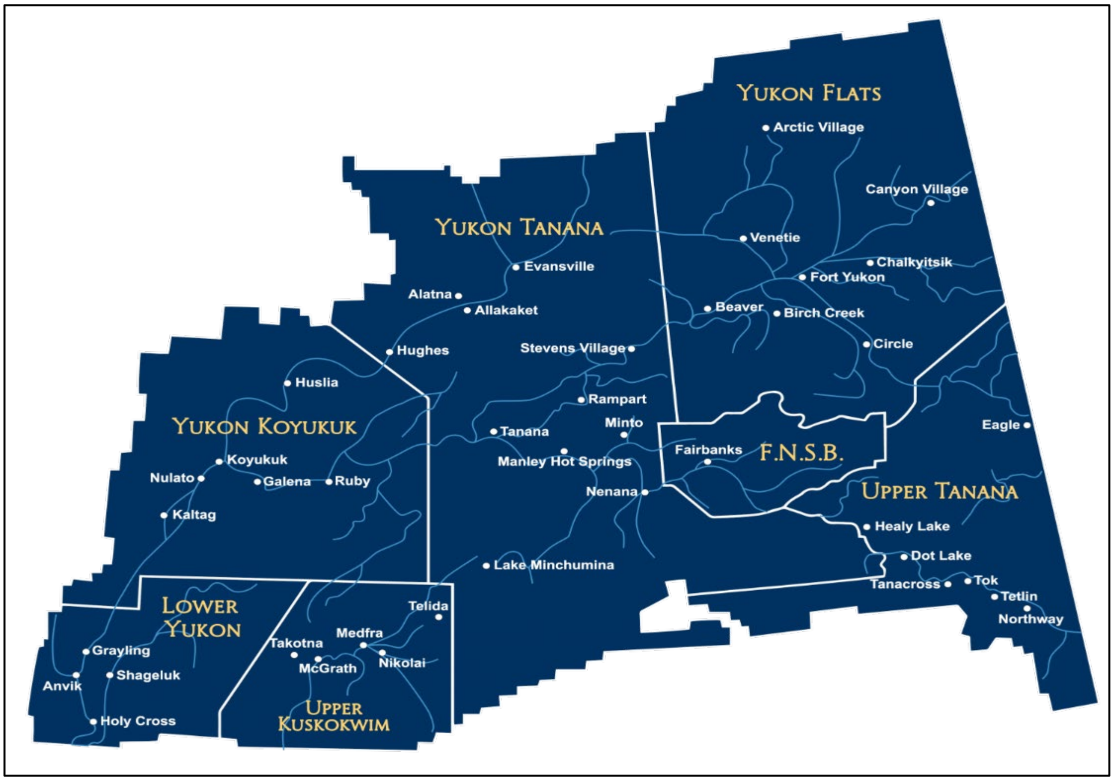
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Arctic Village

Arctic Village is a traditional Yukon Flats Athabascan village that is home to approximately 189 residents. Arctic Village is located on the east fork of the Chandalar River, about a hundred miles north of Fort Yukon. The area consists of flat floodlands near the river, but is mostly wooded hills.

Arctic Village has a continental subarctic climate. Winters are long and harsh, and summers are short but warm. The average high temperature range during July is 65 to 72 °F. The average low temperature during January is well below zero. Extended periods of -50 to -60 °F are common. Extreme temperatures have been measured, ranging from a low of -70 to a high of 90 °F. Precipitation averages 9 inches, and snowfall averages 52.8 inches.

The U.S. EPA indicates that Arctic Village's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Arctic Village as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 73.3% of Arctic Village's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Arctic Village, Alaska

Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar

[2] https://www.huduser.gov/portal/icdbg2022/home.html

panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Arctic Village. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and

utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies southwest of Arctic Village and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Arctic Village’s case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be a viable option for rural Alaska, as its systems are modular and can be easily scaled to meet the specific energy demands of remote communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community’s dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. There are a number of areas around the village that may be suitable.

Arctic Village has no known plans to install a solar PV + BESS system, but this may be one of the best options for the community to reduce its high cost of energy and its GHG emissions.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed Arctic Village is estimated to be 6.2 mph which is a Class 2 (light breeze) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 189 people, turbines turned by even a Class 2 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community’s portfolio as an IPP.

Because of the marginal wind resource in Arctic Village and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Arctic Village because of the number of moving parts that must continue operating at very cold temperatures. Should Arctic Village decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project. However, Arctic Village has no known plans to establish a wind power system.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[3]

It is unknown whether Arctic Village has installed a biomass heating system, or if it has plans to in the future.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

Arctic Village received a grant from the Bipartisan Infrastructure Law (BIL) provision 40101(d) – Department of Energy Electric Grid Resiliency to improve the resilience of their electric grids. Administered by the National Energy Technology Laboratory, the program is designed to

[3] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

strengthen and modernize America's power grid against wildfires, extreme weather, and other natural disasters that are exacerbated by the climate crisis.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

It is unknown whether Arctic Village has plans for future airport or port electrification.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Arctic Village does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are

required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

While Arctic Village is located on the east fork of the Chandalar River, there are no known plans to pursue a hydropower project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In Arctic Village, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Weatherization of housing and building components in Arctic Village would reduce heat loss and improve energy efficiency. Some weatherization was completed in the community over ten years ago. The extent to which buildings in Arctic Village have been weatherized is not known.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

Arctic Village completed a community survey that was issued to the Tribe by Tanana Chiefs Conference in late 2023. This survey provided the Tribe with an opportunity to comment on their energy priorities and challenges, weatherization and electrical needs, and interest in renewable energy systems.

The survey completed by the community of Arctic Village indicated they do not currently have an energy/economic development plan but would like assistance in writing one. Their three top energy priorities are to reduce the cost of electricity, reduce energy costs of public buildings and facilities, and reduce their reliance on diesel.

Arctic Village indicated that it does not have a heat recovery system and does not have any renewable energy projects in their future. Arctic Village is interested in the following type of projects for the future:

- Wind Turbines
- Battery energy storage systems

The highest priority for Arctic Village is to acquire funding for a generator upgrade. The Arctic Village's population and geographic size should allow for the community to provide a high percentage of renewable energy combined with solar, wind, etc. From 2010 – 2014, the Interior Regional Housing Authority came to Arctic Village for do weatherization on the homes in the community. The community would be interested in additional weatherization as recommended. Seventy percent of the homes in Arctic Village are older and need upgrades. Arctic Village would like to have the windows in their homes in the community updated.

Arctic Village would be interested in having an energy audit completed and in weatherization retrofits for their community buildings.

Arctic Village is interested in applying for EPA Climate Pollution Reduction Grants. Their highest priority is applying for energy efficient upgrades along with solar power + BESS to power the community to relieve the reliance on higher cost power.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Arctic Village (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Arctic Village in 2022 (AEA 2023). Arctic Village's 84 residential customers, 6 community facility customers, and 19 other customers required 154,287 kWh in diesel-generated power. A total of 45,618 gallons of fuel were consumed by Arctic Village customers in 2022 at a cost of $318,738 ($6.99 per gallon). Assuming that 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that Arctic Village accounted for approximately 1,020,931 lbs of CO_2 produced in FY2022.

The average fuel cost per kWh in Arctic Village in 2022 was $0.75. The annual non-fuel expenses associated with power generation totaled $16,500 in FY22, resulting in an additional cost of $0.04 per kWh sold. Thus, the combined fuel and non-fuel expenses in Arctic Village were $0.78 per kWh sold in FY22. Arctic Village's electric rate is over 4.5 times the national average of $0.16 per kWh. Arctic Village was PCE eligible for 48.6% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Arctic Village in the amount of $139,944 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,555 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Arctic Village Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
189	84	6	19

Source: AEA 2023

Table 2. Arctic Village Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ Gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
154,287	0	0	3.38	427,093	45,618	2,038

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Arctic Village (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed “market-based” accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings’ heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations’ buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Arctic Village. The contribution of GHGs by fuel type to each sector’s overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Arctic Village:

- Residential Sector
  - Residual Fuel Oil No. 5 = 13.20 MT CO_2e

- Wood and Residuals = 24.59 MT CO_2e

- Commercial Sector
  - Distillate Fuel Oil No. 1 = 208.79 MT CO_2e
  - Propane = 15.94 MT CO_2e
  - Wood and Wood Residuals = 0.58 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Arctic Village was modeled. The analysis indicated that approximately 491.07 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (38.19 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Arctic Village may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** Arctic Village should apply for funding for a 4MW solar array project along with 4MWh BESS to lower energy bills and reduce GHG emissions from diesel generators.
2. **Additional Weatherization.** The community has successfully weatherized some community buildings, but weatherization of additional buildings and residences with modern features would reduce heat escape and lower electric bills and CO_2 emissions further.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 40% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 385 kW Renewable Solar + 594kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gall.)	Delta Fuel (liters)	Delta CO_2 (Kg)	Delta CO_2 (MT)
385 kW PV + 594 kWh BESS	2.29	0.50	40%	33,096	17,821	67,459	180,792	181

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

Arctic Village is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Yukon Flats communities like Anvik to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Arctic Village Council (AVC) is the governing body for Arctic Village, a federally recognized tribe. The AVC has the authority to implement GHG reduction measures through resolutions passed in AVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, AVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Arctic Village to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should apply for funding for a 4MW solar array project along with 4MWh BESS.
2. **Residential Weatherization.** The community has successfully weatherized some community buildings, but weatherization of additional buildings and residences with modern features would reduce heat escape and lower electric bills and CO_2 emissions further.
3. **Biomass Project(s):** Wod fired boilers should be considered for heating more buildings and infrastructure in Arctic Village.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Arctic Village is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community should examine the condition of the current power grid system, including transmission lines and switch gear, which likely requires upgrades.

5 References

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Arctic Village (FY2022)

Arctic Village PCE

Utility: ARCTIC VILLAGE COUNCIL
Reporting Period: 07/01/21 to 06/30/22

Community Population	189
Last Reported Month	May
No. of Monthly Payments Made	7
Residential Customers	84
Community Facility Customers	6
Other Customers (Non-PCE)	19
Fiscal Year PCE Payments	**$139,944**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	143,258	Average Annual PCE Payment per Eligible Customer	$1,555
PCE Eligible kWh - Community Facility Customers	64,418	Average PCE Payment per Eligible kWh	$0.67
Total PCE Eligible kWh	207,676	Last Reported Residential Rate Charged (based on 500 kWh)	$1.00
Average Monthly PCE Eligible kWh per Residential Customer	244	Last Reported PCE Level (per kWh)	$0.74
Average Monthly PCE Eligible kWh per Community Facility Customer	1,534	Effective Residential Rate (per kWh)	$0.26
Average Monthly PCE Eligible Community Facility kWh per Person	49	PCE Eligible kWh vs Total kWh Sold	48.6%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	154,287	Fuel Used (Gallons)	45,618
Non-Diesel kWh Generated	0	Fuel Cost	$318,738
Purchased kWh	0	Average Price of Fuel	$6.99
Total Purchased & Generated	154,287	Fuel Cost per kWh sold	$0.75
		Annual Non-Fuel Expenses	$16,500
		Non-Fuel Expense per kWh Sold	$0.04
		Total Expense per kWh Sold	$0.78

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	213,990	Consumed vs Generated (kWh Sold vs Generated-Purchased)	See Comments
Community Facility kWh Sold	64,593	Line Loss (%)	See Comments
Other kWh Sold (Non-PCE)	148,510	Fuel Efficiency (kWh per Gallon of Diesel)	3.38
Total kWh Sold	427,093	PH Consumption as % of Generation	0.0%
Powerhouse (PH) Consumption kWh	0		
Total kWh Sold & PH Consumption	427,093		

Comments

Only 7 reports filed; Reported diesel kWh=2 mo; fuel used & non fuel=4 mo

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Priority Climate Action Plan

Beaver Village

Beaver, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
BVC	Beaver Village Council
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Beaver, a rural and predominantly Alaska Native community of approximately 56 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Beaver. GHG production levels and energy costs for Beaver were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Beaver in 2022 (AEA 2023). Beaver's 35 residential customers, 3 community facility customers, and 12 other customers required 194,272 kWh in diesel-generated power. A total of 23,045 gallons of fuel were consumed by Beaver customers in 2022 at a cost of $87,315 ($3.79 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Beaver accounted for approximately 515,747 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Beaver in 2022 was $0.27. The annual non-fuel expenses associated with power generation totaled $105,616 in FY22, resulting in an additional cost of $0.32 per kWh sold. Thus, the combined fuel and non-fuel expenses in Beaver were $0.59 per kWh sold in FY22. The last reported electric rate paid by customers was $0.90 per kWh. Beaver's electric rate is more than 5.5 times the national average of $0.16 per kWh. Beaver was PCE eligible for 43.8% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Beaver in the amount of $71,884 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,892 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Beaver. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Beaver:

- Residential Sector
  - Wood and Residuals = 16.04 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 86.30 MT CO_2e
  - Propane = 6.59 MT CO_2e

- Wood and Wood Residuals = 0.24 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Beaver was modeled. The analysis indicated that approximately 175.02 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (49.40 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Beaver, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 289 kw solar PV and a 425 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a PV + battery energy storage system (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Beaver are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

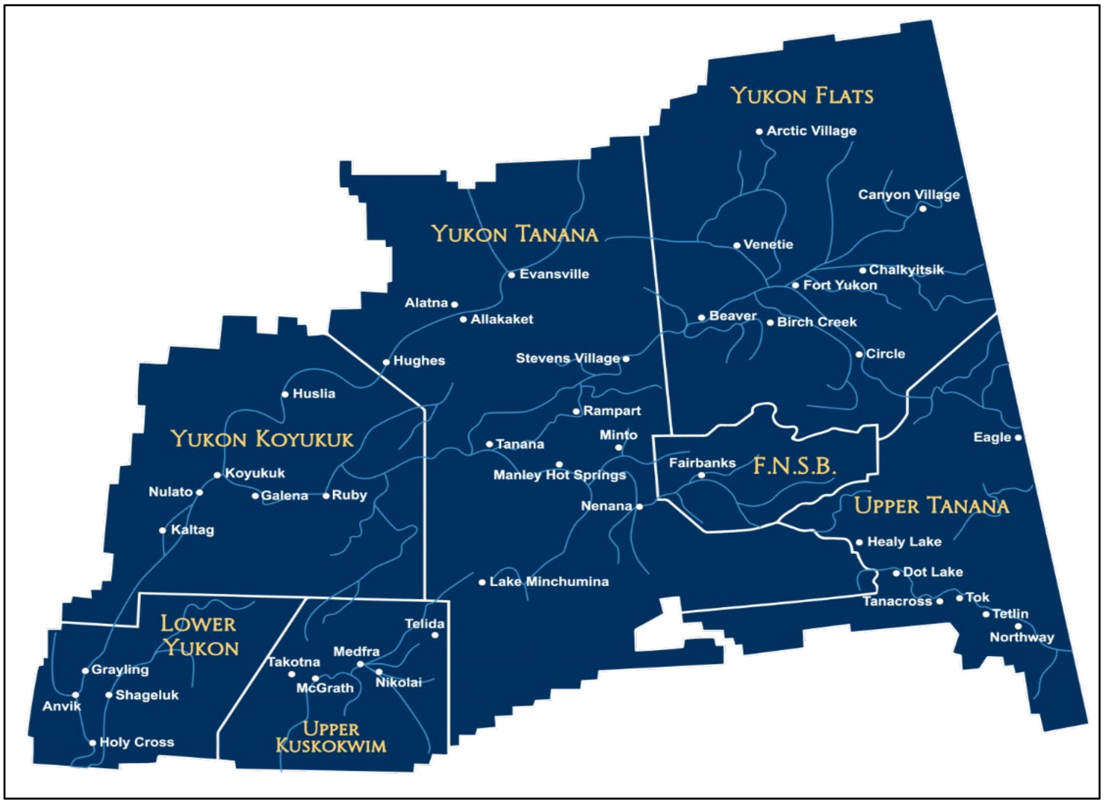
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

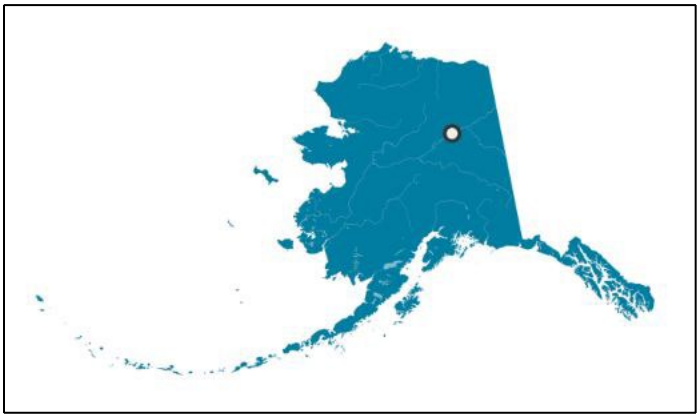
1.4 Scope of this PCAP: The Community of Beaver

Beaver is a traditional Yukon Flats Tanana Athabascan village that is home to approximately 56 residents. Beaver is located on the north bank of the Yukon River, approximately 60 air miles southwest of Fort Yukon and 110 miles north of Fairbanks. It lies in the Yukon Flats National Wildlife Refuge.

Beaver has a continental subarctic climate characterized by seasonal extreme temperatures. The average high temperature during July ranges from 65 to 72 °F. The average low temperature during January is well below zero. Extended periods of -50 to -60 °F are common. Extreme temperatures ranging from a low of -70 to a high of 90 °F have been measured. Precipitation averages 6.5 inches. The average annual snowfall is 43.4 inches. The Yukon River is ice-free from mid-June to mid-October.

The U.S. EPA indicates that Beaver's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Beaver as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 92% of Beaver's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Beaver, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Beaver. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies northwest of Beaver Village and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Beaver's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar PV systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive

(AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Beaver's airport is a state-owned, public-use airport. The airport covers an area of 446 acres and has one runway with a gravel surface. Additionally, there are several other areas around the village that may be suitable.

It is unknown whether Beaver has applied for or is interested in pursuing funding to implement solar PV + BESS infrastructure in the community.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Beaver is estimated to be 6.5 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 56 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Due to the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Beaver because of the number of moving parts that must continue operating at very cold temperatures. Should Beaver pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues,

[3] Beaver Wind Forecast, AK 99558 - WillyWeather

as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

In 2014 Energy Action, with support from AEA, prepared a biomass heat pre-feasibility study for the village of Beaver. The study found that using a biomass heating system to heat the Washateria/Water Plant and Victor Weihl Tribal Building would be feasible. A variety of capital improvements, including a structural audit and energy efficiency upgrades were completed for the facilities. It was recommended that Beaver Village proceed with additional feasibility analysis, site control, and/or engineering. An additional recommendation was made through this process that Beaver Village Council start the process of biomass fuel sourcing through Beaver Kwit' Chin Corporation.

Cordwood systems are not very effective when serving building heat systems that operate in a narrow temperature range. At the time of the study, the Washateria operated in the desired range, and the biomass boiler operational and maintenance requirements were modeled to maintain the existing temperature set points. It was believed that the operations and economics of the project could be improved if the system operated in a broader temperature

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

range.[5] It is unknown if this project was ever sanctioned or executed; currently there are no reports of an existing biomass heating system in Beaver.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

Beaver Village's transmission lines are likely due for upgrading, along with any transformers and other hardware required to maintain the power grid. Should Beaver explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

Beaver Village received a grant from the Bipartisan Infrastructure Law provision 40101(d) – Department of Energy Electric Grid Resiliency to improve the resilience of their electric grids. Administered by the National Energy Technology Laboratory and falling under BIL provision 40101(d), the program is designed to strengthen and modernize America's power grid against wildfires, extreme weather, and other natural disasters that are exacerbated by the climate crisis.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating

[5] Beaver2014.pdf (akenergyauthority.org)

renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Beaver has a state owned, public-use airport. The airport covers an area of 446 acres and has one runway with a gravel surface. There are no plans to incorporate electrification into its airport; however, solar PVs + BESS at the airport could be tied into the grid.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.

- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Beaver does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

While Beaver is located on the north bank of the Yukon River, there are no known plans to pursue a hydrokinetic project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. There are no known plans for Beaver to pursues a heat recovery project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Weatherization of housing and building components in Beaver would reduce heat loss and improve energy efficiency. It is not known whether Beaver has taken significant steps to improve weatherization of community buildings or residences.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Beaver Village in late 2023 to inform its PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Beaver (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Beaver indicated that diesel was the primary energy source of power and GHG emissions in Beaver in 2022 (AEA 2023). Beaver's 35 residential customers, 3 community facility customers, and 12 other customers required 194,272 kWh in diesel-generated power. Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Beaver accounted for approximately 4,347,807 lbs. of CO_2 produced in FY2022.

A total of 23,045 gallons of fuel were consumed by Beaver customers in 2022 at a cost of $87,315 ($3.79 per gallon). The average fuel cost per kWh in Beaver in 2022 was $0.27. The annual non-fuel expenses associated with power generation totaled $105,616 in FY22, resulting in an additional cost of $0.32 per kWh sold. Thus, the combined fuel and non-fuel expenses in Beaver were $0.59 per kWh sold in FY22. Beaver's electric rate is 3.5 times the national average of $0.16 per kWh. Beaver was PCE eligible for 43.8% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Beaver in the amount of $71,884 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,892 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Beaver Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
56	35	3	12

Source: AEA 2023

Table 2. Beaver Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh / gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[6] (lbs)
194,272	0	No data	8.43	334,241	23,045	1,029

Sources: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Beaver (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects

[6] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

the average emissions intensity of grids on which energy consumption occurs. The other method, termed “market-based” accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings’ heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations’ buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Beaver. The contribution of GHGs by fuel type to each sector’s overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Beaver:

- Residential Sector
  - Wood and Residuals = 16.04 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 86.30 MT CO_2e
  - Propane = 6.59 MT CO_2e
  - Wood and Wood Residuals = 0.24 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Beaver was modeled. The analysis indicated that approximately 175.02 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (49.40 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Beaver may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider pursuing grant funding for a solar PV array + BESS to reduce diesel consumption and GHG emissions.
2. **Biomass Heating System:** If never constructed, it is recommended that the community pursue funding for the wood biomass system that was designed and studied for the community of Beaver Village, as this would reduce dependency on diesel fuel and provide an alternate heat system that could reduce overall GHGs.
3. **Additional Weatherization.** It is recommended that the community make advances to weatherize several residences and community buildings to reduce heat escape, heating oil costs, and GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 289 kW PV Renewable Solar + 425 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Mill. $)	Utility Improvements (Mill. $)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
289 kW PV; 425 kWh BESS	1.68	1.00	50%	16,371	13,395	50,704	135,888	136

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

Beaver is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Yukon Flats communities like Beaver to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Beaver Village Council (BVC) is the governing body for Beaver Village, a federally recognized tribe. The BVC has the authority to implement GHG reduction measures through resolutions passed in BVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, BVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Beaver to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider pursuing grant funding for a solar PV array + BESS to reduce diesel consumption and GHG emissions.
2. **Biomass Heating System:** If never constructed, it is recommended that the community pursue funding for the wood biomass system that was designed and studied for the community of Beaver Village, as this would reduce dependency on diesel fuel and provide an alternate heat system that could reduce overall GHGs.
3. **Additional Weatherization.** It is recommended that the community make advances to weatherize several residences and community buildings to reduce heat escape, heating bills, and GHG emissions.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Beaver is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community will examine the condition of its current power grid under recent Department of Energy Electric Grid Resiliency funding; it has likely not been updated or upgraded since the lines were initially installed.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Beaver (FY2022)

Beaver PCE

Utility: BEAVER JOINT UTILITIES
Reporting Period: 07/01/21 to 06/30/22

Community Population	56
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	35
Community Facility Customers	3
Other Customers (Non-PCE)	12
Fiscal Year PCE Payments	**$71,884**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	98,190	Average Annual PCE Payment per Eligible Customer	$1,892
PCE Eligible kWh - Community Facility Customers	46,090	Average PCE Payment per Eligible kWh	$0.50
Total PCE Eligible kWh	144,280	Last Reported Residential Rate Charged (based on 500 kWh)	$0.90
Average Monthly PCE Eligible kWh per Residential Customer	234	Last Reported PCE Level (per kWh)	$0.63
Average Monthly PCE Eligible kWh per Community Facility Customer	1,280	Effective Residential Rate (per kWh)	$0.27
Average Monthly PCE Eligible Community Facility kWh per Person	69	PCE Eligible kWh vs Total kWh Sold	43.8%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	194,272	Fuel Used (Gallons)	23,045
Non-Diesel kWh Generated	0	Fuel Cost	$87,315
Purchased kWh	0	Average Price of Fuel	$3.79
Total Purchased & Generated	194,272	Fuel Cost per kWh sold	$0.27
		Annual Non-Fuel Expenses	$105,616
		Non-Fuel Expense per kWh Sold	$0.32
		Total Expense per kWh Sold	$0.59

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	109,099	Consumed vs Generated (kWh Sold vs Generated-Purchased)	See Comments
Community Facility kWh Sold	72,218	Line Loss (%)	See Comments
Other kWh Sold (Non-PCE)	147,911	Fuel Efficiency (kWh per Gallon of Diesel)	8.43
Total kWh Sold	329,228	PH Consumption as % of Generation	2.6%
Powerhouse (PH) Consumption kWh	5,013		
Total kWh Sold & PH Consumption	334,241		

Comments

Reported kWh generated=5 months, fuel gallons used & fuel cost = 7 months.

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Priority Climate Action Plan

Village of Birch Creek

Birch Creek, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
BCTC	Birch Creek Tribal Council
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Tons
MPH	Miles Per Hour
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Birch Creek, a rural and predominantly Alaska Native community of approximately 22 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Birch Creek. GHG production levels and energy costs for Birch Creek were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Birch Creek in 2022 (AEA 2023). Birch Creek's 23 residential customers, 3 community facility customers, and 5 other customers required 99,312 kWh in diesel-generated power. A total of 14,644 gallons of fuel were consumed by Birch Creek customers in 2022 at a cost of $57,782 ($3.95 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Birch Creek accounted for approximately 327,733 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Birch Creek in 2022 was $0.60. The annual non-fuel expenses associated with power generation totaled $149,910 in FY22, resulting in an additional cost of $0.16 per kWh sold. Thus, the combined fuel and non-fuel expenses in Birch Creek were $0.76 per kWh sold in FY22. Birch Creek's electric rate is nearly 4.75 times the national average of $0.16 per kWh. Birch Creek was PCE eligible for 53.2% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Birch Creek in the amount of $38,578 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,484 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Birch Creek. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Birch Creek:

- Residential Sector
  - Wood and Residuals = 1.43 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 2.78 MT CO_2e
  - Propane = 0.21 MT CO_2e

- Wood and Wood Residuals = 0.01 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Birch Creek was modeled. The analysis indicated that approximately 57.09 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (16.44 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Birch Creek, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 83 kw solar PV and a 146 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Birch Creek are:

- Solar PV + BESS array (may reduce fuel consumption and CO_2 production by up to 20%);
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

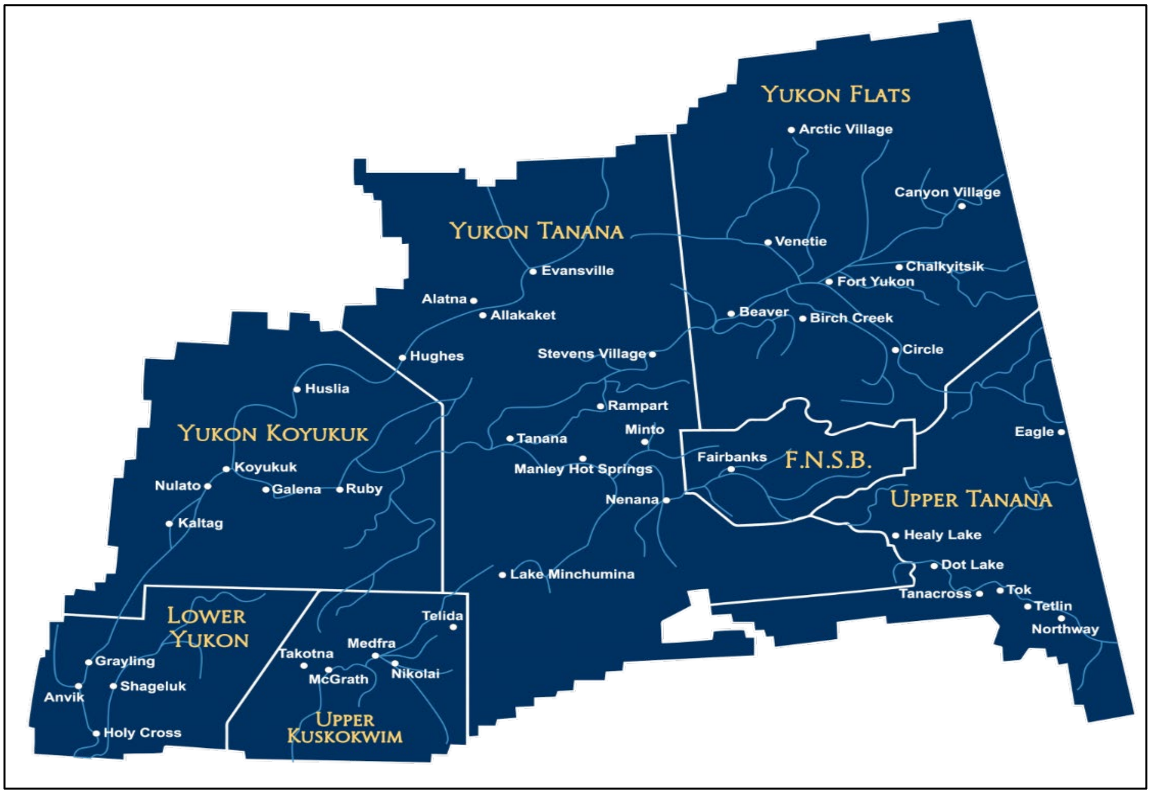
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution.

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
    - Dave Messier – Infrastructure Director
    - Jason Paskvan – Project Manager and Community Liaison
    - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

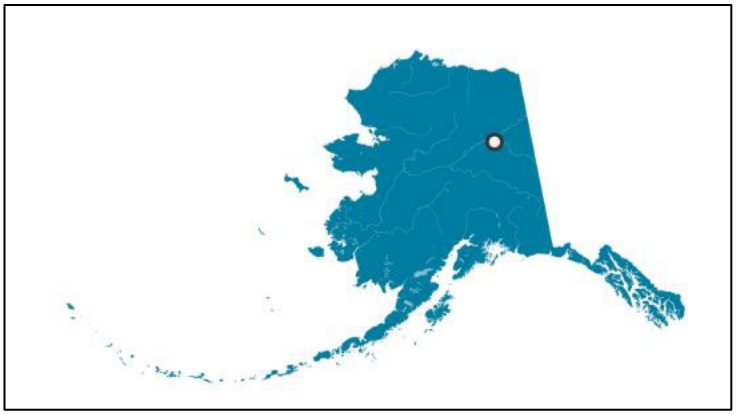
1.4 Scope of this PCAP: The Community of Birch Creek

Birch Creek is a traditional Yukon Flats Athabascan village that is home to approximately 22 residents. Birch Creek is located along Birch Creek, approximately 26 miles southwest of Fort Yukon. Birch Creek's power is supplied by the Birch Creek Electric Company (PCE).

Birch Creek has a continental subarctic climate, characterized by seasonal extremes of temperature. Winters are long and harsh, and summers are warm and short. The average high temperature during July ranges from 65 to 72 °F. The average low temperature during January is well below zero. Extended periods of -50 to -60 °F are common. Extreme temperatures have been measured, ranging from a low of -71 to a high of 97 °F. Annual precipitation averages 6.5 inches, and snowfall averages 43.4 inches per year. Birch Creek is ice-free from mid-June to mid-October.

The U.S. EPA indicates that Birch Creek's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Birch Creek as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Birch Creek's Tribal residents are likely all low or middle income; however, the U.S. Department of Housing and Urban Development (HUD) has no data for this community[2].

Figure 2. Location of Birch Creek, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Birch Creek. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies northwest of Birch Creek and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Birch Creek’s case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar PV systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive

(AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. There are a number of areas around the village that may be suitable.

Birch Creek's power is generated at the Birch Creek Electric Company facility. Upgrades to the power grid would need to be made in order to incorporate solar power in Birch Creek.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more

difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed Birch Creek is estimated to be 7.5 mph[3] which is a Class 1 wind resource, approaching Class 2. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 22 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Birch Creek and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Birch Creek because of the number of moving parts that must continue operating at very cold temperatures. Should Birch Creek decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable

[3] Anvik Wind Forecast, AK 99558 - WillyWeather

example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

Birch Creek received a grant from the Bipartisan Infrastructure Law provision 40101(d) – Department of Energy Electric Grid Resiliency to improve the resilience of their electric grids. Administered by the National Energy Technology Laboratory and falling under BIL provision 40101(d), the program is designed to strengthen and modernize America's power grid against

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

wildfires, extreme weather, and other natural disasters that are exacerbated by the climate crisis.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Birch Creek Airport is a state-owned, public-use airport located one nautical mile (1.85 km) north-northwest of the central business district of Birch Creek. There are no known plans to incorporate electrification into the Birch Creek airport; however, the airport may be able tie into a solar array if one was installed for village use.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.

- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Birch Creek does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Birch Creek is a clear-water tributary of the Yukon River in the interior of Alaska; however, they currently do not have plans to pursue a hydropower project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In Birch Creek, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

In 2013 Interior Regional Housing Authority weatherized most of the homes in Birch Creek. It is unknown whether Birch Creek has undergone significant weatherization since this time. Weatherization of housing and building components in Birch Creek would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

The Village of Birch completed a community survey that was issued to the Tribe by Tanana Chiefs Conference in late 2023. This survey provided the Tribe with an opportunity to comment on their energy priorities and challenges, weatherization and electrical needs, and interest in renewable energy systems.

The survey completed by the community of Birch Creek indicated they currently have an energy/economic development plan but would like help updating it. Their three top energy priorities are to improve reliability of power generation (i.e. reduce power outages), larger water capacity, and better communication options.

Birch Creek indicated that it does not have a heat recovery system and does not have any renewable energy projects in their future. The community is interested in the following types of projects for the future:

- Community-scale solar PV systems
- The possibility of thermal energy

Birch Creek's population and geographic size should allow for the community to provide a high percentage of renewable energy combined with solar, wind, etc. In 2013 Interior Regional

Housing Authority weatherized most of the homes in Birch Creek. They are interested in upgrading the insulation, LED light fixtures, and fans to move warm and cold air around.

Birch Creek is interested in having an energy audit. They would also be interested in weatherization retrofits for their community buildings. Twenty percent of their community buildings do not have basic utilities, including power, water, and sewer.

Birch Creek is interested in applying for EPA CPRGs. Their highest priority is applying for energy efficient upgrades along with solar power + BESS to power the community and relieve the reliance on higher cost power. Their highest priority energy projects from their community plan are power, water, communication, education, equipment, and housing.

Birch Creek is interested in getting an electric assessment to confirm their community's needs. They need help with replacing/repairing some of the electric poles, power lines, and transformers. Birch Creek recently reconstructed their generator engines but would like to investigate exhaust heat from the generator to heat the tribal building.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Birch Creek (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Birch Creek indicated that diesel was the primary energy source of power and GHG emissions in Birch Creek in 2022 (AEA 2023). Birch Creek's 23 residential customers, 3 community facility customers, and 5 other customers required 99,312 kWh in diesel-generated power. A total of 14,644 gallons of fuel were consumed by Birch Creek customers in 2022 at a cost of $57,782 ($3.95 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Birch Creek accounted for approximately 327,733 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Birch Creek in 2022 was $0.60. The annual non-fuel expenses associated with power generation totaled $149,910 in FY22, resulting in an additional cost of

$0.16 per kWh sold. Thus, the combined fuel and non-fuel expenses in Birch Creek were $0.76 per kWh sold in FY22. Birch Creek's electric rate is nearly 4.75 times the national average of $0.16 per kWh. Birch Creek was PCE eligible for 53.2% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Birch Creek in the amount of $38,578 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,484 (AEA 2023).

PCE data are summarized in Tables 1 and 2, below.

Table 1. Birch Creek Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
22	23	3	5

Source: AEA 2023

Table 2. Birch Creek Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[5] (lbs)
99,312	0	96.2%	6.78	98,106	14,644	654

Sources: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Birch Creek (Constellation Energy 2024). The inventory tool was

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Birch Creek. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Birch Creek:

- Residential Sector
  - Wood and Residuals = 1.43 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 2.78 MT CO_2e
  - Propane = 0.21 MT CO_2e
  - Wood and Wood Residuals = 0.01 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Birch Creek was modeled. The analysis indicated that approximately 57.09 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (16.44 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Birch Creek may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that Birch Creek pursue a solar array with a BESS to reduce diesel consumption and GHG emissions.
2. **Additional Weatherization.** The community has successfully weatherized several community buildings, but weatherization of additional buildings and residences with

modern features would reduce heat escape and lower heating fuel bills and CO_2 emissions further.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 83 kWh PV Renewable Solar + 146 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
83 kWh PV; 146 kWh BESS	0.5965	.50	50%	8,054	6,590	24,945	66,853	67

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHGs.

Birch Creek is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Yukon Flats communities like Birch Creek to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Birch Creek Tribal Council (BCTC) is the governing body for Birch Creek Village, a federally recognized tribe. The BCTC has the authority to implement GHG reduction measures through resolutions passed in BCTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, BCTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Birch Creek to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that Birch Creek pursue a solar array with a BESS to reduce diesel consumption and GHG emissions.
2. **Additional Weatherization.** The community has successfully weatherized several community buildings, but weatherization of additional buildings and residences with modern features would reduce heat escape and lower electric bills and CO_2 emissions further.
3. **Biomass Project(s):** Birch Creek should consider applying for funds for a biomass project (e.g. wood chip boiler) as this has been a successful means of energy efficient heating for other communities in the Yukon-Tanana region.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Birch Creek is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed.

5 References

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UL Solutions. 2024. HOMER Pro Microgrid Software. Available online at: HOMER Pro - Microgrid Software for Designing Optimized Hybrid Microgrids (homerenergy.com).

Appendix A

Alaska Energy Authority’s Power Cost Equalization Program
Statistical Report for Birch Creek (FY2022)

Birch Creek PCE

Utility: BIRCH CREEK ELECTRIC COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	22
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	23
Community Facility Customers	3
Other Customers (Non-PCE)	5
Fiscal Year PCE Payments	**$38,578**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	35,299	Average Annual PCE Payment per Eligible Customer	$1,484
PCE Eligible kWh - Community Facility Customers	15,481	Average PCE Payment per Eligible kWh	$0.76
Total PCE Eligible kWh	50,780	Last Reported Residential Rate Charged (based on 500 kWh)	$1.15
Average Monthly PCE Eligible kWh per Residential Customer	128	Last Reported PCE Level (per kWh)	$0.76
Average Monthly PCE Eligible kWh per Community Facility Customer	430	Effective Residential Rate (per kWh)	$0.39
Average Monthly PCE Eligible Community Facility kWh per Person	59	PCE Eligible kWh vs Total kWh Sold	53.2%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	99,312	Fuel Used (Gallons)	14,644
Non-Diesel kWh Generated	0	Fuel Cost	$57,782
Purchased kWh	0	Average Price of Fuel	$3.95
Total Purchased & Generated	99,312	Fuel Cost per kWh sold	$0.60
		Annual Non-Fuel Expenses	$14,910
		Non-Fuel Expense per kWh Sold	$0.16
		Total Expense per kWh Sold	$0.76

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	45,015	Consumed vs Generated (kWh Sold vs Generated-Purchased)	96.2%
Community Facility kWh Sold	22,490	Line Loss (%)	1.2%
Other kWh Sold (Non-PCE)	28,019	Fuel Efficiency (kWh per Gallon of Diesel)	6.78
Total kWh Sold	95,524	PH Consumption as % of Generation	2.6%
Powerhouse (PH) Consumption kWh	2,582		
Total kWh Sold & PH Consumption	98,106		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Chalkyitsik Village

Chalkyitsik, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CVC	Chalkyitsik Village Council
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	CO_2 equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour

LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Chalkyitsik, a rural and predominantly Alaska Native community in Interior Alaska. Chalkyitsik lies on the Black River about 50 miles east of Fort Yukon. The Chalkyitsik Village has a population of approximately 79 residents. This PCAP identifies sources of greenhouse gas (GHG) emissions in the community of Chalkyitsik and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Chalkyitsik. GHG production levels and energy costs for Chalkyitsik were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Chalkyitsik in 2022 (AEA 2023). Chalkyitsik 's 45 residential customers, 11 community facility customers, and 12 other customers required 191,670 kWh in diesel-generated power. A total of 11,736 gallons of fuel were consumed by Chalkyitsik customers in 2022 at a cost of $54,310 ($4.63 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Chalkyitsik accounted for approximately 262,652 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Chalkyitsik in 2022 was $0.36. The annual non-fuel expenses associated with power generation totaled $26,057 in FY22, resulting in an additional cost of $0.17 per kWh sold. Thus, the combined fuel and non-fuel expenses in Chalkyitsik were $0.53 per kWh sold in FY22. The last reported electric rate paid by customers was $0.95 per kWh. Chalkyitsik's electric rate is nearly 6 times the national average of $0.16 per kWh. Chalkyitsik was PCE eligible for 52% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Chalkyitsik in the amount of $42,008 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $750 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Chalkyitsik. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Chalkyitsik:

- Residential Sector
    - Residual Fuel Oil No. 5 = 118.79 MT CO_2e
    - Wood and Residuals = 10.69 MT CO_2e

- Commercial Sector
  - Distillate Fuel Oil No. 1 = 102.07 MT CO_2e
  - Propane = 7.79 MT CO_2e
  - Wood and Wood Residuals = 0.28 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Chalkyitsik was also modeled. The analysis indicated that approximately 379.13 MWh electricity is used in this capacity in Chalkyitsik, resulting in emissions all stemming from diesel in the amount of 109.19 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Chalkyitsik, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 250 kw solar PV and a 375 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software (UL Solutions 2024) for a representative Interior Alaska community, it was projected that a solar PV + battery array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs. Following a review of this information preferred options for cleaner, lower cost energy in Chalkyitsik are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal / city buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

11 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

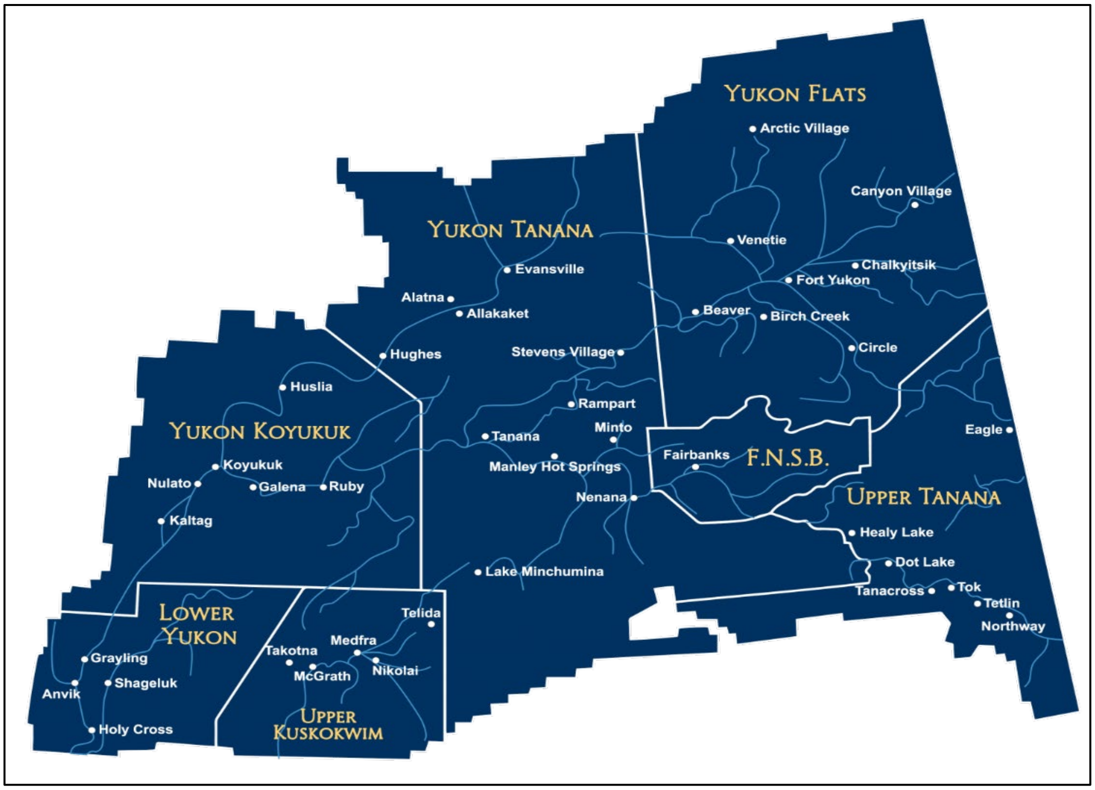
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

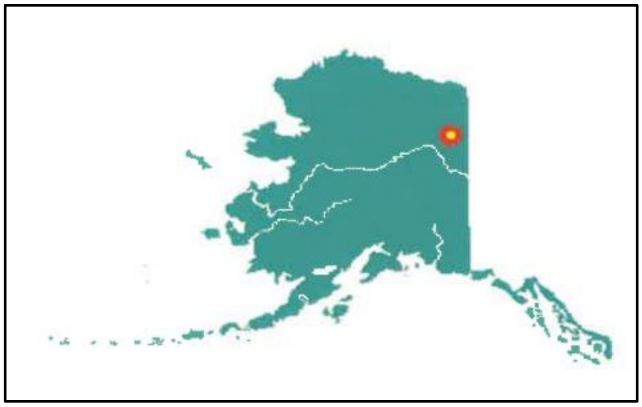
1.4 Scope of this PCAP: The Community of Chalkyitsik

Chalkyitsik is a traditional Yukon Flats Athabascan village that is home to approximately 79 residents. Chalkyitsik is located on the Black River about 50 miles east of Fort Yukon. Chalkyitsik Village Council operates Chalkyitsik Energy Systems which provides electricity to all local houses.

Chalkyitsik has a continental arctic climate, characterized by seasonal extremes of temperature. Winters are long and harsh, and summers warm and short. The average high temperature during July ranges from 65 to 72 °F. The average low temperature during January is well below zero. Extended periods of -50 to -60 °F are common. Extreme temperatures, ranging from a low of -71 to a high of 97 °F, have been measured. Annual precipitation averages 6.5 inches, and annual snowfall averages 43.4 inches. The Black River is ice-free from mid-June to mid-October.

The U.S. EPA indicates that Chalkyitsik's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Chalkyitsik as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 92% of Chalkyitsik's tribal area residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Chalkyitsik, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar

[2] https://www.huduser.gov/portal/icdbg2022/home.html

panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Chalkyitsik. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and

utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies south and west of Chalkyitsik and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat. If they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Chalkyitsik’s case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community’s dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. There are a number of areas around the village that may be suitable.

As noted above, Chalkyitsik Village Council operates Chalkyitsik Energy Systems which provides electricity to all local houses. Upgrades to the power grid would need to be made in order to incorporate solar power in Chalkyitsik.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over

solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed Chalkyitsik is estimated to be 6.2 mph which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a small community, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter. The high initial capital cost can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Chalkyitsik and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Chalkyitsik because of the number of moving parts that must continue operating at very cold temperatures. Should Chalkyitsik decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [3]

In July of 2008 the Department of Energy conducted a Level 2 Feasibility study to determine maximum displacement of fuel oil for heat in commercial buildings. Chalkyitsik is surrounded by forest composed of aspen, black and white spruce, balsam poplar, white spruce and many species of willow. Multiple forest fires have burned in the region over the past 50 years. Fire is a threat to most of the villages and thinning is needed as a fuel mitigation strategy in and around the village. Harvest strategies are being developed to work in both summer and winter conditions. During summer, harvest equipment must be sized so it can be moved across the open water of rivers and harvests must be planned to stay on dry ground. During winter, harvest equipment must work in sub-zero weather, snow up to 3 feet and move across frozen wetlands and rivers. Most of the biomass would be hauled in winter. Concern exists by some whether chips systems are too complicated to be successful in the rural off-road conditions. The annual requirements for heat in Chalkyitsik at the time of the study were 618 tons per year. Ecological sustainability does not seem to be an issues for Chalkyitsik.

Two different building complexes were evaluated, the schools, school housing, and water treatment plant as one complex and the second was the community center/washeteria and tribal office as the second. The evaluation compared each as a system and as individual buildings. Each scenario works best as two systems rather than as individual buildings. Payback on the school complex is 5.2 years with 3 stick fired boilers with 4 burns per day on coldest days

[3] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

and 4.8 years with a single chip fired system. These would burn either 285 cords of round wood or 398 green tons of chips. The village center system pays back in 3.2 years with 2 stick-fired boilers and 6.3 years for a small chip fired system. These would use either 157 cords 6 of round wood or 220 green tons of chips. Chip systems are more complex and at this scale a decision must be made locally based on local capacity as to which system would work best.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Chalkyitsik, the transmission lines and switch gear are likely due for upgrade, along with any transformers and other hardware required to maintain the power grid. Grid component upgrades may be needed to accommodate new projects, including alternative means of electrical generation.

Chalkyitsik received a grant from the Bipartisan Infrastructure Law provision 40101(d) – Department of Energy Electric Grid Resiliency to improve the resilience of their electric grids. Administered by the National Energy Technology Laboratory and falling under provision 40101(d), the program is designed to strengthen and modernize America's power grid against wildfires, extreme weather, and other natural disasters that are exacerbated by the climate crisis.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Chalkyitsik's airport is a state-owned public-use airport. There are no plans to incorporate electrification into the Chalkyitsik port or airport. However, the airport could tie into a solar array if one was installed for village use.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.

- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Chalkyitsik does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Chalkyitsik is located on the Black River about 50 miles east of Fort Yukon. However, they currently do not have plans to pursue a hydropower project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

It is unknown whether Chalkyitsik has undergone significant weatherization since initial construction of residential and other buildings. In Chalkyitsik, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of residential housing and tribal or city building components in Chalkyitsik would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis

- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Chalkyitsik Village in late 2023 to inform its PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Chalkyitsik (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Chalkyitsik indicated that diesel was the primary energy source of power and GHG emissions in Chalkyitsik in 2022 (AEA 2023). Chalkyitsik's 45 residential customers, 11 community facility customers, and 12 other customers required 191,670 kWh in diesel-generated power. Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Chalkyitsik accounted for approximately 262,652 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Chalkyitsik in 2022 was $0.36. The annual non-fuel expenses associated with power generation totaled $26,057 in FY22, resulting in an additional cost of $0.17 per kWh sold. Thus, the combined fuel and non-fuel expenses in Chalkyitsik were $0.53 per kWh sold in FY22. The last reported electric rate paid by customers was $.95 per kWh. Chalkyitsik's electric rate is nearly 6 times the national average of $0.16 per kWh. Chalkyitsik was PCE eligible for 52% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Chalkyitsik in the amount of $42,008 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $750 (AEA 2023). PCE data for both communities are summarized in Tables 1 and 2, below.

Table 1. Chalkyitsik Combined Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
79	45	11	12

Source: AEA 2023

Table 2. Chalkyitsik Combined Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ Gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
No data	No data	No data	No data	No data	No data	No data

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Chalkyitsik (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to Scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Chalkyitsik. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Chalkyitsik:

- Residential Sector
    - Residual Fuel Oil No. 5 = 118.79 MT CO_2e
    - Wood and Residuals = 10.69 MT CO_2e

- Commercial Sector
    - Distillate Fuel Oil No. 1 = 102.07 MT CO_2e
    - Propane = 7.79 MT CO_2e
    - Wood and Wood Residuals = 0.28 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Chalkyitsik was also modeled. The analysis indicated that approximately 379.13 MWh electricity is used in this capacity in Chalkyitsik, resulting in emissions all stemming from diesel in the amount of 109.19 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Chalkyitsik may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider pursuing grant funding for a solar PV array + BESS to reduce diesel consumption and GHG emissions.
2. **Biomass Heating System:** If never constructed, it is recommended that the community pursue funding for the wood biomass system that was designed and studied for the community of Chalkyitsik, as this would reduce the amount of heating oil used and would reduce overall GHGs.

3. **Additional Weatherization.** It is recommended that the community make advances to weatherize several residences and community buildings to reduce heat escape, heating bills, and GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power for Chalkyitsik. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 250 kWh PV Renewable Solar + 375 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Mill. $)	Utility Improvements (Mill. $)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
250 kWh PV; 375 kWh BESS	1.48	1.00	50%	14,913	12,201	46,188	123,785	123

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community of Chalkyitsik, coupled with reduced greenhouse gas emissions.

Chalkyitsik is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Upper Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC and AP&T's chief concerns around Yukon Flats Tanana region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Chalkyitsik Village Council (CVC) is the governing body for Chalkyitsik Village, a federally recognized tribe. The CVC has the authority to implement GHG reduction measures through resolutions passed in CVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, CVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Funding Mechanisms

TCC recommends the following projects should be pursued by Chalkyitsik to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider pursuing grant funding for a solar PV array + BESS to reduce diesel consumption and GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community make advances to weatherize several residences and community buildings to reduce heat escape, heating bills, and GHG emissions.
3. **Biomass Project(s):** If never constructed, it is recommended that the community pursue funding for the wood biomass system that was designed and studied for the community of Chalkyitsik, as this would reduce the amount of heating oil used and would reduce overall GHGs.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Chalkyitsik is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** A backup diesel generator is desperately needed for the community; this would not reduce GHGs but would benefit community resilience to outages. The

community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Chalkyitsik (FY2022)

Chalkyitsik PCE

Utility: CHALKYITSIK VILLAGE COUNCIL

Reporting Period: 07/01/20..06/30/21

Community Population	79
Last Reported Month	February
No. of Monthly Payments Made	8
Residential Customers	45
Community Facility Customers	11
Other Customers (Non-PCE)	12
Fiscal Year PCE Payments	**$42,008**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	43,660	Average Annual PCE Payment per Eligible Customer	$750
PCE Eligible kWh - Community Facility Customers	35,187	Average PCE Payment per Eligible kWh	$0.53
Total PCE Eligible kWh	*78,847*	Last Reported Residential Rate Charged (based on 500 kWh)	$0.95
Average Monthly PCE Eligible kWh per Residential Customer	121	Last Reported PCE Level (per kWh)	$0.50
Average Monthly PCE Eligible kWh per Community Facility Customer	400	Effective Residential Rate (per kWh)	$0.45
Average Monthly PCE Eligible Community Facility kWh per Person	56	PCE Eligible kWh vs Total kWh Sold	52.0%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	191,670	Fuel Used (Gallons)	11,736
Non-Diesel kWh Generated	0	Fuel Cost	$54,310
Purchased kWh	0	Average Price of Fuel	$4.63
Total Purchased & Generated	*191,670*	Fuel Cost per kWh sold	$0.36
		Annual Non-Fuel Expenses	$26,057
		Non-Fuel Expense per kWh Sold	$0.17
		Total Expense per kWh Sold	$0.53

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	46,178	Consumed vs Generated (kWh Sold vs Generated-Purchased)	79.1%
Community Facility kWh Sold	37,795	Line Loss (%)	11.4%
Other kWh Sold (Non-PCE)	67,602	Fuel Efficiency (kWh per Gallon of Diesel)	16.33
Total kWh Sold	*151,575*	PH Consumption as % of Generation	9.5%
Powerhouse (PH) Consumption kWh	18,245		
Total kWh Sold & PH Consumption	*169,820*		

Comments

Reported Data = 8 Months. Fuel Used; Fuel $ = 5 Months. Non-Fuel $ = 6 Months

**The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.*

Tanana Chiefs Conference

Priority Climate Action Plan

Circle Village

Circle, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CVC	Circle Village Council
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Circle, a rural and predominantly Alaska Native community of approximately 56 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Circle. GHG production levels and energy costs for Circle were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Circle in 2022 (AEA 2023). Circle's 46 residential customers, 7 community facility customers, and 9 other customers required 423,092 kWh in diesel-generated power. A total of 35,023 gallons of fuel were consumed by Circle customers in 2022 at a cost of $123,034 ($3.51 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Circle accounted for approximately 783,815 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Circle in 2022 was $0.32. The annual non-fuel expenses associated with power generation totaled $146,196 in FY22, resulting in an additional cost of $0.39 per kWh sold. Thus, the combined fuel and non-fuel expenses in Circle were $0.71 per kWh sold in FY22. The last reported electric rate paid by customers was $0.98 per kWh. Circle's electric rate is slightly more than 6 times the national average of $0.16 per kWh. Circle was PCE eligible for 42.7% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Circle in the amount of $99,406 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,800 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Circle. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Circle:

- Residential Sector
  - Residual Fuel Oil No. 5 = 105.59 MT CO_2e
  - Wood and Residuals = 2.49 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 26.91 MT CO_2e

- Propane = 2.05 MT CO_2e
- Wood and Wood Residuals = 0.07 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Circle was modeled. The analysis indicated that approximately 393.95 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (113.46 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Circle, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 360 kw solar PV and a 572 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Circle are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

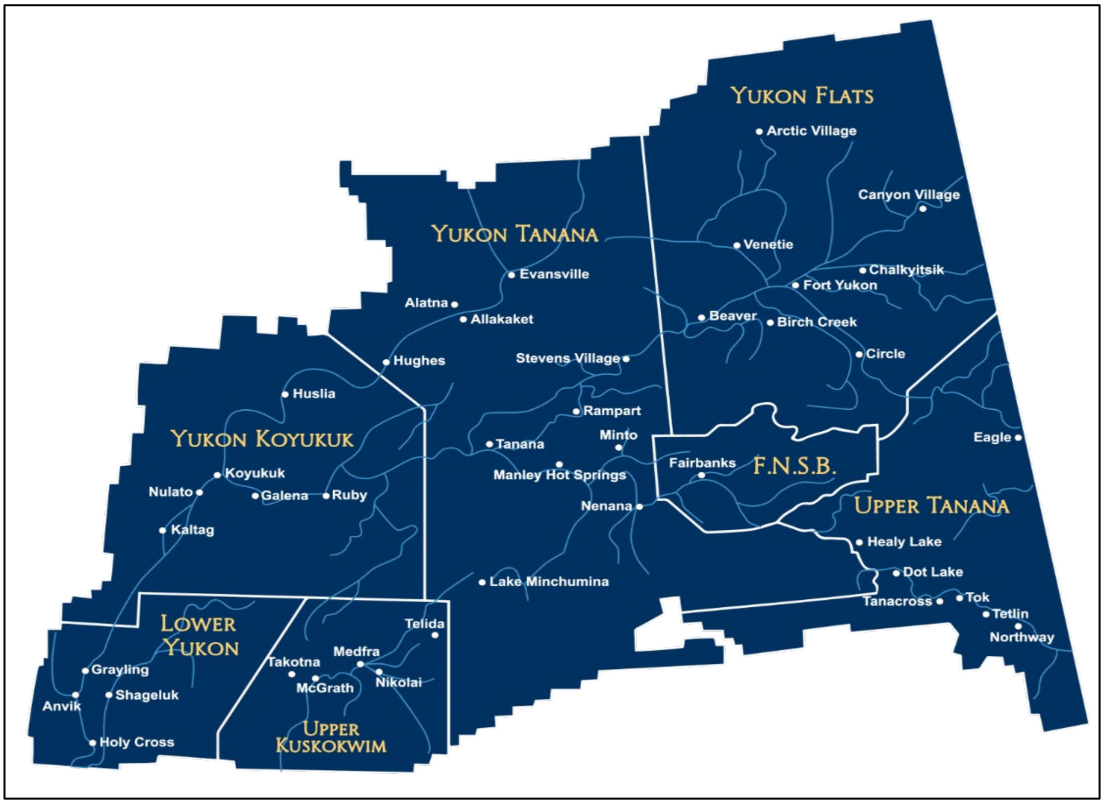
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution.

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Circle

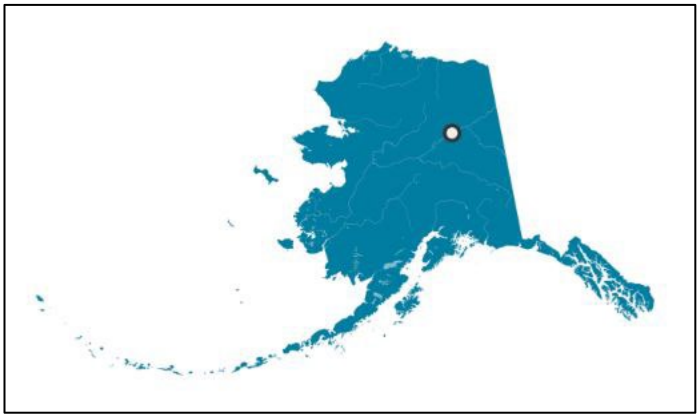
Circle is a traditional Yukon Flats Tanana Athabascan village that is home to approximately 56 residents. Circle is located on the north bank of the Yukon River, approximately 60 air miles southwest of Fort Yukon and 110 miles north of Fairbanks. It lies in the Yukon Flats National Wildlife Refuge.

Circle has a continental subarctic climate characterized by seasonal extreme temperatures. The average high temperature during July ranges from 65 to 72 °F. The average low temperature during January is well below zero. Extended periods of -50 to -60 °F are common.

Extreme temperatures ranging from a low of -70 to a high of 90 °F have been measured. Precipitation averages 6.5 inches. The average annual snowfall is 43.4 inches. The Yukon River is ice-free from mid-June to mid-October.

The U.S. EPA indicates that Circle's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Circle as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 92% of Circle's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Circle, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar

[2] https://www.huduser.gov/portal/icdbg2022/home.html

panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Circle. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and

utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies southwest of Circle Village and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Circle's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar PV systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Circle's airport is a state-owned, public-use airport. The airport covers an area of 446 acres and has one runway with a gravel surface. Additionally, there are several other areas around the village that may be suitable.

It is unknown whether Circle has applied for or is interested in pursuing funding to implement solar PV + BESS infrastructure in the community.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more

difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Circle is estimated to be 6.2 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 56 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Due to the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Circle because of the number of moving parts that must continue operating at very cold temperatures. Should Circle pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable

[3] Circle Wind Forecast, AK 99733 - WillyWeather

example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future.[4]

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community’s transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

Circle Village’s transmission lines are likely due for upgrading, along with any transformers and other hardware required to maintain the power grid. Should Circle explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

Circle Village received a grant from the Bipartisan Infrastructure Law provision 40101(d) – Department of Energy Electric Grid Resiliency to improve the resilience of their electric grids. Administered by the National Energy Technology Laboratory and falling under the provision 40101(d), the program is designed to strengthen and modernize America's power grid against wildfires, extreme weather, and other natural disasters that are exacerbated by the climate crisis.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Circle has a state owned, public-use airport. There are no plans to incorporate electrification into its airport; however, solar PVs + BESS at the airport could be tied into the grid.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- <u>Home Charging</u>: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- <u>Public Charging</u>: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.

- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Circle does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

While Circle is located on the south bank of the Yukon River at the edge of the Yukon Flats, there are no known plans to pursue a hydrokinetic project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. There are no known plans for Circle to pursues a heat recovery project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Weatherization of housing and building components in Circle would reduce heat loss and improve energy efficiency. It is not known whether Circle has taken significant steps to improve weatherization of community buildings or residences.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Circle Village in late 2023 to inform its PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Circle (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Circle indicated diesel was the primary energy source of power and GHG emissions in Circle in 2022 (AEA 2023). Circle's 46 residential customers, 7 community facility customers, and 9 other customers required 423,092 kWh in diesel-generated power. A total of

35,023 gallons of fuel were consumed by Circle customers in 2022 at a cost of $123,034 ($3.51 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Circle accounted for approximately 783,815 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Circle in 2022 was $0.32. The annual non-fuel expenses associated with power generation totaled $146,196 in FY22, resulting in an additional cost of $0.39 per kWh sold. Thus, the combined fuel and non-fuel expenses in Circle were $0.71 per kWh sold in FY22. The last reported electric rate paid by customers was $.98 per kWh. Circle's electric rate is slightly more than 6 times the national average of $0.16 per kWh. Circle was PCE eligible for 42.7% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Circle in the amount of $99,406 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,800 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Circle Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
83	46	7	9

Source: AEA 2023

Table 2. Circle Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh / gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[5] (lbs)
423,092	0	90%	12.08	392,932	35,023	1,565

Sources: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Circle (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Circle. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Circle:

- Residential Sector
  - Residual Fuel Oil No. 5 = 105.59 MT CO_2e
  - Wood and Residuals = 2.49 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 26.91 MT CO_2e
  - Propane = 2.05 MT CO_2e
  - Wood and Wood Residuals = 0.07 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Circle was modeled. The analysis indicated that approximately 393.95 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (113.46 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Circle may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider pursuing grant funding for a solar PV array + BESS to reduce diesel consumption and GHG emissions.

2. **Biomass Heating System:** If never constructed, it is recommended that the community develop the wood biomass system that was designed and studied for the community of Circle Village. This would reduce dependency on heating oil and provide a local, alternate fuel source for the heating system that could reduce overall GHGs.

3. **Additional Weatherization.** It is recommended that the community make advances to weatherize several residences and community buildings to reduce heat escape, heating bills, and GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 360 kWh PV Renewable Solar + 572 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Mill. $)	Utility Improvements (Mill. $)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
360 kWh PV; 572 kWh BESS	2.14	1.00	50%	19,263	15,760	59,659	159,887	160

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

Circle is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Yukon Flats communities like Circle to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Circle Village Council (BVC) is the governing body for Circle Village, a federally recognized tribe. The BVC has the authority to implement GHG reduction measures through resolutions passed in BVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, BVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Circle to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider pursuing grant funding for a solar PV array + BESS to reduce diesel consumption and GHG emissions.

2. **Biomass Heating System:** If never constructed, it is recommended that the community pursue funding for the wood biomass system that was designed and studied for the community of Circle Village. This would reduce dependency on heating oil and provide a local, alternate fuel source for the heating system that could reduce overall GHGs.

3. **Additional Weatherization.** It is recommended that the community make advances to weatherize several residences and community buildings to reduce heat escape, electric bills, and CO_2 emissions.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Circle is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could

be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The community will examine the condition of its current power grid under recent Department of Energy Electric Grid Resiliency funding; it has likely not been updated or upgraded since the lines were initially installed.

5 References

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UAF. 2022. A Solar Design Manual for Alaska. 6th Edition. Available online at: A Solar Design Manual for Alaska, Sixth Edition (uaf.edu). Accessed on Feb. 24, 2024.

UL Solutions. 2024. HOMER Pro Microgrid Software. Available online at: HOMER Pro - Microgrid Software for Designing Optimized Hybrid Microgrids (homerenergy.com).

Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Circle (FY2022)

Circle PCE

Utility: CIRCLE ELECTRIC LLC
Reporting Period: 07/01/21 to 06/30/22

Community Population	83
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	46
Community Facility Customers	7
Other Customers (Non-PCE)	9
Fiscal Year PCE Payments	**$95,406**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	96,597	Average Annual PCE Payment per Eligible Customer	$1,800
PCE Eligible kWh - Community Facility Customers	66,156	Average PCE Payment per Eligible kWh	$0.59
Total PCE Eligible kWh	162,753	Last Reported Residential Rate Charged (based on 500 kWh)	$0.98
Average Monthly PCE Eligible kWh per Residential Customer	175	Last Reported PCE Level (per kWh)	$0.68
Average Monthly PCE Eligible kWh per Community Facility Customer	788	Effective Residential Rate (per kWh)	$0.30
Average Monthly PCE Eligible Community Facility kWh per Person	66	PCE Eligible kWh vs Total kWh Sold	42.7%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	423,092	Fuel Used (Gallons)	35,023
Non-Diesel kWh Generated	0	Fuel Cost	$123,034
Purchased kWh	0	Average Price of Fuel	$3.51
Total Purchased & Generated	423,092	Fuel Cost per kWh sold	$0.32
		Annual Non-Fuel Expenses	$148,198
		Non-Fuel Expense per kWh Sold	$0.39
		Total Expense per kWh Sold	$0.71

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	121,167	Consumed vs Generated (kWh Sold vs Generated-Purchased)	90.0%
Community Facility kWh Sold	94,408	Line Loss (%)	7.1%
Other kWh Sold (Non-PCE)	165,166	Fuel Efficiency (kWh per Gallon of Diesel)	12.08
Total kWh Sold	380,741	PH Consumption as % of Generation	2.9%
Powerhouse (PH) Consumption kWh	12,191		
Total kWh Sold & PH Consumption	392,932		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Dot Lake Village

Dot Lake, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
DLTC	Dot Lake Tribal Council
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
O&M	Operational Expenditures
OPEX	Operational Expenditures
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States
VPSO	Village Public Safety Officer
WTP	Water Treatment Plant

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Dot Lake, a rural and predominantly Alaska Native community of approximately 61 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Dot Lake. GHG production levels and energy costs for Dot Lake were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy, 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Dot Lake in 2022 (AEA 2023). Dot Lake's 24 residential customers, 6 community facility customers, and 15 other customers required a portion of the 10,513,000 kWh of diesel-generated power and 0 kWh of non-diesel-generated power produced by the Alaska Power & Telephone Company (AP&T) facility in Tok, which also provides power to the communities of Tok, Tanacross, and Tetlin. A total of 411,333 total kWh was sold to Dot Lake customers, requiring approximately 4% of the powerhouse consumption of the 724,329 gallons of diesel fuel (28,973 gallons) at the AP&T facility. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Dot Lake accounted for approximately 648,416 lbs of CO_2 produced by the AP&T facility in FY2022.

A total of 724,329 gallons of fuel were consumed at the AP&T facility (about 28,973 gallons by Dot Lake customers) in 2022 at a cost of $2,166,028 ($2.99 per gallon; $86,630 for Dot Lake customers). The average fuel cost per kWh in Dot Lake in 2022 was $0.25. The annual non-fuel expenses associated with power generation at the AP&T facility totaled $1,890,212 in FY22, resulting in an additional cost of $0.22 per kWh sold. Thus, the combined fuel and non-fuel expenses at the AP&T facility that were required to produce power for Dot Lake were $0.47 per kWh sold in FY22. The last reported electric rate paid by customers was $0.57 per kWh. Dot Lake's electric rate is over 3.5 times the national average of $0.16 per kWh. Dot Lake was PCE eligible for 28.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Dot Lake in the amount of $34,361 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,145 (AEA 2023).

Constellation Energy (2024) emission inventory reporting for Dot Lake indicated that approximately 83.02% of GHG emissions (53.87MT) in Dot Lake come from the residential sector, with the highest amount of GHGs coming from burning fuel oil (52.80 MT) and wood (1.07 MT) in stationary locations. Alternatively, 16.98% of stationary emissions come from the commercial and industrial sectors. A negligible amount of emissions resulted from the transportation sector. Total annual electricity usage in Dot Lake was reported as approximately 411 MWh (Constellation 2024).

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Dot Lake are:

- Solar PV + BESS array (may reduce fuel consumption and CO_2 production by up to 20%);
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

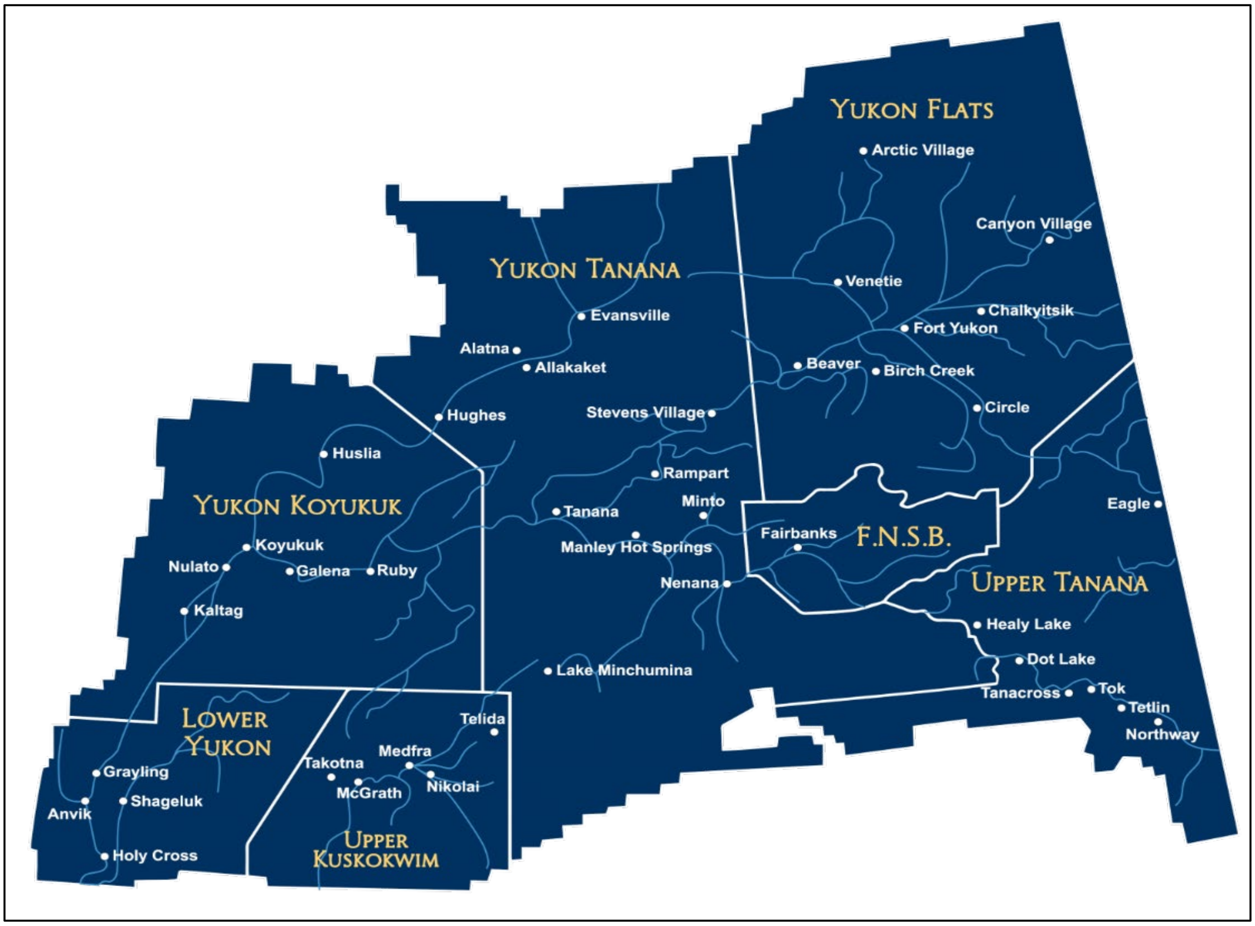
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Dot Lake

Dot Lake is a traditional Upper Tanana Athabascan village that is home to approximately 61 residents. Dot Lake is located on the Alaska Highway, 50 miles northwest of Tok and 155 road miles southeast of Fairbanks (Figure 2). It lies south of the Tanana River. Dot Lake's power is supplied by The Alaska Power & Telephone Company (AP&T).

Dot Lake is located in the continental climatic zone, where winters are cold, and summers are warm. In winter, cool air settles in the valley, and ice fog and smoke conditions are common. The average low temperature during December, January, and February is -22 °F. The average high temperature during June, July, and August is 65 °F. Extreme temperatures ranging from a low of -75 to a high of 90 °F have been measured. Average annual precipitation is 9 inches, and annual snowfall averages 27 inches.

The U.S. EPA indicates that Dot Lake's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Dot Lake as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 72% of Dot Lake's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD).

Figure 2. Location of Dot Lake, Alaska

Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;

- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Dot Lake. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Dot Lake and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Dot Lake's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Dot Lake's airstrip was closed, but the area north of the Lodge where the airstrip was located may still be a suitable location for a solar array. Additionally, there are a number of other areas around the village that may be suitable.

Dot Lake's power is generated at the AP&T facility in Tok and transferred to Dot Lake via underground cables. Upgrades to the power grid would need to be made in order to incorporate solar power in Dot Lake.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Dot Lake is estimated to be 4.3 m/s (9.6 mph) which is a Class 3 (moderate) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 106 people, turbines turned by even a Class 2 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Dot Lake and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Dot Lak because of the number of moving parts that must continue operating at very cold temperatures. Should Dot Lake decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

Notably, in 2016, AP&T won a grant to build a 1.8 MW wind farm located in a Class 4 wind area that would help the communities of Tok, Tetlin, Tanacross and Dot Lake by providing a locally available source of cleaner, more affordable renewable energy. The project was estimated to offset over a quarter million gallons of diesel fuel per year, with annual carbon savings of more than 66,650 metric tons.[2]

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

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[2] https://www.power-grid.com/renewable-energy/alaska-power-telephone-wins-grant-to-build-wind-farm/#gref

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [3]

A 2008 case study by the Cooperative Extension Service at the University of Alaska Fairbanks (UAF 2008) focused on Dot Lake's use of a Garn wood-fired boiler with a heat exchanger that is used in conjunction with an oil-fired boiler to heat 8 homes in the community. The initial cost was less than $70,000, and operating costs are fairly low since the fuel is harvested locally. The USDA recognized this wood fired project as an example of the successful use of woody biomass energy.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Dot Lake, the transmission lines from Tok are likely due for maintenance along with any transformers and other hardware required to maintain the power grid. Should Dot Lake explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating

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[3] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Dot Lake does not have an operating airport at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Dot Lake does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Dot Lake is two miles away from the Tanana River; however, they currently do not have plans to pursue a hydropower project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In Dot Lake, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include

insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of housing and building components in Dot Lake would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1. Community Survey

A community survey offered to Dot Lake in late 2023 to inform to help inform the PCAP development process was not returned.

3.2 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Dot Lake (Constellation Energy, 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and

methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

3.2.1 Stationary Combustion

The Alaska Emissions Inventory Tool estimates Direct GHG emissions from records of stationary (non-transport) combustion of fossil fuels at facilities and includes combustion within boilers, turbines, and process heating, but also incorporates end-uses like space or water heating, and appliances. The data for Dot Lake stemming from the Alaska Emissions Inventory Tool pertain to residential, commercial, community and industrial buildings and facilities:

- **83.02%** of the community's emissions come from the **residential sector.**
    - Residential Fuel Oil No. 5: 52.80 MT GHG Emissions (81.37%).
    - Wood and Wood Residuals: 1.07 MT GHG Emissions (1.65%).
- **16.98%** of the community's emissions come from the **commercial sector**.
- **A negligible amount** of the community's emissions come from the **industrial sector**.

3.2.2 Transportation

Direct GHG emissions associated with fuel combustion in owned or operated mobile sources, such as on-road vehicles (passenger vehicles, trucks,) and off-road vehicles (planes, boats) or equipment (air support, construction, etc.) were also estimated:

- **A negligible amount** of the community's emissions come from the **transportation sector**.

3.2.3 Purchased Electricity

- **A negligible amount** of the community's emissions come from **purchased electricity**.
- **The total electricity** used is **410.96 MWh.**

3.3 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Dot Lake (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Dot Lake indicated that diesel was the primary energy source of power and GHG emissions in Dot Lake in 2022 (AEA 2023). Dot Lake's 24 residential customers, 6 community facility customers, and 15 other customers required a portion of the 10,513,000 kWh of diesel-generated power and 0 kWh of non-diesel-generated power produced by the Alaska Power & Telephone Company (AP&T) facility in Tok, which also provides power to the communities of Tok, Tanacross, and Tetlin. A total of 411,333 total kWh was sold to Dot Lake customers, requiring approximately 4% of the powerhouse consumption of the 724,329 gallons of diesel fuel (28,973 gallons) at the AP&T facility. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Dot Lake accounted for approximately 648,416 lbs of CO_2 produced by the AP&T facility in FY2022.

A total of 724,329 gallons of fuel were consumed at the AP&T facility (about 28,973 gallons by Dot Lake customers) in 2022 at a cost of $2,166,028 ($2.99 per gallon; $86,630 for Dot Lake customers). The average fuel cost per kWh in Dot Lake in 2022 was $0.25. The annual non-fuel expenses associated with power generation at the AP&T facility totaled $1,890,212 in FY22, resulting in an additional cost of $0.22 per kWh sold. Thus, the combined fuel and non-fuel expenses at the AP&T facility that were required to produce power for Dot Lake were $0.47 per kWh sold in FY22. The last reported electric rate paid by customers was $0.57 per kWh. Dot Lake's electric rate is over 3.5 times the national average of $0.16 per kWh. Dot Lake was PCE eligible for 28.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Dot Lake in the amount of $34,361 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,145 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Dot Lake Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
61	24	6	15

Source: AEA 2023

Table 2. Dot Lake Fuel Consumption and CO2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ Gal. Diesel) *	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO2 produced[4] (lbs)
10,513,000	0	82.5%	14.5	411,333	28,973	648,419

Sources: AEA 2023, *AP&T for Tetlin, Tok, Tanacross and Dot Lake combined

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

3.4 GHG Reduction Targets

Dot Lake may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 20% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Capital expenditures (CAPEX) and operational expenditures (OPEX) of the system were also modeled, along with annual generator fuel costs and operation and maintenance (O&M) costs under this scenario. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 20% Renewable Solar + BESS Scenario

PV (kW)	PV Energy Production (kW / yr)	1 kWh Li BESS (#)	Fuel Consum. (gal./yr.)	Generator Prod. (kWh)	CAPEX ($)	OPEX ($)	Annual Generator Fuel Cost ($/yr)	Annual Generator O&M Cost ($/yr)
410.3	399,701.2	464	56,494.1	809,031.7	2,520,727	337,437	171,083	39,858

Source: HOMER Pro Software

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

3.8 Review of Authority to Implement

The Dot Lake Tribal Council (DLTC) is the governing body for Dot Lake Village, a federally-recognized tribe. The DLTC has the authority to implement GHG reduction measures through resolutions passed in DLTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, DLTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Dot Lake to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should apply for funding for a 2MWe solar array project along with 3MWe BESS (top priority).
2. **Residential Weatherization.** It is likely that the homes in Dot Lake have not had further weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** The Gam wood-fired boiler that is used to heat a number of homes in Dot Lake had some initial design flaws, including buried pipes that were easily damaged. Dot Lake should consider applying for funds for maintenance and to potentially expand the number of homes this project serves.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Dot Lake is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Dot Lake (FY2022)

Dot Lake; Dot Lake Village PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	61
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	24
Community Facility Customers	6
Other Customers (Non-PCE)	15
Fiscal Year PCE Payments	**$34,361**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	71,268	Average Annual PCE Payment per Eligible Customer	$1,145
PCE Eligible kWh - Community Facility Customers	47,497	Average PCE Payment per Eligible kWh	$0.29
Total PCE Eligible kWh	118,765	Last Reported Residential Rate Charged (based on 500 kWh)	$0.57
Average Monthly PCE Eligible kWh per Residential Customer	247	Last Reported PCE Level (per kWh)	$0.37
Average Monthly PCE Eligible kWh per Community Facility Customer	660	Effective Residential Rate (per kWh)	$0.20
Average Monthly PCE Eligible Community Facility kWh per Person	65	PCE Eligible kWh vs Total kWh Sold	28.9%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	0	Fuel Used (Gallons)	0
Non-Diesel kWh Generated	0	Fuel Cost	$0
Purchased kWh	0	Average Price of Fuel	$0.00
Total Purchased & Generated	0	Fuel Cost per kWh sold	See Comments
		Annual Non-Fuel Expenses	$0
		Non-Fuel Expense per kWh Sold	See Comments
		Total Expense per kWh Sold	$0.00

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	91,012	Consumed vs Generated (kWh Sold vs Generated-Purchased)	See Comments
Community Facility kWh Sold	58,561	Line Loss (%)	See Comments
Other kWh Sold (Non-PCE)	261,760	Fuel Efficiency (kWh per Gallon of Diesel)	N/A
Total kWh Sold	411,333	PH Consumption as % of Generation	N/A
Powerhouse (PH) Consumption kWh	0		
Total kWh Sold & PH Consumption	411,333		

Comments

See Tok for power generation

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Native Village of Eagle

Eagle, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIRAC	Eagle IRA Council
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
HUD	Housing and Urban Development
IPP	Independent Power Producer

kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
OCED	US Department of Energy Office of Clean Energy Demonstrations
O&M	Operational Expenditures
OPEX	Operational Expenditures
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Eagle, a rural and predominantly Alaska Native community of approximately 132 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Eagle. GHG production levels and energy costs for Eagle was first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy, 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Eagle in 2022 (AEA 2023). Eagle's 140 residential customers, 12 community facility customers, and 35 other customers required 393,815 kWh in diesel-generated power. A total of 70,142 gallons of fuel were consumed by Eagle customers in 2022 at a cost of $212,241 ($2.80 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Eagle accounted for approximately 1,569,778 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Eagle in 2022 was $0.29. The annual non-fuel expenses associated with power generation totaled $297,912 in FY22, resulting in an additional cost of $0.41 per kWh sold. Thus, the combined fuel and non-fuel expenses in Eagle were approximately $0.71 per kWh sold in FY22. The last reported electric rate paid by customers was $0.87 per kWh. Thus, Eagle's electric rate is nearly 5.5 times the national average of $0.16 per kWh. Eagle was PCE eligible for 46.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Eagle in the amount of $140,360 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $923 (AEA 2023).

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Eagle, the maximum fraction of existing energy production that could be replaced by renewables is 40%, represented by a 552 kw solar PV and a 823 kWh BESS.

Constellation Energy (2024) modeled GHG emission sources and outputs for Eagle. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Eagle:

- Residential Sector

- Residual Fuel Oil No. 5 = 139.39 MT CO_2e
- Wood and Residuals = 4.28 MT CO_2e

- Commercial Sector
  - Distillate Fuel Oil No. 1 = 30.62 MT CO_2e
  - Propane = 2.34 MT CO_2e
  - Wood and Wood Residuals = 0.08 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Eagle was modeled. The analysis indicated that approximately 145.35 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (40.19 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Eagle are:

- Solar PV + BESS array to reduce diesel fuel consumption and CO_2 emission;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

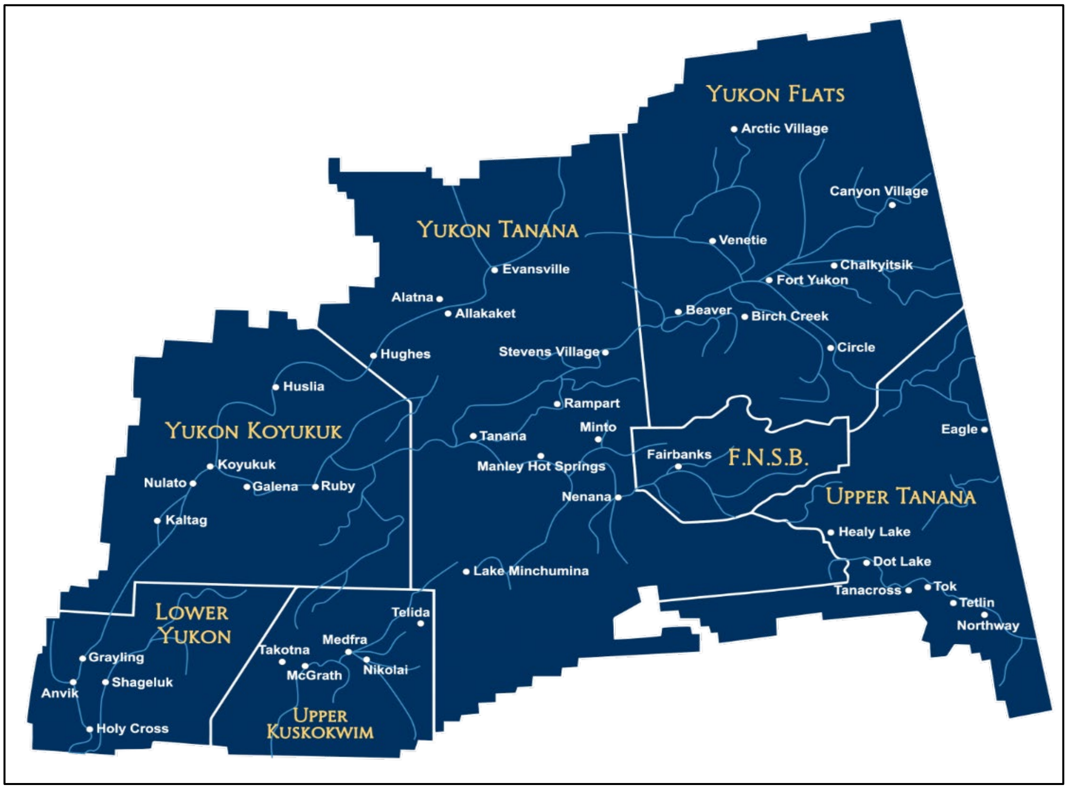
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution.

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

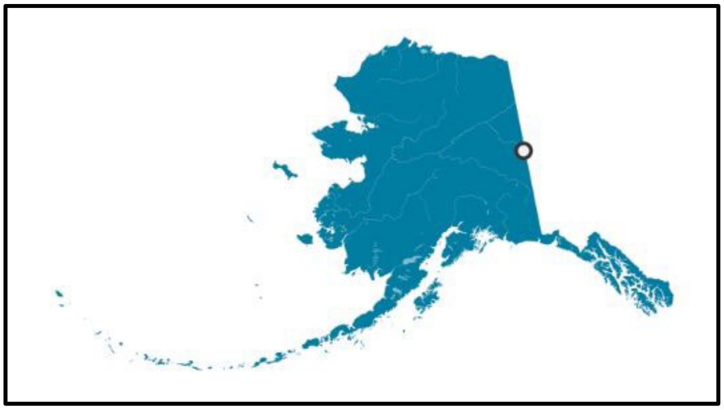
- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Eagle

Eagle is a traditional Upper Tanana Athabascan village that is home to approximately 132 residents. Eagle Village is on the left bank of the Yukon River, 3 miles east of the City of Eagle, on the Taylor Highway. The village is southeast of the Yukon Charley Rivers National Preserve.

Eagle experiences seasonal temperature extremes. January temperatures range from -22 to -2 °F; July temperatures range from 50 to 72 °F. Average annual precipitation is 11.3 inches. Ice fog is common during the winter. The U.S. EPA indicates that Eagle's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Eagle as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 76.5% of Eagle's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2]

Figure 2. Location of Eagle, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Eagle. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies northwest of Eagle and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Eagle's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Eagle's public airport is located one mile southeast of the central business district of Eagle. There is one runway with a gravel surface and features a small terminal building. Additionally, there are several other areas around the village that may be suitable.

One power plant, owned and operated by the Alaska Power and Telephone (AP&T) Company, supplies electricity to Eagle Village. The average load is about 80 kW. In 2012, the AP&T submitted an application to Round 6 of the Renewable Energy Fund grant program seeking funding from the Alaska Energy Authority (AEA) for a 30 kW solar array to offset the consumption of diesel fuel used to generate electricity. Up to this point, all electricity consumed in Eagle and Eagle Village was generated by the diesel power plant. The application stated that providing "clean, renewable energy may lead to lower electric rates in the long term and will provide a public benefit to these struggling communities."

The project was awarded by AEA, and the solar array was commissioned in May 2015 at a total cost of $212,000. The project's original budget was $165,750, but delays, additional required materials, and civil costs added significantly to the final cost. The final completed project was 24 kW in size. The Eagle PV array appears to be functioning as expected. Maximum instantaneous power penetration was just over 40% of the total village load. This peak was observed during spring 2016. The maximum daily energy penetration was approximately 11%, also measured during spring 2016.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus

reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Eagle is estimated to be 5.8 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 132 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable

[3] Eagle Wind Forecast, AK 99738 - WillyWeather

example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [4]

The State of Alaska Renewable Energy Fund provided the majority of the funding for an upgrade to a biomass boiler in the water treatment plant building in Eagle. This funding allowed Eagle to switch to a local, renewable resource for fuel in several buildings to decrease the amount of fuel oil purchased each year. The Alaska Department of Commerce and Economic Development and the Environmental Protection Agency Safe Drinking Water Act also contributed funds to the biomass project.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Eagle, transmission lines, transformers, and switch gear may be due for upgrade, along with other hardware required to maintain the power grid. Should Eagle explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Eagle has a state-owned public airport located two miles east of the Eagle. The airport covers 87 acres with one gravel runway. Currently, there are no plans for electrification of the airport or waterfront.

2.1.6 EV’s & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).

- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Eagle does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Eagle is located adjacent to the Eagle River, just inside the old mouth of the Eagle River along the hillside. AP&T initiated a project for development and assessment of a hydrokinetic project in the Yukon River near Eagle from 2008 - 2010[5]. AP&T was working with a hydrokinetic turbine manufacturer to develop site-appropriate technology. Recently AP&T has contracted with companies to provide the turbine equipment for the project. The New Energy Corp. technology is similar to the technology deployed at Ruby in 2008, but with a larger generation capacity. Due to the large potential and interest in hydrokinetic technology in Alaska, this project will seek to collect data on many vital questions for all hydrokinetic projects, including environmental interaction, performance and efficiency, deployment challenges, support design, debris avoidance, and economics. The objective of the project was the demonstration of technology that could be used to produce electricity from moving water without the construction of large, expensive and potentially environmentally damaging dams.

The Eagle project included a larger turbine (25kW) that was designed to provide power to Eagle and Eagle Village. During design, many of the lessons learned from the project at Ruby were taken into account. The turbine began operating in mid-June 2010. Throughout the course of its operation it typically produced between 15-18kW. At this output, the single installed turbine would have been capable of fulfilling approximately 20-25% of Eagle's daytime and 40% of its nightly electricity demand, offsetting some diesel use in the process. The ability of the turbine to produce electricity successfully demonstrated the integrity of the hydrokinetic principle. However, there were some issues with the transmission and integration systems. These issues compromised the ability to successfully use this electricity, as an overheating transmission cable and the limited capability of the power conversion system contributed to frequent outages.

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[5] EETG: Yukon Hydrokinetic Project – EETG: Yukon Hydrokinetic Project - Alaska Energy Wiki (wikidot.com)

Hydrokinetic technology has shown potential, however the challenges seen with these projects reflects that more research is needed especially in the area of debris management.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. There is no known heat recovery project planned for Eagle.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

It is not known when the last significant weatherization efforts occurred for Eagle. However, weatherization of housing and building components would reduce heat loss and improve energy efficiency in the community.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory

- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Eagle in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Eagle (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Eagle in 2022 (AEA 2023). Eagle's 140 residential customers, 12 community facility customers, and 35 other customers required 393,815 kWh in diesel-generated power. A total of 70,142 gallons of fuel were consumed by Eagle customers in 2022 at a cost of $212,241 ($2.80 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Eagle accounted for approximately 1,569,778 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Eagle in 2022 was $0.29. The annual non-fuel expenses associated with power generation totaled $297,912 in FY22, resulting in an additional cost of $0.41 per kWh sold. Thus, the combined fuel and non-fuel expenses in Eagle were approximately $0.71 per kWh sold in FY22. The last reported electric rate paid by customers was $0.87 per kWh. Thus, Eagle's electric rate is nearly 5.5 times the national average of $0.16

per kWh. Eagle was PCE eligible for 46.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Eagle in the amount of $140,360 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $923 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Eagle Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
132	140	12	35

Source: AEA 2023

Table 2. Eagle Fuel Consumption and CO_2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ Gal. Diesel) *	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[6] (lbs)
847,008	8,734	81.9%	12.46	780,140	70,142	3,134

Sources: AEA 2023, *AP&T for Eagle

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Eagle (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated

[6] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Eagle. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Eagle:

- Residential Sector
  - Residual Fuel Oil No. 5 = 139.39 MT CO_2e
  - Wood and Residuals = 4.28 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 30.62 MT CO_2e
  - Propane = 2.34 MT CO_2e
  - Wood and Wood Residuals = 0.08 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Eagle was modeled. The analysis indicated that approximately 145.35 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (40.19 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

3.4 GHG Reduction Targets

Eagle may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for additional funding to reach maximum energy cost savings, and in doing so reduce diesel consumption, generator run time, and GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings to reduce heating oil consumption and GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 40% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 552 kWh PV Renewable Solar + 823 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar+BESS (Fuel Used*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
552 kWh PV; 823 kWh BESS	3.2	1.00	40%	45,592	24,546	92,931	249,054	249

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

Eagle is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Upper Tanana communities like Eagle to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Eagle IRA Council (EIRAT) is the governing body for Eagle Village, a federally-recognized tribe. The EIRAT has the authority to implement GHG reduction measures through resolutions passed in EIRAT meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, EIRAT meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Eagle to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for additional funding to reach maximum energy cost savings, and in doing so reduce diesel consumption, generator run time, and GHG emissions.

2. **Residential Weatherization.** It is likely that many community homes and residences in Eagle have not had significant weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable. It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings to reduce heating oil consumption and GHG emissions.

3. **Biomass Project(s):** While a biomass boiler has successfully reduced consumption of heating fuel, a second boiler may have additional positive effects. There may be funding opportunities for Eagle to pursue to expand their existing system.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Eagle is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The community should examine the condition of the current power grid and consider applying for grid resiliency funding, as it likely has not been significantly upgraded since initial construction.

5 References

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University of Alaska Fairbanks, Solar Photovoltaic Performance Overview: Pike-et-al-Solar-Photovoltaic-Performance-Overview.pdf (uaf.edu)

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Appendix A

Alaska Energy Authority’s Power Cost Equalization Program

Statistical Report for Eagle (FY2022)

Eagle; Eagle Village PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	132
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	140
Community Facility Customers	12
Other Customers (Non-PCE)	35
Fiscal Year PCE Payments	**$140,360**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	264,840	Average Annual PCE Payment per Eligible Customer	$923
PCE Eligible kWh - Community Facility Customers	73,826	Average PCE Payment per Eligible kWh	$0.41
Total PCE Eligible kWh	338,666	Last Reported Residential Rate Charged (based on 500 kWh)	$0.87
Average Monthly PCE Eligible kWh per Residential Customer	158	Last Reported PCE Level (per kWh)	$0.54
Average Monthly PCE Eligible kWh per Community Facility Customer	513	Effective Residential Rate (per kWh)	$0.33
Average Monthly PCE Eligible Community Facility kWh per Person	47	PCE Eligible kWh vs Total kWh Sold	46.9%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	874,008	Fuel Used (Gallons)	70,142
Non-Diesel kWh Generated	8,734	Fuel Cost	$212,241
Purchased kWh	0	Average Price of Fuel	$3.03
Total Purchased & Generated	882,742	Fuel Cost per kWh sold	$0.29
		Annual Non-Fuel Expenses	$297,912
		Non-Fuel Expense per kWh Sold	$0.41
		Total Expense per kWh Sold	$0.71

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	300,091	Consumed vs Generated (kWh Sold vs Generated-Purchased)	81.9%
Community Facility kWh Sold	74,190	Line Loss (%)	11.6%
Other kWh Sold (Non-PCE)	348,494	Fuel Efficiency (kWh per Gallon of Diesel)	12.46
Total kWh Sold	722,775	PH Consumption as % of Generation	6.5%
Powerhouse (PH) Consumption kWh	57,365		
Total kWh Sold & PH Consumption	780,140		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Evansville/Bettles

Evansville, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
ETC	Evansville Tribal Council
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer

kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
OCED	US Department of Energy Office of Clean Energy Demonstrations
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Evansville / Bettles ("Evansville"), a rural and predominantly Alaska Native community of approximately 19 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Evansville. GHG production levels and energy costs for Evansville was first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Evansville in 2022 (AEA 2023). Evansville's 34 residential customers, 7 community facility customers, and 29 other customers required 526,800 kWh in diesel-generated power. A total of 43,948 gallons of fuel were consumed by Evansville customers in 2022 at a cost of $142,580 ($3.24 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Evansville accounted for approximately 983,556 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Evansville in 2022 was $0.30. The annual non-fuel expenses associated with power generation totaled $139,543 in FY22, resulting in an additional cost of $0.29 per kWh sold. Thus, the combined fuel and non-fuel expenses in Evansville were $0.59 per kWh sold in FY22. The last reported electric rate paid by customers was $0.75 per kWh. Evansville's electric rate is over 4.5 times the national average of $0.16 per kWh. Evansville was PCE eligible for 20.6% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Evansville in the amount of $38,108 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $929 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Evansville. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Evansville:

- Residential Sector
    - Residual Fuel Oil No. 5 = 184.79 MT CO_2e
- Commercial Sector
    - Distillate Fuel Oil No. 1 = 15.78 MT CO_2e

- Propane = 1.20 MT CO_2e
- Wood and Wood Residuals = 0.04 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Evansville was modeled. The analysis indicated that approximately 202.06 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (58.19 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Evansville, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 480 kw solar PV and a 675 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information, preferred options for cleaner, lower cost energy in Evansville are:

- A solar PV + BESS project to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

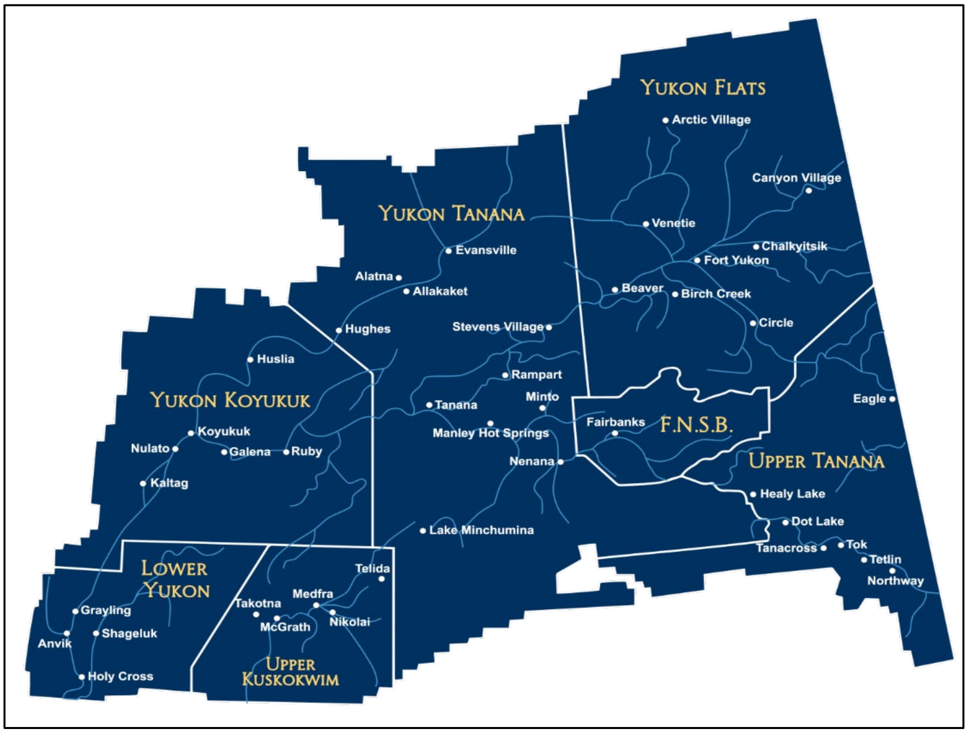
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution.

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support
- TCC Cooperators

- Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
- Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.

- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Evansville

Evansville is a traditional Yukon Tanana Athabascan village that is home to approximately 19 residents. Evansville is located about 180 air miles and 250 road miles northwest of Fairbanks, adjacent to Bettles.

Evansville experiences a cold, continental climate with extreme temperature differences. The average high temperature during July is 70 °F; the average low during January is well below 0 °F. Extended periods of -40 °F are common. The highest temperature ever recorded was 93 °F; the lowest was -70 °F. Average annual precipitation is 13.4 inches, with 77 inches of snowfall.

The U.S. EPA indicates that Evansville's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Evansville as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 63% of Evansville's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2]

Figure 2. Location of Evansville, Alaska

Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Evansville. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies west of Evansville and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Evansville's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been

effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Bettles' state-owned, public airport is located in the city of Bettles and is utilized by Evansville and Bettles. There is one runway with a gravel surface. Additionally, there are several other areas around the village that may be suitable.

The Alaska Power and Telephone (AP&T) Company supplies electricity to Evansville and Bettles. Upgrades to electric grid components in the communities may be required to incorporate solar or other renewable energy systems. Currently, there are no known efforts to study or construct solar PVs or BESS in the community.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more

difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Evansville is estimated to be 5.6 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 19 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions

[3] Evansville Wind Forecast, AK 99726 - WillyWeather

that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

The State of Alaska Renewable Energy Fund provided funding for an upgrade to a biomass boiler in the water treatment plant building in Evansville. This funding allowed Evansville to switch to the local, renewable resource of woody biomass in select buildings to decrease the amount of fuel oil purchased each year. The Alaska Department of Commerce and Economic Development and the Environmental Protection Agency Safe Drinking Water Act also contributed funds to the biomass project.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Evansville, transmission lines, switch gear, and other electric grid components may be due for updating to ensure reliability of the local power grid. Should Evansville explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Evansville / Bettles has a state-owned public airport with one gravel runway. No electrification of the airport is being considered at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Evansville does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are

required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Evansville and Bettles are located on the southeast bank of the Koyukuk River. However, no hydrokinetic projects are planned at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive and may not be practicable for Evansville.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of housing and building components in Evansville would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Evansville in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Evansville (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Evansville in 2022 (AEA 2023). Evansville's 34 residential customers, 7 community facility customers, and 29 other customers required 526,800 kWh in diesel-generated power. A total of 43,948 gallons of fuel were consumed by Evansville customers in 2022 at a cost of $142,580 ($3.24 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Evansville accounted for approximately 983,556 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Evansville in 2022 was $0.30. The annual non-fuel expenses associated with power generation totaled $139,543 in FY22, resulting in an additional cost of $0.29 per kWh sold. Thus, the combined fuel and non-fuel expenses in Evansville were $0.59 per kWh sold in FY22. The last reported electric rate paid by customers was $0.75 per kWh.

Evansville's electric rate is over 4.5 times the national average of $0.16 per kWh. Evansville was PCE eligible for 20.6% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Evansville in the amount of $38,108 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $929 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Evansville Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
19	34	7	29

Source: AEA 2023

Table 2. Evansville Fuel Consumption and CO_2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ Gal. Diesel) *	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[5] (lbs)
526,800	-	91.1%	11.99	493,587	43,948	1,964

Sources: AEA 2023, *AP&T for Evansville

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Evansville (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Evansville. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Evansville:

- Residential Sector
  - Residual Fuel Oil No. 5 = 184.79 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 15.78 MT CO_2e
  - Propane = 1.20 MT CO_2e
  - Wood and Wood Residuals = 0.04 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Evansville was modeled. The analysis indicated that approximately 202.06 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (58.19 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

3.4 GHG Reduction Targets

Evansville may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for funding to acquire a solar PV + BESS array. This would offset diesel fuel consumption for electrical generation in the community and reduce GHG emissions.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings. This would reduce the amount of heating oil required to warm these buildings and would reduce GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 480 kWh PV Renewable Solar + 675 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
480 kWh PV; 675 kWh BESS	2.67	1.00	50%	24,171	19,777	74,863	200,632	201

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

Evansville is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Yukon Tanana communities like Evansville to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Evansville IRA Council (EIRAT) is the governing body for Evansville Village, a federally recognized tribe. The EIRAT has the authority to implement GHG reduction measures through resolutions passed in EIRAT meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, EIRAT meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Evansville to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for funding to acquire a solar PV + BESS array. This would offset diesel fuel consumption for electrical generation in the community and reduce GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings. This would reduce the amount of heating oil required to warm these buildings and would reduce GHG emissions. It is possible that major weatherization of several buildings and residences after initial construction has not occurred.
3. **Biomass Project(s):** Evansville has had some success with a wood-fired boiler to heat homes in the community, reducing GHGs through lowered fuel oil consumption. An additional boiler may be able to heat additional buildings and / or residences and further reduce the cost of heat and emissions of resulting GHGs.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Evansville is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed. If new or upgraded components are required for the grid to operate efficiently, there may be grid resiliency funding avenues available.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Evansville/Bettles (FY2022)

Bettles; Evansville PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	19
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	34
Community Facility Customers	7
Other Customers (Non-PCE)	29
Fiscal Year PCE Payments	**$38,108**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	82,862	Average Annual PCE Payment per Eligible Customer	$929
PCE Eligible kWh - Community Facility Customers	15,960	Average PCE Payment per Eligible kWh	$0.39
Total PCE Eligible kWh	98,822	Last Reported Residential Rate Charged (based on 500 kWh)	$0.75
Average Monthly PCE Eligible kWh per Residential Customer	203	Last Reported PCE Level (per kWh)	$0.43
Average Monthly PCE Eligible kWh per Community Facility Customer	190	Effective Residential Rate (per kWh)	$0.32
Average Monthly PCE Eligible Community Facility kWh per Person	70	PCE Eligible kWh vs Total kWh Sold	20.6%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	526,800	Fuel Used (Gallons)	43,948
Non-Diesel kWh Generated	0	Fuel Cost	$142,580
Purchased kWh	0	Average Price of Fuel	$3.24
Total Purchased & Generated	526,800	Fuel Cost per kWh sold	$0.30
		Annual Non-Fuel Expenses	$139,543
		Non-Fuel Expense per kWh Sold	$0.29
		Total Expense per kWh Sold	$0.59

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	107,953	Consumed vs Generated (kWh Sold vs Generated-Purchased)	91.1%
Community Facility kWh Sold	34,116	Line Loss (%)	6.3%
Other kWh Sold (Non-PCE)	337,984	Fuel Efficiency (kWh per Gallon of Diesel)	11.99
Total kWh Sold	480,053	PH Consumption as % of Generation	2.6%
Powerhouse (PH) Consumption kWh	13,534		
Total kWh Sold & PH Consumption	493,587		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Fort Yukon

Fort Yukon, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power and Telephone
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
GZGTG	Gwichyaa Zhee Gwich'in Tribal Government
HUD	Housing and Urban Development
IPP	Independent Power Producer

kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
OCED	US Department of Energy Office of Clean Energy Demonstrations
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Fort Yukon, a rural and predominantly Alaska Native community of approximately 514 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Fort Yukon. GHG production levels and energy costs for Fort Yukon was first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Fort Yukon in 2022 (AEA 2023). Fort Yukon's 272 residential customers, 17 community facility customers, and 89 other customers required 3,234,644 kWh in diesel-generated power. A total of 225,458 gallons of fuel were consumed by Fort Yukon customers in 2022 at a cost of $1,322,086 ($5.86 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Fort Yukon accounted for approximately 5,045,750 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Fort Yukon in 2022 was $0.49. The annual non-fuel expenses associated with power generation totaled $552,915 in FY22, resulting in an additional cost of $0.21 per kWh sold. Thus, the combined fuel and non-fuel expenses in Fort Yukon were approximately $0.70 per kWh sold in FY22. The last reported electric rate paid by customers was $0.64 per kWh. Thus, Fort Yukon's electric rate is four times the national average of $0.16 per kWh. Fort Yukon was PCE eligible for 47.2% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Fort Yukon in the amount of $371,157 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,284 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Fort Yukon. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Fort Yukon:

- Residential Sector
  - Natural Gas =34.66 MT CO_2e
  - Residual Fuel Oil No. 5 = 1,293.52 MT CO_2e
  - Wood and Residuals = 35.28 MT CO_2e

- Commercial Sector
  - Distillate Fuel Oil No. 1 = 383.24 MT CO_2e
  - Propane = 29.26 MT CO_2e
  - Wood and Wood Residuals = 1.06 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Fort Yukon was modeled. The analysis indicated that approximately 2,732.90 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (787.07MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Fort Yukon, the maximum fraction of existing energy production that could be replaced by renewables is 30%, represented by a 1900 kw solar PV and a 1961 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Fort Yukon are:

- Solar PV + BESS array to reduce diesel fuel consumption and CO_2 emission – the community has taken excellent steps to achieve results in this area;
- Additional weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers) – the community has made excellent progress in this area between 2008 – 2018 and is utilizing advanced technology to incorporate locally-sourced biomass fuel as a renewable energy source for heat;
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

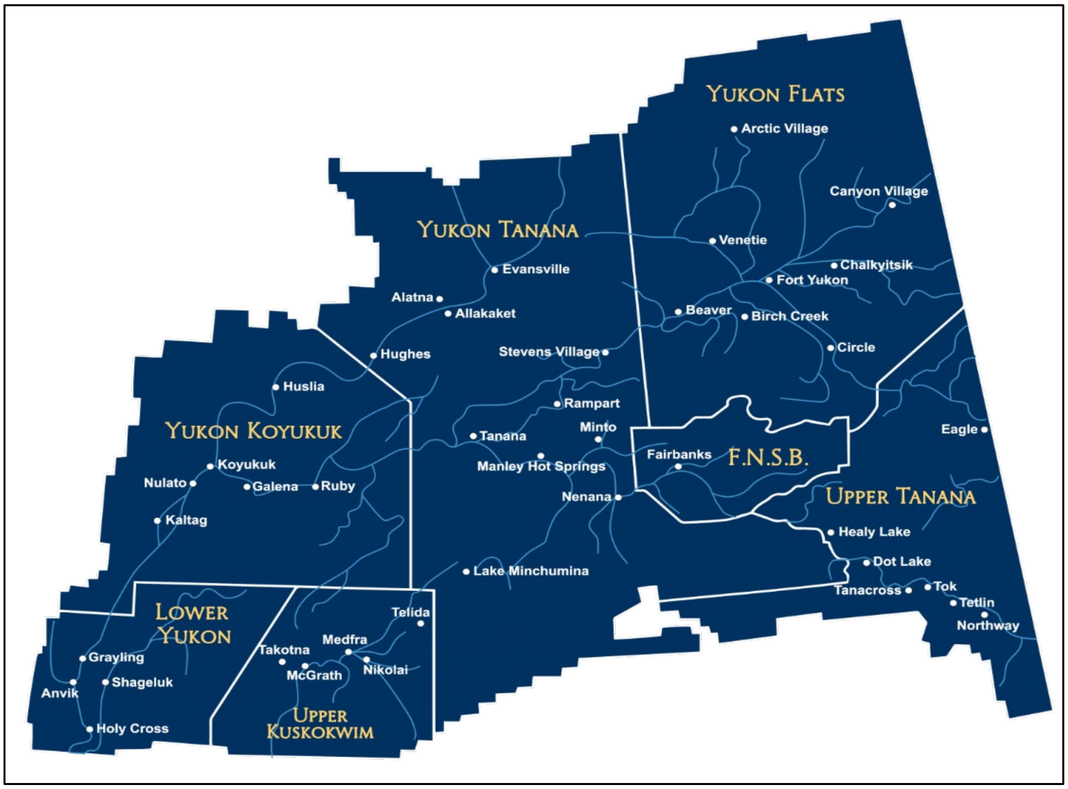
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHGs and other harmful air pollution. TCC

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

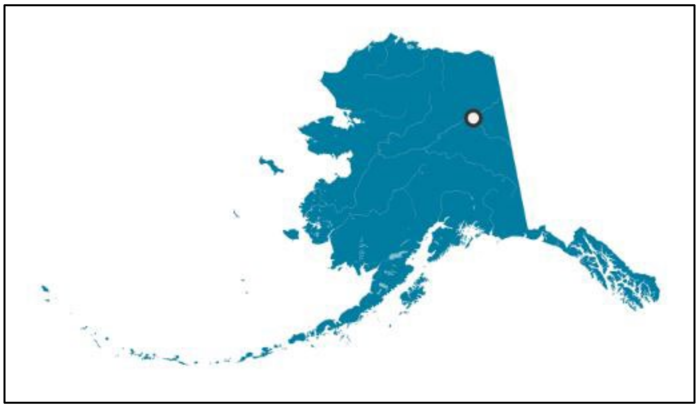
- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Fort Yukon

Fort Yukon is a traditional Yukon Flats Athabascan village that is home to approximately 514 residents. Fort Yukon is located at the confluence of the Yukon and Porcupine Rivers, about 145 air miles northeast of Fairbanks.

Fort Yukon winters are long and harsh, and the summers are short but warm. After freeze-up, the plateau is a source of cold, continental arctic air. Daily minimum temperatures between November and March are usually below 0 °F. Extended periods of -50 to -60 °F are common. Summer high temperatures run 65 to 72 °F; a high of 97 °F has been recorded. Total annual precipitation averages 6.58 inches, with 43.4 inches of snowfall. The Yukon River is ice-free from the end of May through mid-September. The U.S. EPA indicates that Fort Yukon's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Fort Yukon as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 61.6% of Fort Yukon's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2]

Figure 2. Location of Fort Yukon, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Fort Yukon. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies southwest of Fort Yukon and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Fort Yukon’s case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community’s dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been

effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Fort Yukon's public airport is located one mile southeast of the central business district of Fort Yukon. There is one runway with a gravel surface and features a small terminal building. Additionally, there are several other areas around the village that may be suitable.

The Gwichyaa Zhee Gwich'in Tribal Government (GZGTG) applied for funding in 2014 under a U.S. Department of Energy (DOE) Office of Indian Energy program to deploy clean energy on tribal lands, which included solar power and weatherization. The Tribe was awarded 50% of the project costs for the construction of an 18kW, grid-tied solar PV array on the fort Yukon Tribal Hall and the construction of a 3kW solar PV array on the Tribal greenhouse, among several weatherization components (GZGTG n.d.); see also section 2.1.9, below. The project was completed with 100% local labor in Fall 2016. The solar project and weatherization efforts have collectively resulted in a 35% reduction of fuel used at the tribal hall / office and a 68% reduction in electric costs at the tribal hall. More recently, Fort Yukon recently received a Bipartisan Infrastructure Law Tribal Electrification Grant to implement renewable energy systems, such as solar PV + BESS.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus

reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Fort Yukon is estimated to be 6.2 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 514 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable

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[3] Fort Yukon Wind Forecast, AK 99738 - WillyWeather

example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHGs.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

The Fort Yukon Gwitchyaa Zhee Corporation (GZ) and Council of Athabascan Tribal Governments (CATG) worked with additional partners over a ten-year period to develop a model Integrated Biomass Energy Program for Fort Yukon referred to as the Fort Yukon Combined heat and power (CHP) project (CATG 2019). This integrated approach linked sustainable forest management with an in-village for-profit wood harvest and delivery business to displace diesel energy with wood energy for heat and power. The program was based on the concept of ecological, economic, and social sustainability with a goal of displacing as much diesel and fuel oil as is technically feasible and sustainable; essentially systematically converting a village to significant amounts of wood use. The result was a project designed to improve operating efficiency, economy of scale, and increased benefits to GZ, the CATG, and the community of Fort Yukon.

The CHP project provided biomass and diesel generation-recovered heat via a new district heating system to the major commercial buildings in Fort Yukon. The CATG clinic receives heat from a separate biomass boiler to meet their heating needs. The award from the DOE Tribal Energy Program was divided into two phases: Design/Permitting (phase 1) and Construction (phase 2). Phase 1 (Design & Permitting) was cost shared using State of Alaska Renewable

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

Energy Funding (REF) funds through the Alaska Energy Authority (AEA). Phase 2 (Construction) was funded by DOE, AEA, and the U.S. Department of Agriculture Rural Utility Service (USDA-RUS). Phase 1 of this grant, along with a separate grant from the Denali Commission, provided funding for development of the wood delivery infrastructure necessary to support the CHP project. Under phase 2, this DOE supported final design of the boiler, bidding, purchase and transport of boilers, installation, technical support, and engineering. The AEA and other grants supported permitting, final design, material / equipment purchase, and construction and installation of the new diesel power plant and district heating distribution system. A DOE Tribal Energy Program award was also received to support the preconstruction tasks and installation of wood boilers at the CATG clinic and at the new GZ diesel power plant as part of an overall program to create a for-profit wood energy utility in the Native Village of Fort Yukon. A recent community survey noted that the biomass system may not be functioning correctly and could require maintenance (Section 3.1, below).

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

Fort Yukon has one power plant that supplies electricity to the village. It is owned and operated by the Alaska Power and Telephone (AP&T) Company. GZ previously worked with the AEA on the development of a rural power system upgrade project that replaced its existing antiquated diesel power plant and provided needed upgrades to the existing electrical distribution system.

As noted above, Fort Yukon recently received a Bipartisan Infrastructure Law Tribal Electrification Grant to implement renewable energy systems, such as solar PV + BESS. Fort Yukon also recently received a Bipartisan Infrastructure Law 40101(d) Grid Resilience grant through TCC. They will receive funding for electric grid resiliency that includes preventing / reducing the number of electrical outages. This grant is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar or other renewables.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Fort Yukon has a state-owned public airport located in the city of Fort Yukon. The airport covers an area of 261 acres with one gravel runway. Currently, there are no plans for electrification of the airport or waterfront.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Fort Yukon does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers. Fort Yukon has no known plans to incorporate a hydrokinetic project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In 2014 Fort Yukon received federal funding from the U.S. EPA for the Fort Yukon Greenhouse Project[5]. To reduce GHG emissions and help residents save on food expenses, Tanana Chiefs Conference (TCC), an intertribal consortium in a rural, roadless area of Alaska has undertaken the use of crops for community consumption in an energy-efficient greenhouse warmed by recovered waste heat.

As noted above, Fort Yukon referred developed the Fort Yukon Combined heat and power (CHP) project to combine a biomass boiler with a diesel-powered heat recovery system. TCC also constructed an energy-efficient greenhouse under a Climate Showcase Communities grant with the GZGTG in Fort Yukon, AK, which, when final (with other funding) will recover heat from the city's diesel-fired power plant, extending the growing season. TCC is coordinating closely with the Alaska Energy Authority to ensure that the new power plant in Fort Yukon is optimized for maximum heat recovery to be able to adequately supply several community buildings as well as the greenhouse.

The heat recovery project to support the Fort Yukon Greenhouse helps reduce the need to import processed food via air, reducing indirect GHG emissions. In also helps combat the very high cost of food in the community. Produce from the greenhouse is sold at two local stores and is available to the local school and assisted living facility at wholesale rates. The project allows local students to learn about food miles, local economies, nutrition, and sustainable agriculture. Gardening workshops will be held for all interested citizens. The community may be planning to integrate another wood-fired heating system to further reduce diesel consumption and GHG emissions in the future.

[5] Fort Yukon Greenhouse Project | Climate and Energy Resources for State, Local, and Tribal Governments | US EPA

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The GZGTG applied for funding in 2014 under a U.S. DOE Office of Indian Energy program for the replacement of inefficient florescent lighting fixtures in the tribal hall with higher efficiency LED lights, the installation of cellulose insulation to the attic of the tribal hall to assist with heat retention, and the installation of the solar PVs + BESS, as described above in section 2.1.1. The Project was completed with 100% local labor. The Tribe contributed some of their own funds to exchanging fluorescent to LED lights to reduce energy consumption. The project was completed by the end of Sept 2016 and results have shown a decrease in fuel used at the tribal hall / office of 35% and a decrease in electric costs at the tribal hall of 68%.

A community survey, mentioned below in Section 3.1, indicated that nearly 80% of the older homes in Fort Yukon need upgrades. These homes could use weatherization including new flooring, upgraded windows, and doors with insulation.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)

- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

The survey completed by the community of Fort Yukon indicated they do not have a current energy/economic development plan. Their two top energy priorities are to reduce the cost of electricity and reduce their reliance on diesel fuel.

Fort Yukon has a new subdivision that needs power, and they would like to explore a solar panel grid for distribution of electricity to support its needs. There are often outages in the current power plant that need to be addressed (a recent DOE grant will help them to do this). They do not have a heat recovery system in place but do have a current electricity distribution map. There is biomass heat distribution to 4-5 buildings, but it currently may not be in use. Fort Yukon is interested in an updated biomass project for the future. Nearly 80% of the older homes in Fort Yukon need upgrades. These homes could use weatherization including new flooring, upgraded windows, and doors with insulation. It has been 20 years since an energy audit has been done for the community buildings. The community would like to see a new energy audit for their community buildings. They would like to see a plan for weatherization for these buildings.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Fort Yukon (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Fort Yukon in 2022 (AEA 2023). Fort Yukon's 272 residential customers, 17 community facility customers, and 89 other customers required 3,234,644 kWh in diesel-generated power. A total of 225,458 gallons of fuel were consumed by Fort Yukon customers in 2022 at a cost of $1,322,086 ($5.86 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Fort Yukon accounted for approximately 5,045,750 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Fort Yukon in 2022 was $0.49. The annual non-fuel expenses associated with power generation totaled $552,915 in FY22, resulting in an additional cost of $0.21 per kWh sold. Thus, the combined fuel and non-fuel expenses in Fort Yukon were approximately $0.70 per kWh sold in FY22. The last reported electric rate paid by customers was $0.64 per kWh. Thus, Fort Yukon's electric rate is four times the national average of $0.16 per kWh. Fort Yukon was PCE eligible for 47.2% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Fort Yukon in the amount of $371,157 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,284 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Fort Yukon Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
514	272	17	89

Source: AEA 2023

Table 2. Fort Yukon Fuel Consumption and CO_2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ Gal. Diesel) *	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[6] (lbs)
3,234,644	0	82.7%	14.35	2,762,756	225,458	10,075

Sources: AEA 2023, *AP&T for Fort Yukon

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power

[6] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Fort Yukon (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Fort Yukon. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Fort Yukon:

- Residential Sector
  - Wood and Residuals = 1.43 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 2.78 MT CO_2e
  - Propane = 0.21 MT CO_2e
  - Wood and Wood Residuals = 0.01 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Fort Yukon was modeled. The analysis indicated that approximately 57.09 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (16.44 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

3.4 GHG Reduction Targets

Fort Yukon may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- Additional biomass heating systems or repair of existing systems to more efficiently heat community buildings and reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Additional weatherization to retain more heat in buildings, thus producing fewer GHGs;

- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** The community has installed a small solar array and is working with TCC under a BIA Tribal Electrification grant to implement additional renewable system components. Additional funding to maximize solar energy for the community would further reduce GHGs.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for additional weatherization of residences and tribal / city buildings to reduce heating oil consumption and lower GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 30% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 1900 kWh PV Renewable Solar + 1961 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
1900 kWh PV; 1961 kWh BESS	9.5	1.0	30%	169,094	56,365	213,363	571,812	572

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

Fort Yukon is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Yukon Flats communities like Fort Yukon to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The GZGTG is the governing body for Fort Yukon Village, a federally-recognized tribe. The GZGTG has the authority to implement GHG reduction measures through resolutions passed in GZGTG meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, GZGTG meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Fort Yukon to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community has installed a small solar array and is working with TCC under a BIA Tribal Electrification grant to implement additional renewable system components. Additional funding to maximize solar energy for the community would further reduce GHGs.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for additional weatherization of residences and tribal / city buildings.

3. **Biomass Project(s):** It is recommended that the community apply for funding to ensure that the existing biomass / heat recovery system is maintained and functioning properly to fully maximize renewable resources for efficient heating and reduced GHG emissions. The community should also consider funding opportunities for Fort Yukon to pursue expansion of their existing system.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide

additional fuel savings, including during winter. However, the wind source around Fort Yukon is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The community received a DOE Electric Grid Resiliency Grant for upgrading components of its grid system. Once these upgrades are completed, the community should consider assessing whether needs remain that require additional funding.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Fort Yukon (FY2022)

Fort Yukon PCE

Utility: GWITCHYAA ZHEE UTILITY COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	514
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	272
Community Facility Customers	17
Other Customers (Non-PCE)	89
Fiscal Year PCE Payments	**$371,157**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	861,616	Average Annual PCE Payment per Eligible Customer	$1,284
PCE Eligible kWh - Community Facility Customers	401,173	Average PCE Payment per Eligible kWh	$0.29
Total PCE Eligible kWh	1,262,789	Last Reported Residential Rate Charged (based on 500 kWh)	$0.64
Average Monthly PCE Eligible kWh per Residential Customer	264	Last Reported PCE Level (per kWh)	$0.35
Average Monthly PCE Eligible kWh per Community Facility Customer	1,967	Effective Residential Rate (per kWh)	$0.29
Average Monthly PCE Eligible Community Facility kWh per Person	65	PCE Eligible kWh vs Total kWh Sold	47.2%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	3,234,644	Fuel Used (Gallons)	225,458
Non-Diesel kWh Generated	0	Fuel Cost	$1,322,086
Purchased kWh	0	Average Price of Fuel	$5.86
Total Purchased & Generated	3,234,644	Fuel Cost per kWh sold	$0.49
		Annual Non-Fuel Expenses	$552,915
		Non-Fuel Expense per kWh Sold	$0.21
		Total Expense per kWh Sold	$0.70

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	1,041,859	Consumed vs Generated (kWh Sold vs Generated-Purchased)	82.7%
Community Facility kWh Sold	458,606	Line Loss (%)	14.6%
Other kWh Sold (Non-PCE)	1,175,262	Fuel Efficiency (kWh per Gallon of Diesel)	14.35
Total kWh Sold	2,675,727	PH Consumption as % of Generation	2.7%
Powerhouse (PH) Consumption kWh	87,029		
Total kWh Sold & PH Consumption	2,762,756		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Galena Village

Louden Village

Galena and Louden, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour

LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
LTC	Louden Tribal Council
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Galena, a rural and predominantly Alaska Native community of approximately 460 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Galena. GHG production levels and energy costs for Galena were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Galena in 2022 (AEA 2023). Galena's 207 residential customers, 14 community facility customers, and 172 other customers required 5,033,573 kWh in diesel-generated power. A total of 392,347 gallons of fuel were consumed by Galena customers in 2022 at a cost of $899,570 ($2.29 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Galena accounted for approximately 8,780,756 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Galena in 2022 was $0.21. The annual non-fuel expenses associated with power generation totaled $907,574 in FY22, resulting in an additional cost of $0.21 per kWh sold. Thus, the combined fuel and non-fuel expenses in Galena were $0.42 per kWh sold in FY22. The last reported electric rate paid by customers was $.60 per kWh. Galena's electric rate is 3.75 times the national average of $0.16 per kWh. Galena was PCE eligible for 20.5% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Galena in the amount of $197,865 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $895 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Galena. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Galena:

- Residential Sector
    - Natural Gas = 34.66 MT CO_2e
    - Residual Fuel Oil No. 5 = 1,504.71 MT CO_2e
    - Wood and Residuals = 26.73 MT CO_2e
- Commercial Sector

- Distillate Fuel Oil No. 1 = 424.07 MT CO_2e
- Propane = 32.37 MT CO_2e
- Wood and Wood Residuals = 1.18 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Galena was modeled. The analysis indicated that approximately 4,191.39 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (1,207.12 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic (PV) + battery energy storage system (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Galena are:

- Solar PV + BESS array (may reduce fuel consumption and CO_2 production by up to 20%);
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

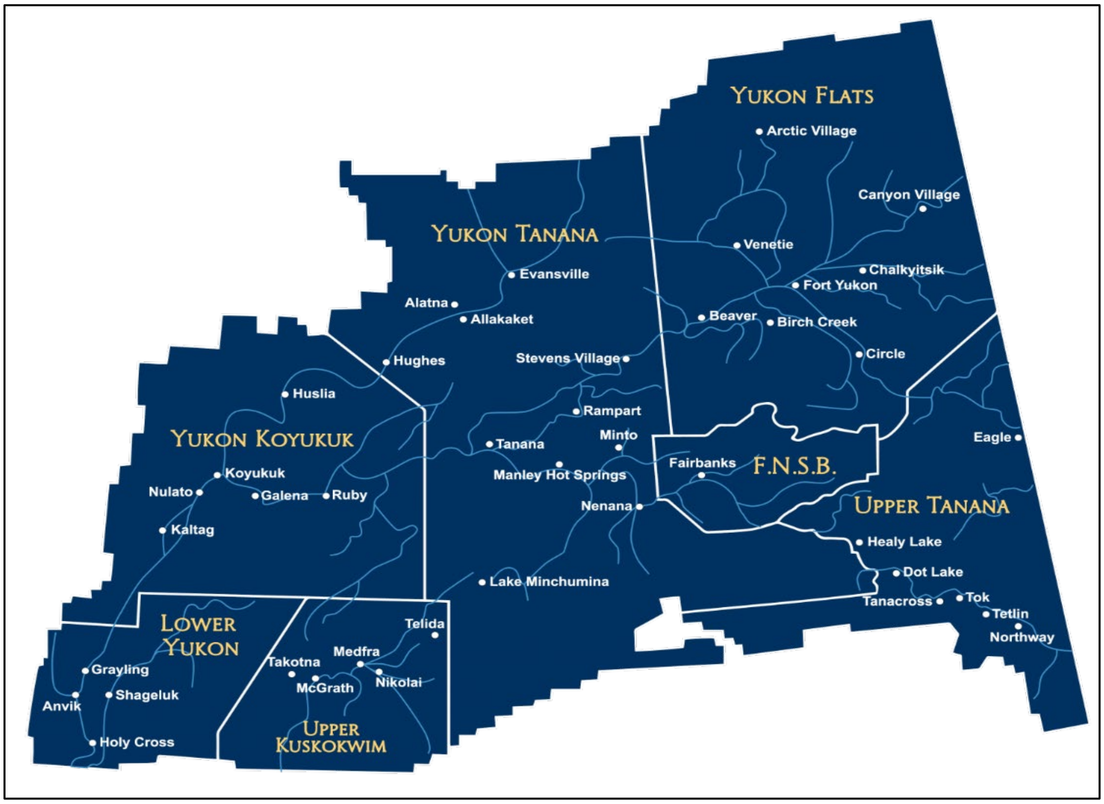
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Galena

Galena is a traditional Yukon Koyukuk Tanana Athabascan village that is home to approximately 440 residents. Galena is located on the north bank of the Yukon River, 45 miles east of Nulato and 270 air miles west of Fairbanks. It lies northeast of the Innoko National Wildlife Refuge.

Galena experiences a cold, continental climate with extreme temperature differences. The average daily high temperature during July is in the low 70s; the average daily low temperature during January ranges from 10 to below 0 °F. Sustained temperatures of -40 °F are common during winter. Extreme temperatures have been measured from -64 to 92 °F. Annual precipitation averages 12.7 inches, with 60 inches of snowfall. The river is ice-free from mid-May through mid-October. The U.S. EPA indicates that Galena's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Galena as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 43% of Galena's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Galena, Alaska

Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Galena. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies southwest of Galena Village and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Galena's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs.

Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Galena's airport is a state-owned, public-use airport. The airport covers an area of 446 acres and has one runway with a gravel surface. Additionally, there are several other areas around the village that may be suitable.

Galena received a portion of a grant from The US Department of Energy Office of Clean Energy Demonstrations (OCED) to reduce emissions and establish largely Solar/Batter arrays. This will provide more than 35% of the annual electric power through renewable energy for Galena and the other seven remote tribal communities included in this grant.

The U.S. Department of Energy (DOE) awarded funding to the Louden Tribe/ Galena Village (Tribe) to procure, install, integrate, and operate a ground-mounted community-scale solar photovoltaic (PV) panel array to supplement the existing power distribution system located on city-owned property in the City of Galena, Alaska.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Galena is estimated to be 6.9 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 56 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Due to the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Galena because of the number of moving parts that must continue operating at very cold temperatures. Should Galena pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

[3] Circle Wind Forecast, AK 99733 - WillyWeather

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future.[4]

In light of the community's dependency on imported fossil fuels, the Sustainable Energy for Galena Alaska (SEGA) Project was established in 2014. The project was initiated due to the fuel reserves left behind by the United States Air Force, which totaled 1.5 million gallons, and was intended to power the former airbase that now serves as the Galena Interior Learning Academy (GILA).

The inefficiency of the existing heating system resulted in the loss of approximately half of the heating value. The community of Galena decided between 2008 and 2009 to shift toward utilizing wood as a heating source for the school. This decision was made to conserve the diminishing fuel supply and to improve the overall energy efficiency of the school's heating system. We aim to use sustainable biomass that will meet the needs of future generations and the environment.

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

In 2014, Sustainable Energy for Galena Alaska (SEGA) was created, a nonprofit jointly run by the Galena City School District, the City of Galena, and the Louden Tribal Council to keep Galena warm using locally sourced popular, spruce, and birch harvested in a way that is sustainable for future generations. SEGA harvests from the land of the Native Village Corporation, Gana-A'Yoo Limited, and processes it into enough wood chips to fuel the learning academy for a year at a time.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

Galena Village's transmission lines are likely due for upgrading, along with any transformers and other hardware required to maintain the power grid. Should Galena explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

Galena Village received a grant from the Bipartisan Infrastructure Law provision 40101(d) – Department of Energy Electric Grid Resiliency to improve the resilience of their electric grids. Administered by the National Energy Technology Laboratory and falling under the provision 40101(d), the program is designed to strengthen and modernize America's power grid against wildfires, extreme weather, and other natural disasters that are exacerbated by the climate crisis.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

The Edward G. Pitka Sr. Airport is a state-owned public-use airport located in Galena, Alaska. Edward G. Pitka Sr Airport covers an area of 1,250 acres It has two runways with an asphalt and concrete surface.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.

- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Galena does not have plans to incorporate EV charging stations as it is only accessible by air and water.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

The Yukon River Village of Galena and the University of Alaska Fairbanks received a grant from the US Department of Energy. The project will focus on hydrokinetic technologies, which use energy generated from the natural movement of water. Galena, an off the road system and 270 miles west of Fairbanks, is served by a local microgrid that uses diesel-powered generators. Reliable hydrokinetic turbines could allow the diesel generators to be turned off during ice-free months. With no need to build an expensive dam, energy generated by hydrokinetic turbines is potentially less costly for the community. The river, when running, could provide 10 to 100 times more energy than the community needs.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. There are no known plans for Galena to pursues a heat recovery project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Weatherization of housing and building components in Galena would reduce heat loss and improve energy efficiency. It is not known whether Galena has taken significant steps to improve weatherization of community buildings or residences.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory

- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

The survey completed by the community of Galena indicated they currently do not have an energy/economic development plan and would like help updating it. Their three top energy priorities are to reduce the cost of electricity, Improve reliability of power generation (i.e. reduce power outages), and reduce their reliance on diesel fuel.

Upgrades to the power plant are needed to incorporate the upcoming large scale solar array. Many costs will be covered under grants but the tribe needs to work with City of Galena as the project moves forward to ensure all upgrades are complete. There is biomass heat distribution to 4-5 buildings but is not currently in use. Galena has an upcoming solar project. They are interested in opening or expanding the following types of projects:

- Run-of-river hydroelectric systems
- Battery energy storage systems for the Galena City School District

Nearly 80% of the older homes in Fort Yukon need upgrades. These homes could use weatherization updates. The community would like to see a new energy audit for their community buildings. They would like to see a plan for weatherization for these buildings.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Galena (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel,

including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Galena indicated diesel was the primary energy source of power and GHG emissions in Galena in 2022 (AEA 2023). Galena's 207 residential customers, 14 community facility customers, and 172 other customers required 5,033,573 kWh in diesel-generated power. A total of 392,347 gallons of fuel were consumed by Galena customers in 2022 at a cost of $899,570 ($2.29 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Galena accounted for approximately 8,780,756 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Galena in 2022 was $0.21. The annual non-fuel expenses associated with power generation totaled $907,574 in FY22, resulting in an additional cost of $0.21 per kWh sold. Thus, the combined fuel and non-fuel expenses in Galena were $0.42 per kWh sold in FY22. The last reported electric rate paid by customers was $.60 per kWh. Galena's electric rate is 3.75 times the national average of $0.16 per kWh. Galena was PCE eligible for 20.5% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Galena in the amount of $197,865 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $895 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Galena Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
440	207	14	172

Source: AEA 2023

Table 2. Galena Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh / gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced [5] (lbs)
5,033,573	0	86.1%	12.83	4,420,228	392,347	17,531

Sources: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Galena (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Galena. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Galena:

- Residential Sector
  - Natural Gas = 34.66 MT CO2e
  - Residual Fuel Oil No. 5 = 1,504.71 MT CO2e
  - Wood and Residuals = 26.73 MT CO2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 424.07 MT CO2e
  - Propane = 32.37 MT CO2e
  - Wood and Wood Residuals = 1.18 MT CO2e

The level of on-site combustion emissions that result in electricity generation for Galena was modeled. The analysis indicated that approximately 4,191.39 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (1,207.12 MT CO2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Galena may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider pursuing grant funding for a solar PV array + BESS to reduce diesel consumption and GHG emissions.
2. **Biomass Heating System:** If never constructed, it is recommended that the community pursue funding for the wood biomass system that was designed and studied for the community of Galena Village, as this would reduce dependency on diesel fuel and provide an alternate heat system that could reduce overall GHGs.
3. **Additional Weatherization.** It is recommended that the community make advances to weatherize several residences and community buildings to reduce heat escape, electric bills, and CO_2 emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 30% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 2172 kWh PV Renewable Solar + 3301 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Mill. $)	Utility Improvements (Mill. $)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
2172 kWh PV; 3301 kWh BESS	12.9	1.00	30%	294,260	98,087	371,299	995,080	996

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

Galena is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Yukon Flats communities like Galena to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Galena Village Council (BVC) is the governing body for Galena Village, a federally recognized tribe. The BVC has the authority to implement GHG reduction measures through resolutions passed in BVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, BVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Galena to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider pursuing grant funding for a solar PV array + BESS to reduce diesel consumption and GHG emissions.

2. **Biomass Heating System:** If never constructed, it is recommended that the community pursue funding for the wood biomass system that was designed and studied for the community of Galena Village, as this would reduce dependency on diesel fuel and provide an alternate heat system that could reduce overall GHGs.

3. **Additional Weatherization.** It is recommended that the community make advances to weatherize several residences and community buildings to reduce heat escape, electric bills, and CO_2 emissions.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide

additional fuel savings, including during winter. However, the wind source around Galena is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The community will examine the condition of its current power grid under recent Department of Energy Electric Grid Resiliency funding; it has likely not been updated or upgraded since the lines were initially installed.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Galena / Louden (FY2022)

Galena PCE

Utility: CITY OF GALENA
Reporting Period: 07/01/21 to 06/30/22

Community Population	440
Last Reported Month	June
No. of Monthly Payments Made	11
Residential Customers	207
Community Facility Customers	14
Other Customers (Non-PCE)	172
Fiscal Year PCE Payments	**$197,865**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	575,423	Average Annual PCE Payment per Eligible Customer	$895
PCE Eligible kWh - Community Facility Customers	311,950	Average PCE Payment per Eligible kWh	$0.22
Total PCE Eligible kWh	887,373	Last Reported Residential Rate Charged (based on 500 kWh)	$0.60
Average Monthly PCE Eligible kWh per Residential Customer	253	Last Reported PCE Level (per kWh)	$0.26
Average Monthly PCE Eligible kWh per Community Facility Customer	2,026	Effective Residential Rate (per kWh)	$0.34
Average Monthly PCE Eligible Community Facility kWh per Person	64	PCE Eligible kWh vs Total kWh Sold	20.5%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	5,033,573	Fuel Used (Gallons)	392,347
Non-Diesel kWh Generated	0	Fuel Cost	$899,570
Purchased kWh	0	Average Price of Fuel	$2.29
Total Purchased & Generated	5,033,573	Fuel Cost per kWh sold	$0.21
		Annual Non-Fuel Expenses	$907,574
		Non-Fuel Expense per kWh Sold	$0.21
		Total Expense per kWh Sold	$0.42

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	763,713	Consumed vs Generated (kWh Sold vs Generated-Purchased)	86.1%
Community Facility kWh Sold	391,169	Line Loss (%)	12.2%
Other kWh Sold (Non-PCE)	3,179,357	Fuel Efficiency (kWh per Gallon of Diesel)	12.83
Total kWh Sold	4,334,239	PH Consumption as % of Generation	1.7%
Powerhouse (PH) Consumption kWh	85,989		
Total kWh Sold & PH Consumption	4,420,228		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Village of Grayling

Grayling, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GIRAC	Grayling IRA Council
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer

kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
OCED	Office of Clean Energy Demonstrations
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Grayling, a rural and predominantly Alaska Native community of approximately 189 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Grayling. GHG production levels and energy costs for Grayling was first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), power generation data from the Alaska Village Electric Cooperative (AVEC), and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Grayling in 2022 (AEA 2023). Grayling's 67 residential customers, 10 community facility customers, and 28 other customers required 612,867 kWh in diesel-generated power. A total of 49,469 gallons of fuel were consumed by Grayling customers in 2022 at a cost of $142,023 ($2.87 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Grayling accounted for approximately 1,107,116 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Grayling in 2022 was $0.25. The annual non-fuel expenses associated with power generation totaled $ $112,945 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Grayling were approximately $0.45 per kWh sold in FY22. The last reported electric rate paid by customers was $0.59 per kWh. Thus, Grayling's electric rate is over 3.5 times the national average of $0.16 per kWh. Grayling was PCE eligible for 60.2% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Grayling in the amount of $98,376 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,278 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Grayling. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Grayling:

- Residential Sector
  - Natural Gas = 23.11 MT CO_2e
  - Residual Fuel Oil No. 5 = 527.97 MT CO_2e
  - Wood and Residuals = 8.55 MT CO_2e

- Commercial Sector
  - Distillate Fuel Oil No. 1 = 188.37 MT CO_2e
  - Propane = 14.38 MT CO_2e
  - Wood and Wood Residuals = 0.52 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Grayling was modeled. The analysis indicated that approximately 562.52 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (16.01 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar PV + BESS scenario to meet this fraction. For Grayling, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 564 kWh solar PV and a 781 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic (PV) + battery energy storage system (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Grayling are:

- Solar PV + BESS array to reduce diesel fuel consumption and CO_2 emission;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

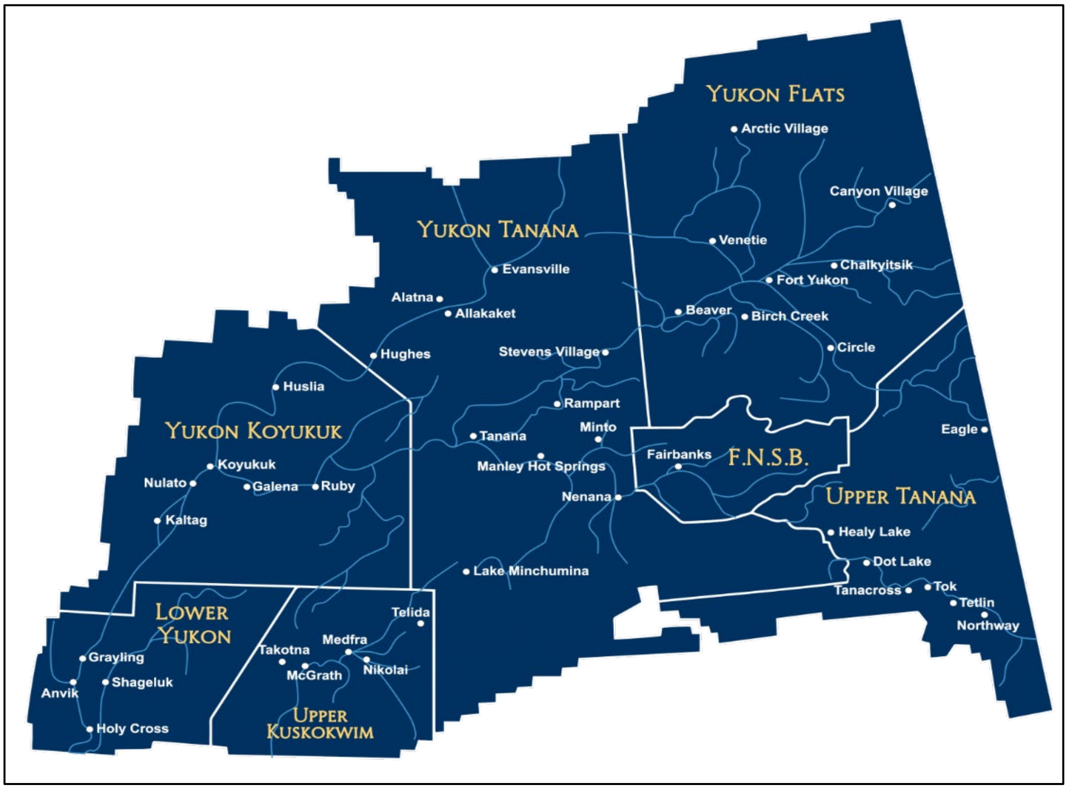
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

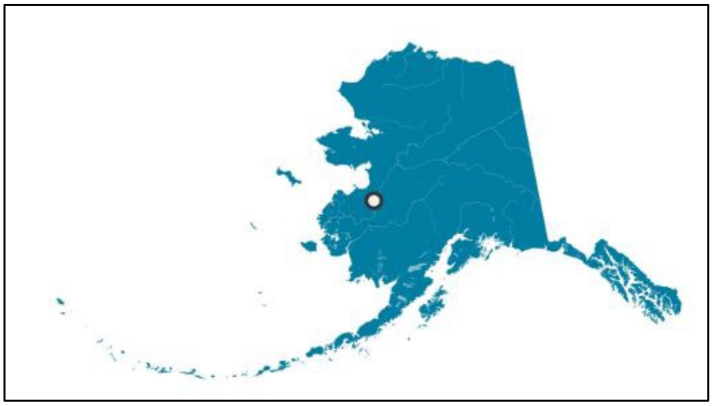
- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Grayling

Grayling is a traditional Lower Yukon Athabascan village that is home to approximately 189 residents. Grayling is located in Interior Alaska on the west bank of the Yukon River, east of the Nulato Hills. It is 18 air miles north of Anvik.

The climate of Grayling is continental, with long, cold winters and relatively warm summers. Temperature extremes range between -60 to 87 °F. Annual snowfall averages 110 inches, with 21 inches of total precipitation. The Yukon River is ice-free from June through October. The U.S. EPA indicates that Grayling's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Grayling as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 87.7% of Grayling's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2]

Figure 2. Location of Grayling, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Grayling. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Grayling and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (Department of Energy - DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Grayling’s case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community’s dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Grayling's public airport is located one mile southeast of the central business district of Grayling. There is one runway with a gravel surface and features a small terminal building. Additionally, there are several other areas around the village that may be suitable.

Grayling received a portion of a grant from the U.S. Department of Energy (DOE) Office of Clean Energy Demonstrations (OCED) to reduce emissions and establish solar / battery arrays. This will provide more than 35% of the annual electric power through renewable energy for Grayling and the other seven remote tribal communities included in this grant.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Grayling is estimated to be 8.7 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 189 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique

[3] Grayling Wind Forecast, AK 99590 - WillyWeather

challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [4]

Since 2008, the Alaska State Legislature has supported renewable electric and thermal energy projects through the Renewable Energy Grant Recommendation Program, administered by the AEA. In Round 6 of the Program, the Interior Regional Housing Authority, which seeks opportunities to promote community self-sufficiency through community energy projects, received money to complete pre-feasibility studies of biomass heat in community buildings in seven villages including Grayling. A pre-feasibility study has been funded through that grant (Energy Action 2014).

This pre-feasibility assessment considers biomass heat at the main school building of the David Louis Memorial School in Grayling. The proposed biomass project would use an estimated 86 cords per year to displace about 85% of the main School building's fuel oil consumption, which totals 10,000 gallons per year. The project is considered financially unfeasible at this time, largely because the local price of cordwood does not represent sufficient savings over the purchase price of fuel oil (Energy Action 2014). The project also faces technical challenges, since cordwood systems are not very effective when serving building heat loads that operate in a narrow temperature range, such as 180 / 160°F. It was recommended that the school district consider other ways of reducing energy costs, which may include energy management, retro-commissioning, energy efficiency upgrades, and other types of renewable energy.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Grayling, transmission lines, transformers, and switch gear may be due for upgrade, along with other hardware required to maintain the power grid. Should Grayling explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

The Alaska Village Electric Cooperative (AVEC), with the funding of Denali Commission and AEA, have been investing in various upgrades that will improve plant efficiency enabling future integration of renewable energy. The existing manual single-phase three-in-one panel controls are being replaced with automated switchgear controls, a significant upgrade to the cooling system, and two new electronic gensets are being installed.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Grayling has a state-owned public airport located two miles east of the Grayling. The airport covers 87 acres with one gravel runway. Currently, there are no plans for electrification of the airport or waterfront.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Grayling does not have plans to incorporate EV charging stations as it is only accessible by air or water.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Grayling is located on the west bank of the Yukon River, east of the Nulato Hills; however, no hydrokinetic projects are currently planned for the community.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

AVEC, through Denali Commission and AEA funding, has been investing in various upgrades that will improve plant efficiency enabling future integration of renewable energy (AVEC 2024). AVEC and ANTHC are working together to upgrade the heat recovery system supplying heat to the water treatment plant in Grayling that was constructed in 2018. This project replaces the exhaust manifold on the primary Detroit Diesel Series 60 generator engine with a marine manifold with a turbocharger and also includes updating the required controls.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

It is not known when the last significant weatherization efforts occurred for Grayling. However, weatherization of housing and building components would reduce heat loss and improve energy efficiency in the community.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Grayling in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Grayling (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest, and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Grayling in 2022 (AEA 2023). Grayling's 67 residential customers, 10 community facility customers, and 28 other customers required 612,867 kWh in diesel-generated power. A total of 49,469 gallons of fuel were consumed by Grayling customers in 2022 at a cost of $142,023 ($2.87 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Grayling accounted for approximately 1,107,116 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Grayling in 2022 was $0.25. The annual non-fuel expenses associated with power generation totaled $ $112,945 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Grayling were approximately $0.45 per kWh sold in FY22. The last reported electric rate paid by customers was $0.59 per kWh. Thus, Grayling's electric rate is over 3.5 times the national average of $0.16 per kWh. Grayling was PCE eligible for 60.2% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Grayling in the amount of $98,376 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,278 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Grayling Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
189	67	10	28

Source: AEA 2023

Table 2. Grayling Fuel Consumption and CO_2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ Gal. Diesel) *	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[5] (lbs)
612,867	-	92.7%	12.39	591,498	49,469	2,210

Sources: AEA 2023, *AP&T for Grayling

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 AVEC Power Generation Data

AVEC is the electric utility for eight of the communities in TCC's region, including Grayling. AVEC provides the following data for Grayling:

- Diesel Generators:
  - Station 1: Detroit Diesel S60K4 1200, 236 kW
  - Station 2: Cummins LTA10 1200, 168 kW
  - Station 3: Cummins LTA10 1800, 203 kW
- Average Load: 72 kW
- Estimated peak load: 139 kW
- Average annual power generated: 632,910 kWh
- Average fuel consumed: 48,679 gallons/year
- Average fuel efficiency: 13.01 kWh/gallon

3.4 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Grayling (Constellation Energy, 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Grayling. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Grayling:

- Residential Sector
    - Natural Gas = 23.11 MT CO_2e
    - Residual Fuel Oil No. 5 = 527.97 MT CO_2e

- Wood and Residuals = 8.55 MT CO_2e

- Commercial Sector
  - Distillate Fuel Oil No. 1 = 188.37 MT CO_2e
  - Propane = 14.38 MT CO_2e
  - Wood and Wood Residuals = 0.52 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Grayling was modeled. The analysis indicated that approximately 562.52 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (16.01 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

3.5 GHG Reduction Targets

Grayling may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative

3.6 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for additional funding to reach maximum energy cost savings and CO_2 emissions

reduction. Electric generation created through solar will reduce diesel fuel consumption and generator run time.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings to reduce consumption of heating oil and lower GHG emissions.

3.7 Benefits Analysis

An analysis was performed under a scenario in which 50% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 564 kWh PV Renewable Solar + 781 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Millions)	Utility Improvements (Millions)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
564 kWh PV; 781 kWh BESS	3.04	1.00	50%	27,208	22,262	84,267	225,836	226

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

3.8 Review of Authority to Implement

The Grayling IRA Council (GIRAC) is the governing body for Grayling Village, a federally recognized tribe. The GIRAC has the authority to implement GHG reduction measures through resolutions passed in GIRAC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, GIRAC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Grayling to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended the community consider applying for funding for a solar PV + BESS that will reduce fuel consumption and GHG emissions.
2. **Residential Weatherization.** It is likely that many community homes and residences in Grayling have not had significant weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** While a biomass boiler has successfully reduced consumption of heating fuel, a second boiler may have additional positive effects. There may be funding opportunities for Grayling to pursue to expand their existing system.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Grayling is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** It is recommended the community examine the condition of the current power grid and consider applying for grid resiliency funding, as it likely has not been significantly upgraded since initial construction.

5 References

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Grayling (FY2022)

Galena PCE

Utility: CITY OF GALENA
Reporting Period: 07/01/21 to 06/30/22

Community Population	440
Last Reported Month	June
No. of Monthly Payments Made	11
Residential Customers	207
Community Facility Customers	14
Other Customers (Non-PCE)	172
Fiscal Year PCE Payments	**$197,865**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	575,423	Average Annual PCE Payment per Eligible Customer	$895
PCE Eligible kWh - Community Facility Customers	311,950	Average PCE Payment per Eligible kWh	$0.22
Total PCE Eligible kWh	887,373	Last Reported Residential Rate Charged (based on 500 kWh)	$0.60
Average Monthly PCE Eligible kWh per Residential Customer	253	Last Reported PCE Level (per kWh)	$0.26
Average Monthly PCE Eligible kWh per Community Facility Customer	2,026	Effective Residential Rate (per kWh)	$0.34
Average Monthly PCE Eligible Community Facility kWh per Person	64	PCE Eligible kWh vs Total kWh Sold	20.5%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	5,033,573	Fuel Used (Gallons)	392,347
Non-Diesel kWh Generated	0	Fuel Cost	$899,570
Purchased kWh	0	Average Price of Fuel	$2.29
Total Purchased & Generated	5,033,573	Fuel Cost per kWh sold	$0.21
		Annual Non-Fuel Expenses	$907,574
		Non-Fuel Expense per kWh Sold	$0.21
		Total Expense per kWh Sold	$0.42

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	763,713	Consumed vs Generated (kWh Sold vs Generated-Purchased)	86.1%
Community Facility kWh Sold	391,169	Line Loss (%)	12.2%
Other kWh Sold (Non-PCE)	3,179,357	Fuel Efficiency (kWh per Gallon of Diesel)	12.83
Total kWh Sold	4,334,239	PH Consumption as % of Generation	1.7%
Powerhouse (PH) Consumption kWh	85,989		
Total kWh Sold & PH Consumption	4,420,228		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Healy Lake Village

Healy Lake, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HLVC	Healy Lake Village Council
HUD	Housing and Urban Development
IPP	Independent Power Producer

kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
OCED	US Department of Energy Office of Clean Energy Demonstrations
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Healy Lake, a rural and predominantly Alaska Native community of approximately 20 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Healy Lake. GHG production levels and energy costs for Healy Lake was first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy, 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Healy Lake in 2022 (AEA 2023). Healy Lake's 10 residential customers, 3 community facility customers, and 2 other customers required 103,619 kWh in diesel-generated power. A total of 11,571 gallons of fuel were consumed by Healy Lake customers in 2022 at a cost of $35,927 ($3.10 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Healy Lake accounted for approximately 258,959 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Healy Lake in 2022 was $0.37. The annual non-fuel expenses associated with power generation totaled $93,207 in FY22, resulting in an additional cost of $0.96 per kWh sold. Thus, the combined fuel and non-fuel expenses in Healy Lake were approximately $1.34 per kWh sold in FY22. The last reported electric rate paid by customers was $0.89 per kWh. Thus, Healy Lake's electric rate is over 5.5 times the national average of $0.16 per kWh. Healy Lake was PCE eligible for 41.1% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Healy Lake in the amount of $17,433 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,341 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Healy Lake. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Healy Lake:

- Residential Sector
  - Wood and Residuals = 1.07 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 21.34 MT CO_2e

- Propane = 1.63 MT CO_2e
- Wood and Wood Residuals = 0.06 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Healy Lake was modeled. The analysis indicated that approximately 87.11 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (25.09 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar PV + BESS scenario to meet this fraction. For Healy Lake, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 94 kWh solar PV and a 135 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic (PV) + battery energy storage system (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Healy Lake are:

- Solar PV + BESS array to reduce diesel fuel consumption and CO_2 emission;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

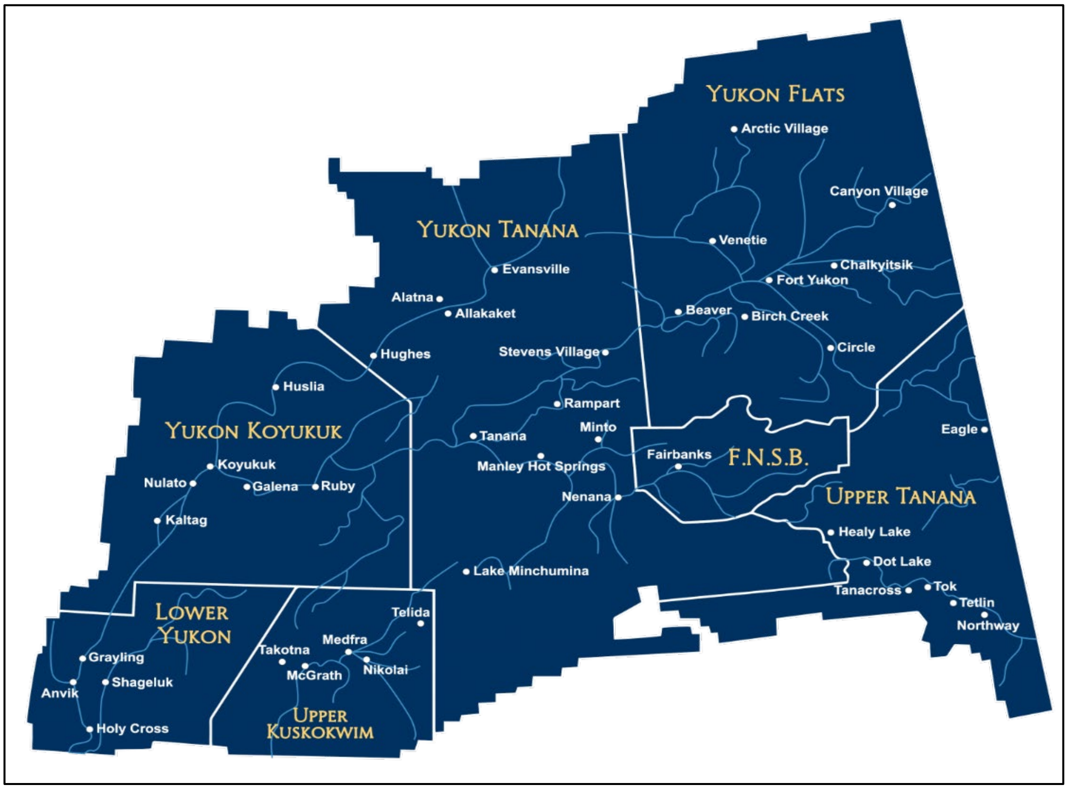
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

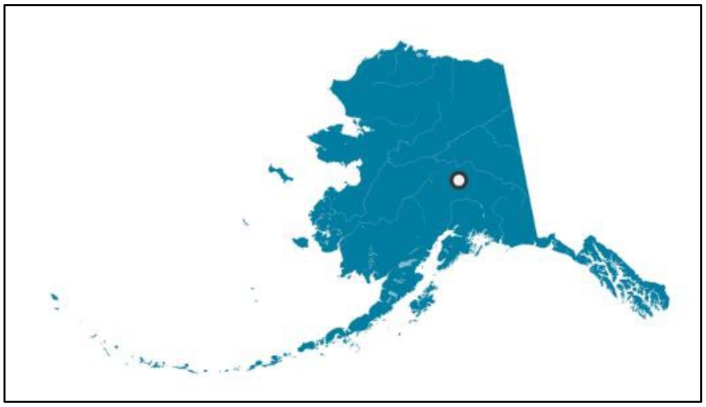
1.4 Scope of this PCAP: The Community of Healy Lake

Healy Lake is a traditional Upper Tanana Athabascan village that is home to approximately 20 residents. The 5-mile long Healy Lake lies on the course of the Healy River, 29 miles east of Delta Junction. The climate of Healy Lake lies within the continental climatic zone, with cold winters and warm summers. Average temperatures range from -32 to 72 °F.

Healy Lake's Tribal population is below poverty level, and the community is identified as a Historically Disadvantaged Community existing in an Area of Persistent Poverty. Healy Lake's

Tribal residents are likely all low or middle income; however, the U.S. Department of Housing and Urban Development (HUD) has no data for this community)[2]

Figure 2. Location of Healy Lake, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Healy Lake. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies southwest of Healy Lake and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Healy Lake's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. PV systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska

Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Healy Lake's public airport is located one mile southeast of the central business district of Healy Lake. There is one runway with a gravel surface and features a small terminal building. Additionally, there are several other areas around the village that may be suitable.

Healy Lake Village Council previously received funding from the Tribal Solar Accelerator Fund to install a solar hybrid grid tie-in system that will offset at least 50% of annual cost of power for the clinic/office, which are the communities most expensive buildings for electrical costs (Tribal Solar, n.d.).

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Healy Lake is estimated to be 9.5 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 20 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique

[3] Healy Lake Wind Forecast, AK 99706 - WillyWeather

challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [4]

In 2013, a feasibility study was performed for Healy Lake through the support of the Alaska Wood Energy Task Group and the Fairbanks Economic Development Corporation (Koontz and Wall 2013). This was a study to determine the feasibility of using an automated wood-fired boiler for heat in place of the existing heat sources for the washateria and the adjoining Margaret Kirsteatter Community Hall. Three types of boilers were assessed (stick-fired, chip-fured, or pellet boilers).

The two buildings are connected by a covered walkway. The washeteria is heated by an older oil-fed boiler, and the community hall contains a wood stove. Piping between the two buildings is simple and requires no buried pipe or trenching. The washeteria boiler piping has been modified to provide hot water to a fan coil unit in the Community Hall, which blows hot air into the building and provides a level of background heat. The intent of the project would be to heat the Hall for elders' daily lunches and to help the kitchen function year-round.

The study showed that all three types of boilers examined were determined to be economically viable and each was an appealing option (Koontz and Wall 2013). The major difference between chip- and stick-fired boilers was that the stick-fired boiler required hand-feeding at least 3 times per day to reach maximum output. The chip fired boiler required a chipper but feeding an auto feed boiler once per week with chips. The pellet boiler option required importing pellets rather than using a local source, so while appealing, it was not as attractive an option as the other two. It is unknown if any further work was done based on the recommendations in this study, but the study provided the information needed for Healy Lake residents and other stakeholders to make decisions on the project.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Healy Lake, transmission lines, transformers, and switch gear may be due for upgrade, along with other hardware required to maintain the power grid. Should Healy Lake explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

Healy Lake received a grant from the Bipartisan Infrastructure Law provision 40101(d) – Department of Energy Electric Grid Resiliency to improve the resilience of their electric grids. Administered by the National Energy Technology Laboratory, the program is designed to strengthen and modernize America's power grid against wildfires, extreme weather, and other natural disasters that are exacerbated by the climate crisis.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Healy River Airport is a state owned, public use airport serving Healy Lake, Alaska. Healy River Airport covers an area of 1,294 acres and has one runway with an asphalt surface. There are no plans to add electrification to the Healy River Airport.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Healy Lake does not have plans to incorporate EV charging stations as it is only accessible

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Healy Lake has no known plans to develop a hydrokinetic energy project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. There are no known plans for a heat recovery system in Healy Lake at this time.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Many of the older homes in Healy Lake need upgrades, and in 2018 only half of the homes in the area had weatherization updates (See Section 3.1, below). However, weatherization of housing and building components would reduce heat loss and improve energy efficiency in the community.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

The survey completed by the community of Healy Lake indicated they currently do not have an energy/economic development plan. Their three top energy priorities are to reduce the cost of electricity, improve reliability of power generation (i.e. reduce power outages), and reduce energy costs of public buildings and facilities.

Upgrades to the power plant are needed. They are interested in opening or expanding the following types of projects:

- Community-scale solar photovoltaic systems with BESS
- Wind Turbines

Healy Lake's highest priority is lowering the cost of electricity. Many of the older homes in Healy Lake need upgrades. In 2018, only half of the homes in the area had weatherization updates. Most homes in Healy Lake don't have basic utilities including power, water, and sewer. The community would like to see a new energy audit for their community buildings. They would like to see a plan for weatherization for these buildings.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Healy Lake (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Healy Lake in 2022 (AEA 2023). Healy Lake's 10 residential customers, 3 community facility customers, and 2 other customers required 103,619 kWh in diesel-generated power. A total of 11,571 gallons of fuel were consumed by Healy Lake customers in 2022 at a cost of $35,927 ($3.10 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Healy Lake accounted for approximately 258,959 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Healy Lake in 2022 was $0.37. The annual non-fuel expenses associated with power generation totaled $93,207 in FY22, resulting in an additional cost of $0.96 per kWh sold. Thus, the combined fuel and non-fuel expenses in Healy Lake were approximately $1.34 per kWh sold in FY22. The last reported electric rate paid by customers was $.89 per kWh. Thus, Healy Lake's electric rate is over 5.5 times the national average of $0.16 per kWh. Healy Lake was PCE eligible for 41.1% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Healy Lake in the amount of $17,433 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,341 (AEA 2023).

Table 1. Healy Lake Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
20	10	3	2

Source: AEA 2023

Table 2. Healy Lake Fuel Consumption and CO_2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ Gal. Diesel) *	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[5] (lbs)
103,619	-	93.3%	8.96	100,868	11,571	517

Sources: AEA 2023, *AP&T for Healy Lake

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Healy Lake (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed “market-based” accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings’ heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations’ buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Healy Lake. The contribution of GHGs by fuel type to each sector’s overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Healy Lake:

- Residential Sector
  - Wood and Residuals = 1.07 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 21.34 MT CO_2e

- Propane = 1.63 MT CO_2e
- Wood and Wood Residuals = 0.06 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Healy Lake was modeled. The analysis indicated that approximately 87.11 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (25.09 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

3.4 GHG Reduction Targets

Healy Lake may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for funding for solar PV + BESS funding to reach maximum energy cost savings through renewables, and in doing so, lower CO_2 emissions reduction.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings to reduce consumption of heating oil and lower GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 94 kWh PV Renewable Solar + 135 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
94 kWh PV; 135 kWh BESS	0.612	1.00	50%	6,364	5,207	19,710	52,824	53

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

3.7 Review of Authority to Implement

The Healy Lake Village Council (HLVC) is the governing body for Healy Lake Village, a federally recognized tribe. The HLVC has the authority to implement GHG reduction measures through resolutions passed in HLVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, HLVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Healy Lake to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for funding for solar PV + BESS funding to reach maximum energy cost savings through renewables, and in doing so, lower CO_2 emissions reduction.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings to reduce consumption of heating oil and lower GHG emissions.

3. **Biomass Project(s):** A biomass project was studied and proven to be feasible for the community to lower heating fuel expenses. This would also reduce GHG emissions in the community. If the project was never constructed, it is recommended the community consider working with partners to apply for funding to construct the project.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Healy Lake is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** Several components of the electric grid in Healy Lake are currently being upgraded under a Grid Resiliency Grant from DOE. Following these upgrades, it is recommended the community examine the condition of any remaining hardware components that might require upgrades and consider apply for funding to upgrade these additional components also.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Healy Lake (FY2022)

Healy Lake PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	20
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	10
Community Facility Customers	3
Other Customers (Non-PCE)	2
Fiscal Year PCE Payments	**$17,433**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	23,285	Average Annual PCE Payment per Eligible Customer	$1,341
PCE Eligible kWh - Community Facility Customers	16,800	Average PCE Payment per Eligible kWh	$0.43
Total PCE Eligible kWh	40,085	Last Reported Residential Rate Charged (based on 500 kWh)	$0.89
Average Monthly PCE Eligible kWh per Residential Customer	194	Last Reported PCE Level (per kWh)	$0.57
Average Monthly PCE Eligible kWh per Community Facility Customer	467	Effective Residential Rate (per kWh)	$0.33
Average Monthly PCE Eligible Community Facility kWh per Person	70	PCE Eligible kWh vs Total kWh Sold	41.4%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	103,619	Fuel Used (Gallons)	11,571
Non-Diesel kWh Generated	0	Fuel Cost	$35,927
Purchased kWh	0	Average Price of Fuel	$3.10
Total Purchased & Generated	103,619	Fuel Cost per kWh sold	$0.37
		Annual Non-Fuel Expenses	$93,207
		Non-Fuel Expense per kWh Sold	$0.96
		Total Expense per kWh Sold	$1.34

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	24,788	Consumed vs Generated (kWh Sold vs Generated-Purchased)	93.3%
Community Facility kWh Sold	54,888	Line Loss (%)	2.7%
Other kWh Sold (Non-PCE)	17,033	Fuel Efficiency (kWh per Gallon of Diesel)	8.96
Total kWh Sold	96,709	PH Consumption as % of Generation	4.0%
Powerhouse (PH) Consumption kWh	4,159		
Total kWh Sold & PH Consumption	100,868		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Priority Climate Action Plan

Holy Cross Village

Holy Cross, AK

Table of Contents

1 List of Figures

2 List of Tables

3 List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
AVEC	Alaska Village Electric Cooperative
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CCHRC	Cold Climate Housing Research Center
CO_2	Carbon Dioxide
CO_2e	CO_2 Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HCTC	Holy Cross Tribal Council

HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Ton
NREL	National Renewable Energy Lab
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RACEE	Remote Alaskan Community Energy Efficiency Competition
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Holy Cross, a rural and predominantly Alaska Native community of approximately 167 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Holy Cross. GHG production levels and energy costs for Holy Cross were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), power generation data from the Alaska Village Electric Cooperative (AVEC) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Holy Cross in 2022 (AEA 2023). Holy Cross's 68 residential customers, 9 community facility customers, and 21 other customers required 560,424 kWh of diesel-generated power and 0 kWh of non-diesel-generated power. A total of 565,158 total kWh was sold to Holy Cross customers, requiring approximately 42,865 gallons of diesel fuel. Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 959,319 lbs CO_2 were produced in Holy Cross in FY2022.

The average fuel cost per kWh in Holy Cross in 2022 was $0.22. The annual non-fuel expenses associated with power generation totaled $107,751 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Holy Cross required to produce power in Holy Cross were $0.42 per kWh sold in FY22. The last reported electric rate was $0.55 per kWh. Holy Cross's electric rate is nearly three and a half times the national average of $0.16 per kWh. Holy Cross was PCE eligible for 57.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Holy Cross in the amount of $82,606 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,073 (AEA 2023).

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Holy Cross, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 487 kw solar PV and a 754 kWh BESS.

Constellation Energy (2024) modeled GHG emission sources and outputs for Holy Cross. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Holy Cross:

- Residential Sector
  - Residual Fuel Oil No. 5 = 739.16 MT CO_2e
  - Wood and Residuals = 12.12 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 159.61 MT CO_2e
  - Propane = 12.18 MT CO_2e
  - Wood and Wood Residuals = 0.44 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Holy Cross was modeled. The analysis indicated that approximately 561.93 MWh electricity is used in this capacity in Holy Cross, resulting in emissions all stemming from diesel in the amount of 161.84 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software (UL Solutions 2024) for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO2 emission, and operational costs. Following a review of this information preferred options for cleaner, lower cost energy in Holy Cross are:

- Additional Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution.

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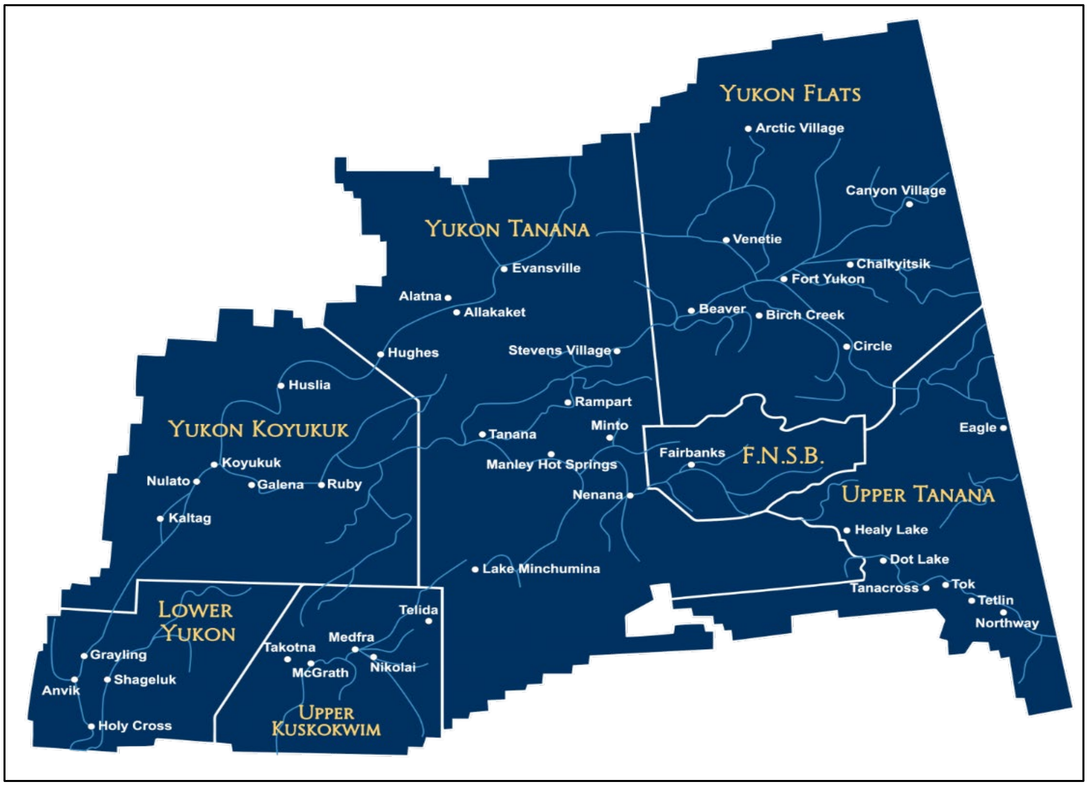
[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Village Electric Cooperative (AVEC), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

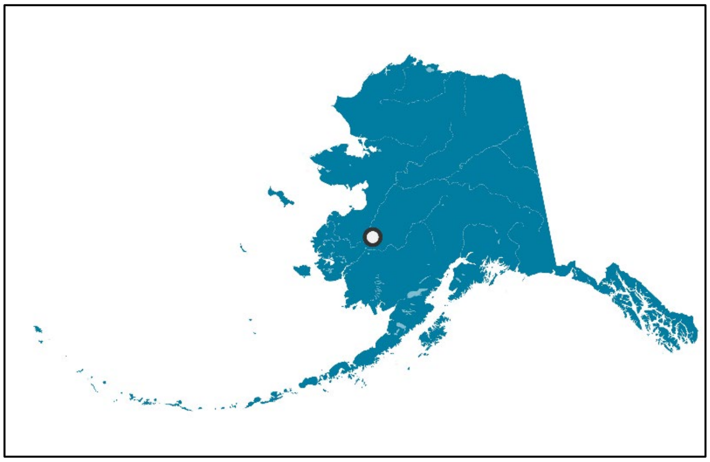
1.4 Scope of this PCAP: The Community of Holy Cross

Holy Cross is a traditional Lower Yukon Athabascan village home to approximately 167 residents. Holy Cross is located in Interior Alaska on the west bank of Ghost Creek Slough off the Yukon River, 40 miles northwest of Aniak and 420 air miles southwest of Fairbanks (Figure 2). Access is primarily by plane or barge. Holy Cross's power is generated locally at a diesel power plant operated by AVEC.

Holy Cross is located in the continental climatic zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. Extreme temperatures ranging from a low of -63°F to a high of 93°F have been measured. Average annual precipitation is 19 inches and average snowfall of 79 inches.

The U.S. EPA indicates that Holy Cross's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Holy Cross as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 83% of Holy Cross's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Holy Cross, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- o Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Holy Cross. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or

individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Holy Cross and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Holy Cross's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can

be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Holy Cross's airstrip is close to town, so this generally could work for a tie in location. Additionally, there are a number of other areas around the village that may be suitable.

Holy Cross was awarded a DOE Remote Alaskan Community Energy Efficiency Competition (RACEE) grant to increase tribal energy security through the implementation of energy efficiency projects. A portion of this grant was used to install a small solar photovoltaic (PV) system for the Tribal Hall and Water House (NREL 2018).

The Office of Clean Energy Demonstrations (OCED) within the U.S. DOE awarded TCC clean energy funding for the expansion of solar power and battery systems in eight Tribal Communities. As a part of the grant award, Holy Cross's Solar PV and BESS project will include the installation of 250kW PV, a 250kW Inverter, and 360 kW BESS .

2.1.1 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Holy Cross is estimated to be 7.2 mph[3] which is a Class 1 wind resource, approaching Class 2. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 167 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Holy Cross and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Holy Cross because of the number of moving parts that must continue operating at very cold temperatures. Should Holy Cross decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/holy-cross.html

2.1.2 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [4]

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Holy Cross, upgrades to the switchgear, controllers, and transformers are likely due, including regulating ramp rates on the diesel generators. Updating the switchgear and controllers is often a necessary step for proper incorporation of renewables. Holy Cross is currently collaborating with AVEC to conduct a solar feasibility study for local solar energy and battery storage potential in Holy Cross. The project would investigate available battery storage technologies for solar energy, sizing, and cost benefits for the community. The project is expected to be completed in 2024.

Holy Cross received the Bipartisan Infrastructure Law 40101(d) Grid Resilience Grant through TCC. Holy Cross will receive funding for electric grid resiliency (preventing / reducing number of electrical outages). This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Currently, there are no plans for airport or port electrification in Holy Cross; however, future solar PV + BESS systems could be installed in this area and tied into the grid.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow,

especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Holy Cross does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Holy Cross is bordered by Ghost Creek Slough off of the Yukon River. This available hydrological resource has spurred interest in the potential for hydrokinetic energy systems. It would require locating a water diversion structure several miles upstream, then routing a penstock that entire distance. The resulting costs of such a project may be prohibitively high.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In Holy Cross an expansion of the community's waste heat recovery system began in the fall of 2019. Multiple partners collaborated to expand the system. The Tanana Chiefs Conference (TCC), partnering with the Alaska Native Tribal Health Consortium (ANTHC), applied for and received a USDA grant to add the waste heat to the Water Treatment Plant and the Community Hall. Since the Community Hall is near the City Office, TCC was able to use RACEE funds to add length to the waste heat recovery return line to get the City Office waste heat incorporated with that for the Community Hall. A single loop from the electric plant now supplies both buildings.

The power plant in Holy Cross is managed by Alaska Village Electric Cooperative (AVEC). AVEC had some issues connecting all locations, and the final ones were coming online in summer 2021.

AVEC noted that the Holy Cross heat recovery system was operational and producing heat at 66 kBTU/HR. In order to produce the same amount of heat that the heat recovery system is producing at present, an additional 3,000 gallons of fuel would have to be burned, since one gallon of diesel contains 137,381 BTUs, or 137.38 kBTUs. Saving 66 kBTUs per hour means saving approximately 1/2 gallon of fuel every hour. That is equivalent to 12 gallons per day, or 360 gallons per month. With a 9-month heating season, that translates to 3,240 gallons using waste heat to service the facilities (TCC 2022).

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The last major weatherization effort was performed in collaboration with the City of Holy Cross and several partners, including Holy Cross Tribal Council, TCC, ANTHC, and the Iditarod Area School District, under which the Lodge, School, Old Tribal Office, City Office, Community Hall, Youth Center and the Clinic all received weatherization upgrades. In addition, 56 homes in Holy Cross, as well as multiple city buildings, were included in a community-wide LED lighting retrofit project. This project consisted of the inventory of existing features and the replacement of lightbulbs with energy efficient LED bulbs.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Holy Cross in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Holy Cross (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest, and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and resulting emissions in Holy Cross in 2022 (AEA 2023). Holy Cross's 68 residential customers, 9 community facility customers, and 21 other customers required 560,424 kWh of diesel-generated power and 0 kWh of non-diesel-generated power. A total of 565,158 total kWh was sold to Holy Cross customers, requiring approximately 42,865 gallons of diesel fuel. Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 959,319 lbs CO_2 were produced in Holy Cross in FY2022.

A total of 42,865 gallons of fuel were consumed at a cost of $119,042 ($2.78 per gallon). The average fuel cost per kWh in Holy Cross in 2022 was $0.22. The annual non-fuel expenses associated with power generation totaled $107,751 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Holy Cross required to produce power in Holy Cross were $0.42 per kWh sold in FY22. The last reported electric rate was $0.55 kWh. Holy Cross's electric rate is nearly three and a half times the national average of $0.16 per kWh. Holy Cross was PCE eligible for 57.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Holy Cross in the amount of $82,606 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,073 (AEA 2023) PCE data is summarized in Tables I and 2, below.

Table 1. Holy Cross Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
167	68	9	21

Source: AEA 2023

Table 2. Holy Cross Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ Gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced [5] (lbs)
560,424	0	96.7%	13.07	565,158	42,865	959,318

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 AVEC Power Generation Data

AVEC is the electric utility for eight of the communities in TCC's region, including Holy Cross. AVEC provides the following data for Holy Cross:

- Diesel Generators:
  - Station 1: Detroit Diesel S60K4 1200, 236 kW
  - Station 2: Detroit Diesel S60K4 1200, 236 kW
  - Station 3: Cummins LTA10 1800, 250 kW
- Average Load: 68 kW
- Estimated peak load: 134 kW
- Average annual power generated: 560,424 kWh
- Average fuel consumed: 42,865 gallons/year
- Average fuel efficiency: 13.07 kWh/gallon

3.4 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Holy Cross (Constellation Energy 2024). The inventory tool is based off modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and

methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Holy Cross. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Holy Cross:

- Residential Sector
  - Residual Fuel Oil No. 5 = 739.16 MT CO_2e
  - Wood and Residuals = 12.12 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 159.61 MT CO_2e
  - Propane = 12.18 MT CO_2e

- o Wood and Wood Residuals = 0.44 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Holy Cross was modeled. The analysis indicated that approximately 561.93 MWh electricity is used in this capacity and that the resulting emissions all come from diesel in the amount of 161.84 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.5 GHG Reduction Targets

Holy Cross may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.6 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community apply for additional funding for solar PVs + BESS to further reduce diesel consumption and reach the projected maximum emissions reduction under the renewable energy scenario described above.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings to reduce heating fuel consumption and GHG emissions.

3.7 Benefits Analysis

An analysis was performed under a scenario in which 50% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium

(Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 487kW Renewable Solar + 754kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj. Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
487 kW PV + 754 kWh BESS	2.79	1	50%	23,576	19,289	73,018	195,687	196

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

The rural and remote communities of the Lower Yukon region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC & Holy Cross's chief concerns around the Lower Yukon region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.8 Review of Authority to Implement

The Holy Cross Tribal Council (HCTC) is the governing body for Holy Cross Village, a federally recognized tribe. The HCTC has the authority to implement GHG reduction measures through resolutions passed in HCTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, HCTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Holy Cross to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community apply for additional funding for solar PVs + BESS to further reduce diesel consumption and reach the projected maximum emissions reduction under the renewable energy scenario described above.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings to reduce heating fuel consumption and GHG emissions.

3. **Biomass Project(s):** It is recommended that Holy Cross consider applying for funds for a woodchip boiler system to contribute heating to community buildings and homes. The cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally-sourced wood is considered carbon-neutral, so the biomass boiler system decreases the carbon footprint of heating the community buildings.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Holy Cross is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The community will examine the condition of its current power grid under recent Department of Energy Electric Grid Resiliency funding; transmission lines and switch gear have likely not been upgraded since initially installed.

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Appendix A

Alaska Energy Authority’s Power Cost Equalization Program

Statistical Report for Holy Cross (FY2022)

Holy Cross PCE

Utility: ALASKA VILLAGE ELECTRIC COOP
Reporting Period: 07/01/21 to 06/30/22

Community Population	167
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	68
Community Facility Customers	9
Other Customers (Non-PCE)	21
Fiscal Year PCE Payments	**$82,606**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	235,230	Average Annual PCE Payment per Eligible Customer	$1,073
PCE Eligible kWh - Community Facility Customers	67,392	Average PCE Payment per Eligible kWh	$0.27
Total PCE Eligible kWh	302,622	Last Reported Residential Rate Charged (based on 500 kWh)	$0.55
Average Monthly PCE Eligible kWh per Residential Customer	288	Last Reported PCE Level (per kWh)	$0.29
Average Monthly PCE Eligible kWh per Community Facility Customer	624	Effective Residential Rate (per kWh)	$0.25
Average Monthly PCE Eligible Community Facility kWh per Person	34	PCE Eligible kWh vs Total kWh Sold	55.8%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	560,424	Fuel Used (Gallons)	42,865
Non-Diesel kWh Generated	0	Fuel Cost	$119,042
Purchased kWh	0	Average Price of Fuel	$2.78
Total Purchased & Generated	560,424	Fuel Cost per kWh sold	$0.22
		Annual Non-Fuel Expenses	$107,751
		Non-Fuel Expense per kWh Sold	$0.20
		Total Expense per kWh Sold	$0.42

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	271,774	Consumed vs Generated (kWh Sold vs Generated-Purchased)	96.7%
Community Facility kWh Sold	196,128	Line Loss (%)	See Comments
Other kWh Sold (Non-PCE)	73,973	Fuel Efficiency (kWh per Gallon of Diesel)	13.07
Total kWh Sold	541,875	PH Consumption as % of Generation	4.2%
Powerhouse (PH) Consumption kWh	23,283		
Total kWh Sold & PH Consumption	565,158		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Hughes Village

Hughes, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
HTC	Hughes Tribal Council
HVLP	Hughes Village Light and Power
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons

PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Hughes, a rural and predominantly Alaska Native community of approximately 81 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Hughes. GHG production levels and energy costs for Hughes were evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024). Then, a simulated scenario for maximum renewable energy systems and GHG reduction was produced.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Hughes in 2022 (AEA 2023). Hughes' 49 residential customers, 3 community facility customers, and 17 other customers required 500,443 kWh of diesel-generated power. A total of 42,726 gallons of fuel were consumed at a cost of $206,635 ($4.84 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 956,207 lbs of CO_2 were produced in Hughes in FY2022.

The average fuel cost per kWh in Hughes in 2022 was $0.48. The annual non-fuel expenses associated with power generation totaled $116,300 in FY22, resulting in an additional cost of $0.27 per kWh sold. Thus, the combined fuel and non-fuel expenses in Hughes required to produce power in Hughes were $0.76 per kWh sold in FY22. The last reported electric rate was $0.71 per kWh. Hughes' electric rate is nearly five times the national average of $0.16 per kWh. Hughes was PCE eligible for 51.3% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Hughes in the amount of $111,186 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $2,138 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Hughes. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Hughes:

- Residential Sector
    - Residual Fuel Oil No. 5 = 66.00 MT CO_2e
    - Wood and Residuals = 0.36 MT CO_2e
- Commercial Sector

- Distillate Fuel Oil No. 1 = 38.05 MT CO_2e
- Propane = 29.0 MT CO_2e
- Wood and Wood Residuals = 0.11 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Hughes was modeled. The analysis indicated that approximately 110.44 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (31.81 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Hughes, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 440 kw solar PV and a 660 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software (UL Solutions 2024) for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Hughes are:

- Solar PV + BESS array to reduce fuel consumption and GHG emissions;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

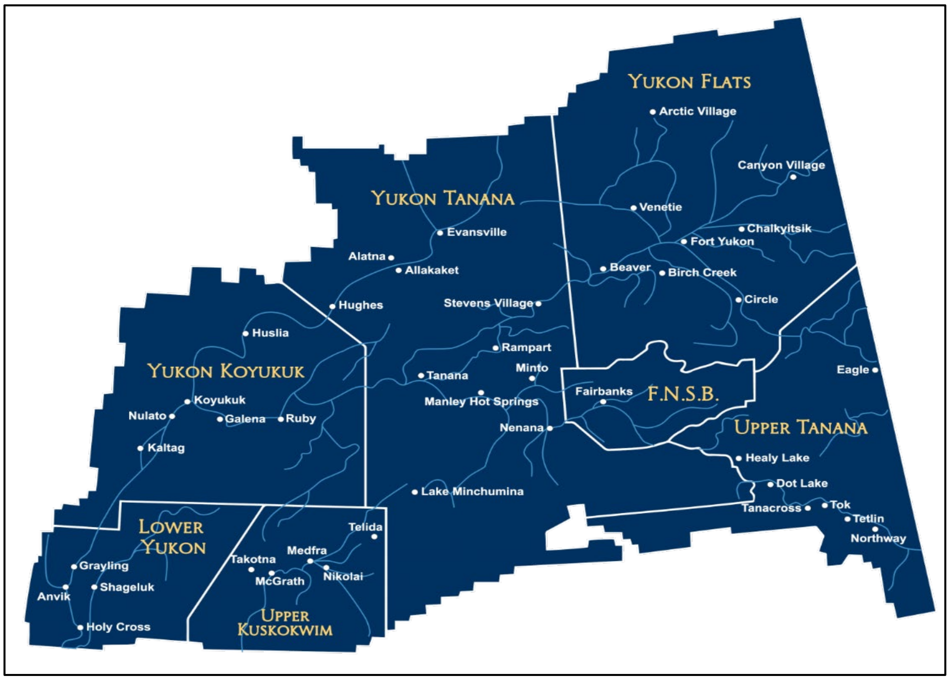
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

and implement ambitious plans for reducing GHG emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

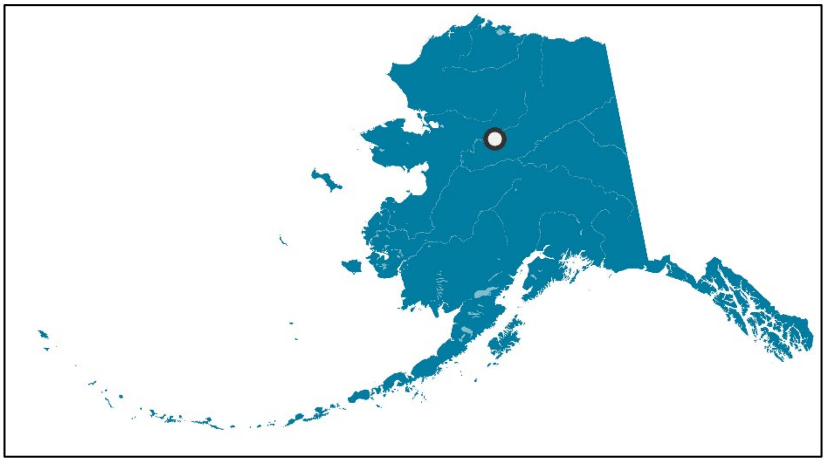
1.4 Scope of this PCAP: The Community of Hughes

Hughes, Alaska is a traditional Koyukon Athabascan village home to approximately 81 residents. Hughes is located on a 500-foot bluff on the east bank of the Koyukuk River, 115 air miles northeast of Galena and 210 air miles northwest of Fairbanks (Figure 2). It lies in the Yukon-Tanana region, and access is primarily by plane or barge. Hughes' power stems from a diesel power plant operated by Hughes Village Light and Power.

Hughes is located in the continental climatic zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. Extreme temperatures ranging from a low of -68°F to a high of 90°F have been measured. Average annual precipitation is 13 inches, and average snowfall of 30 inches. The Koyokuk River is generally ice-free from June through October.

The U.S. EPA indicates that Hughes' Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Hughes as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 80% of Hughes' Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Hughes, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies.

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation; Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Hughes. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a

broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Hughes and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Hughes’ case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many

remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.
Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive.

The development of a solar-diesel microgrid with battery storage in Hughes began in 2017. Through a Department of Energy (DOE) grant and Hughes/TCC cost sharing agreement, the first phase of this 120 kW solar project was completed in 2018 with 380 solar panels installed. In 2019, the wiring for the panels and inverter was completed. A battery storage shelter was constructed in 2020 to support the 250kW/335kWh ABB Emesh BESS. The system came online in 2021, giving the village its first power with the diesel generators off and working towards the goal of 25% cut to Hughes' annual diesel usage.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus

reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Hughes is estimated to be 6.7 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 81 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Hughes, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Hughes, because of the number of moving parts that must continue operating at very cold temperatures. Should Hughes decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/hughes.html

because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

In 2015 with funds from the state of Alaska, Hughes received a district biomass heating system with two wood fired boilers. The system provides heat to the city post office building, the school, the washeteria and water treatment plant building. Since the district heating loop was installed and the project commissioned, it has used between 30 and 50 cords of wood per year of local wood harvest and driftwood. The Tribe purchases the cordwood from community members and employs one part-time operator to run the system. Since that time, one of the buildings has reported a reduction in energy use, and a second building reported steady usage.

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

A third building reported increased energy usage, but largely due to increases in occupancy and hours of operation within the building.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Hughes, a community wide single-phase to three-phase upgrade, including powerlines, has been implemented since initial construction. Hughes also recently received a Bipartisan Infrastructure Law (BIL) 40101(d) Grid Resilience Grant through TCC. Hughes will receive funding for electric grid resiliency to prevent or reduce electrical outages. This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no known plans for electrification of Hughes' waterfront infrastructure or airport.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power

grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Hughes does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Hughes is bordered by the Koyukuk River. The available hydrological resource has spurred interest in the potential for hydrokinetic energy systems. However, there are no known hydrokinetics projects proposed at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In Hughes, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

A major weatherization effort in Hughes was performed by TCC in 2013, under which 17 homes received weatherization upgrades. Additionally, in 2018, the community of Hughes received grant funding from ANTHC & TCC for a community-wide LED lighting retrofit project. LED lightbulbs were replaced in most interior and exterior fixtures in the fall of 2018.

2 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

Hughes Village completed a community survey that was issued to the Tribe by Tanana Chiefs Conference in late 2023. This survey provided the Tribe with an opportunity to comment on their energy priorities and challenges, weatherization and electrical needs, and interest in renewable energy systems.

The survey completed by Hughes Village indicated that they do not currently have an energy/economic development plan but would like help writing one. The three top energy priorities are to reduce the cost of home heating, reduce the cost of electricity, and reduce their reliance on diesel fuel.

Hughes responded that their current needs in terms of electricity generation would be on-site training for maintaining their existing generator and solar PV + BESS system. They have ongoing concerns about their community power plant.

Hughes does not have a heat recovery system, and they do have a current electric distribution map. Hughes currently operates a solar project and is wanting to expand it with additional solar panels on the east and west sides of the existing array.

Hughes noted that their highest priority energy projects would be an energy audit in all homes, the expansion of the existing solar array, and an energy plan for the community. The last home energy weatherization occurred more than five years ago and they are interested in current weatherization upgrades, as up to 60% of the homes are advanced in age. The community needs education on residential energy efficiency. Most homes do have basic utilities, including power, water and sewer.

Hughes responded that it has been over five years since the community buildings have had an energy audit or weatherization retrofit, and only 20% of the buildings were involved at that time. They are interested in having a more current energy audit and retrofit on community buildings; over 60% of those buildings do not have basic utilities.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Hughes (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and resulting GHG emissions in Hughes in 2022 (AEA 2023). Hughes' 49 residential customers, 3 community facility customers, and 17 other customers required 500,443 kWh of diesel-generated power and 8,769 kWh of non-diesel-generated power (Tables 1 and 2, below). A total of 469,178 total kWh sold and powerhouse consumption required 42,726 gallons of diesel fuel. A total of 42,726 gallons of fuel were consumed at a cost of $206,635 ($4.84 per gallon). Assuming 22.38 lbs. of CO_2 are produced per gallon of diesel consumed, it can be determined that 956,207 lbs. of CO_2 were produced in Hughes in FY2022.

The average fuel cost per kWh in Hughes was $0.48. The annual non-fuel expenses associated with power generation totaled $116,300 in FY22, resulting in an additional cost of $0.27 per kWh sold. Thus, the combined fuel and non-fuel expenses in Hughes were $0.76 per kWh sold in FY22. The last reported residential customer rate was 0.71 kWh paid by Hughes residents. Hughes' electric rate is nearly five times the national average of $0.16 per kWh. Hughes was PCE eligible for 51.3% of its total kWh sold in Fiscal Year (FY) 22 resulting in PCE payments to Hughes in the amount of $111,186 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer in Hughes was $2,138 (AEA 2023). PCE data is summarized in Tables 1 & 2, below.

Table 1 Hughes Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
81	49	3	17

Source: AEA 2023

Table 2. Hughes Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced [5] (lbs)
500,443	8,769	83.9%	11.71	469,178	42,726	956,207

Source: AEA 2023

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Hughes (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Hughes. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Hughes:

- Residential Sector
  - Residential Fuel Oil No. 5: 145.19 MT CO_2e
  - Wood and Wood Residuals: 6.41 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1: 11.02 MT CO_2e
  - Propane: 5.88 MT MT CO_2e
  - Wood and Wood Residuals: 0.21 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Hughes was modeled. The analysis indicated that approximately 435.69 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (121.71 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Hughes intends to reduce GHG emissions by pursuing funding opportunities that will pay for:

- An expanded community solar + BESS project that would reduce CO_2 emissions.

- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative;

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community apply for funding for expanding existing solar PV + BESS to the maximum estimated size modeled in this PCAP to further reduce GHG emissions.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for additional weatherization of residences and tribal / city buildings to reduce heating costs and conserve heating fuels, thereby lowering GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 440 kW Renewable Solar + 660 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
440 kW PV; 660 kWh BESS	2.48	1.00	50%	23,499	19,227	72,781	195,053	195

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

The rural and remote communities of the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC's & Hughes' chief concerns for the Yukon Tanana region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.7 Review of Authority to Implement

The Hughes Tribal Council (HTC) is the governing body for Hughes Village, a federally recognized tribe. The HTC has the authority to implement GHG reduction measures through resolutions passed in HTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, HTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

3 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Hughes to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community apply for funding for expanding existing solar PV + BESS to the maximum estimated size modeled in this PCAP to further reduce GHG emissions.

2. **Residential Weatherization.** It is recommended that the community apply for funding for additional weatherization of residences and tribal / city buildings to reduce heating costs and conserve heating fuels, thereby lowering GHG emissions.

3. **Biomass Project(s):** The wood-fired boiler installed in Hughes appears to have been successful in reducing some energy bills, and likely with it GHGs. It is recommended that Hughes consider whether an additional biomass project could further reduce heating bills for other buildings in Hughes.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Hughes is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** DOE grant funding has ensured that several forthcoming improvements to the Hughes power grid will result in needed upgrades. Following these upgrades, the community should assess whether all major needs were upgraded through this funding, or if additional funding is required to complete upgrading all lines, switch gear, and other components.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Hughes (FY2022)

Hughes PCE

Utility: HUGHES POWER & LIGHT
Reporting Period: 07/01/21 to 06/30/22

Community Population	81
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	49
Community Facility Customers	3
Other Customers (Non-PCE)	17
Fiscal Year PCE Payments	**$111,186**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	151,984	Average Annual PCE Payment per Eligible Customer	$2,138
PCE Eligible kWh - Community Facility Customers	67,324	Average PCE Payment per Eligible kWh	$0.51
Total PCE Eligible kWh	219,308	Last Reported Residential Rate Charged (based on 500 kWh)	$0.71
Average Monthly PCE Eligible kWh per Residential Customer	258	Last Reported PCE Level (per kWh)	$0.51
Average Monthly PCE Eligible kWh per Community Facility Customer	1,870	Effective Residential Rate (per kWh)	$0.20
Average Monthly PCE Eligible Community Facility kWh per Person	69	PCE Eligible kWh vs Total kWh Sold	51.3%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	500,443	Fuel Used (Gallons)	42,726
Non-Diesel kWh Generated	8,769	Fuel Cost	$206,635
Purchased kWh	0	Average Price of Fuel	$4.84
Total Purchased & Generated	509,212	Fuel Cost per kWh sold	$0.48
		Annual Non-Fuel Expenses	$116,300
		Non-Fuel Expense per kWh Sold	$0.27
		Total Expense per kWh Sold	$0.76

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	196,567	Consumed vs Generated (kWh Sold vs Generated-Purchased)	83.9%
Community Facility kWh Sold	82,294	Line Loss (%)	7.9%
Other kWh Sold (Non-PCE)	148,309	Fuel Efficiency (kWh per Gallon of Diesel)	11.71
Total kWh Sold	427,170	PH Consumption as % of Generation	8.2%
Powerhouse (PH) Consumption kWh	42,008		
Total kWh Sold & PH Consumption	469,178		

Comments

Jun bill rendered 7/2 - FY23 base rate applied

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Huslia Village

Huslia, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
AVEC	Alaska Village Electric Cooperative
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	CO_2 equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
HTC	Huslia Tribal Council
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
OCED	Office of Clean Energy Demonstrations
PCAP	Priority Climate Action Plan

PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Huslia, a rural and predominantly Alaska Native community of approximately 293 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emission in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Huslia. GHG production levels and energy costs for Huslia were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), power generation data from the Alaska Village Electric Cooperative (AVEC) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Huslia in 2022 (AEA 2023). Huslia's residential customers, 15 community facility customers, and 40 other customers required 1,132,732 kWh of diesel-generated power. A total of 1,101,669 total kWh was sold to Huslia customer, requiring approximately 86,443 gallons of diesel fuel. Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,934,594 lbs CO_2 were produced in Huslia in FY2022.

The average fuel cost per kWh in Huslia in 20022 was $0.25. The annual non-fuel expenses associated with power generation totaled $211,551 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Huslia required to produce power in Huslia were $0.45 per kWh sold in FY22. The last reported electric rate was $0.56 per kWh. Huslia's electric rate is about three-and-a-half times the national average of $0.16 per kWh. Huslia was PCE eligible for 56.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Huslia in the amount of $166,629 to offset its high energy cost. The average annual subsidized PCE payment per eligible customer was $1,436 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Huslia. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Huslia:

- Residential Sector
    - Residual Fuel Oil No. 5 = 686.36 MT CO_2e
    - Wood and Residuals = 11.40 MT CO_2e
- Commercial Sector
    - Distillate Fuel Oil No. 1 = 275.60 MT CO_2e

- Propane = 21.04 MT CO_2e
- Wood and Wood Residuals = 0.76 MT CO_2

The level of on-site combustion emissions that result in electricity generation for Beaver was modeled. The analysis indicated that approximately 1,075.84 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (309.84 MT CO2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Huslia, the maximum fraction of existing energy production that could be replaced by renewables is 30%, represented by a 519 kw solar PV and a 720 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software (UL Solutions 2024) for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO2 emission, and operational costs. Following a review of this information preferred options for cleaner, lower cost energy in Huslia are:

- Additional Solar PV + BESS array to reduce fuel consumption and CO_2 emissions;
- Weatherization of residences, tribal buildings, and commercial buildings;
- A second biomass project; and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories identify sources of greenhouse gas (GHG) emissions in their communities and develop diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

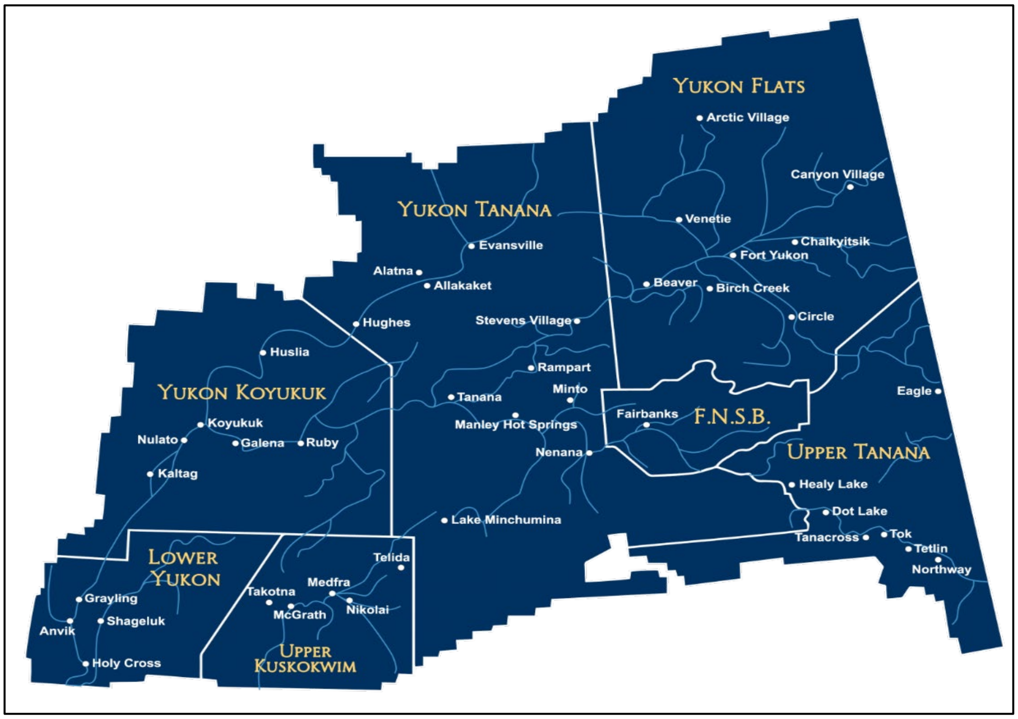
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

and implement ambitious plans for reducing GHG emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy .

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Village Electric Cooperative (AVEC), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

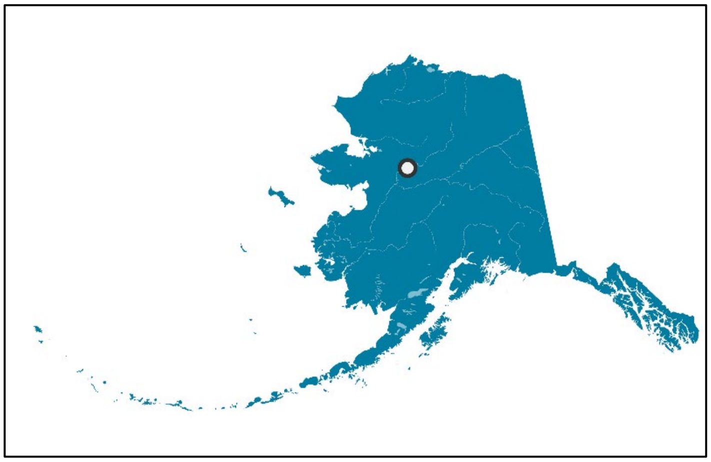
1.4 Scope of this PCAP: The Community of Huslia

Huslia, Alaska is a traditional Athabascan village home to approximately 293 residents. Huslia is located on the north bank of the Koyukuk River, 170 river miles northwest of Galena and 290 air miles west of Fairbanks (Figure 2). It lies within the Koyukuk National Wildlife Refuge, and access is primarily by plane or barge. Huslia's power is generated locally at a diesel power plant operated by AVEC.

Huslia is located in the continental climatic zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. Extreme temperatures ranging from a low of -65°F to a high of 90°F have been measured. Average annual precipitation is 13 inches, and average snowfall 70 inches.

The U.S. EPA indicates that Huslia's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Huslia as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 77% of Huslia's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Huslia, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- o Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Huslia. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or

individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Huslia and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Huslia’s case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can

be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive.

Huslia recently collaborated with TCC to win a DOE Office of Clean Energy Demonstrations (OCED) grant to develop a community solar and battery project. This project will include a 300 kW PV and a 500 kW battery energy storage system (BESS), which will be integrated into the existing AVEC power plant. TCC will serve as an independent power producer, owning and operating the system and selling power to AVEC on behalf of the community. They predict that solar generation from this project could displace 32,250 gallons of diesel fuel annually and reduce GHG emissions by up to 40%. Generator run time in the community would reduce from 100% to approximately 65% of the time, and provide benefits in reduced emissions, noise, maintenance and operating costs, and more open maintenance periods. The revenue from power sales will be redirected into the community.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind

turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Huslia is estimated to be 6.9 mph[3] which is a Class 2 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 293 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

In considering wind power, it should be recognized that the need for a replacement heat source in the power plant to keep generators in Huslia warm is even more critical with wind, because they can produce power during winter. ANTHC (2024) notes that if wind is pursued, a secondary load electric boiler would be required in the power plant, similar to solar. This boiler will keep the generators warm by injecting heat into the coolant loop, while serving as a dispatchable load to regulate electrical distribution frequency.

Because of the marginal wind resource in Huslia, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Huslia because of the number of moving parts that must continue operating at very cold temperatures. Should Huslia decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid

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[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/huslia.html

upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.

The Huslia Tribal Council (HTC) and the Tanana Chiefs Conference (TCC), partnering with the City of Huslia, the Yukon-Koyukuk School District, and Alaska Native Tribal Health Consortium, applied to the U.S. Department of Energy Office of Indian Energy for funding of a community biomass boiler system, and funding was awarded. The biomass system will contribute to heating three community buildings with locally harvested fuels: the clinic, the water treatment plant/washeteria, and the school. The remaining heating needs are supported by in-building oil-fired boilers, burning imported heating fuel. Some issues, such as control set points on the oil boilers, need to be resolved before the biomass heating system is used at full capacity. The project objectives of the community biomass boiler system were cost reduction, carbon reduction, community resilience, and economic development. Once fully operational, the cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally-sourced wood is considered carbon-neutral, so the biomass boiler system decreases the carbon footprint of heating the community buildings (TCC 2021).

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Huslia, upgrades to the switchgear, controllers, and transformers are likely due for updating, and a BESS may be needed to regulate ramp rates on the diesel generators. Updating the switchgear and controllers is often a necessary step for proper incorporation of renewables.

Huslia received a Bipartisan Infrastructure Law (BIL) 40101(d) Grid Resilience Grant through TCC. Huslia will receive funding for electric grid resiliency (preventing / reducing number of electrical outages). This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no plans at this time for electrification of the waterfront or the airport in Huslia.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.
- EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:
- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.

- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Huslia does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head .

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Huslia is situated on the Koyukuk River. This available hydrological resource has spurred interest in the potential for hydrokinetic energy systems. However, there are no plans to introduce a hydrokinetic project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Huslia, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

It is not known whether Huslia has had any significant weatherization efforts in the last decade.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory

- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Huslia in late 2023 to inform to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Huslia (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Huslia in 2022 (AEA 2023). Huslia's 101 residential customers, 15 community facility customers, and 40 other customers required 1,132,732 kWh of diesel-generated power and 0 kWh of non-diesel-generated power. A total of 1,101,669 total kWh was sold to Huslia customer, requiring approximately 86,443 gallons of diesel fuel. Assuming that 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,934,594 lbs CO_2 were produced in Huslia in FY2022.

The average fuel cost per kWh in Huslia in 20022 was $0.25. The annual non-fuel expenses associated with power generation totaled $211,551 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Huslia required to produce power in Huslia were $0.45 per kWh sold in FY22. The last reported electric rate was 0.56 kWh. Huslia's electric rate is three-and-a-half times the national average of $0.16 per kWh. Huslia was

PCE eligible for 56.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Huslia in the amount of $166,629 to offset its high energy cost. The average annual subsidized PCE payment per eligible customer was $1,436 (AEA 2023).

PCE data is summarized in Tables 1 and 2, below.

Table 1. Huslia Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
293	101	15	40

Source: AEA 2023

Table 2. Huslia Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced [4] (lbs)
1,132,732	0	93.9%	13.1	1,101,669	86,443	1,934,594

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 AVEC Power Generation Data

AVEC is the electric utility for eight of the communities in TCC's region, including Huslia. AVEC provides the following data for Huslia:

- Diesel Generators:

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

- Station 1: Detroit Diesel S60K4 1200, 236 kW
- Station 2: Cummins LTA10 1800, 250 kW
- Station 3: Detroit Diesel S60K4 1800, 365 kW

- Average Load: 126 kW
- Estimated peak load: 253 kW
- Average annual power generated: 1,104,005 kWh
- Average fuel consumed: 79,918 gallons/year
- Average fuel efficiency: 14 kWh/gallon

3.4 Greenhouse (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Huslia (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Huslia. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Huslia:

- Residential Sector
    - Residual Fuel Oil No. 5 = 686.36 MT CO_2e
    - Wood and Residuals = 11.40 MT CO_2e
- Commercial Sector
    - Distillate Fuel Oil No. 1 = 275.60 MT CO_2e
    - Propane = 21.04 MT CO_2e
    - Wood and Wood Residuals = 0.76 MT CO_2

The level of on-site combustion emissions that result in electricity generation for Beaver was modeled. The analysis indicated that approximately 1,075.84 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (309.84 MT CO2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.5 GHG Reduction Targets

Huslia may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;

- Completing the mechanical work needed for the new wood cord boiler system to be fully operational;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative;

3.6 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Assessment of Whether Expanded Solar PV and BESS Would be Beneficial.** It is recommended that the community assess whether additional solar PV + BESS would further reduce diesel generation or GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings to reduce the cost of heating and lower GHG emissions.

3.7 Benefits Analysis

An analysis was performed under a scenario in which 30% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power (Table 3, below).

Table 3. TCC Community Modeling: 519 kWh Renewable Solar + 720 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
519 kWh PV 720 kWh BESS	2.94	1.00	30%	64,832	21,611	81,806	219,239	219

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

The rural and remote communities of the Yukon Koyukuk region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as described above.

TCC & Huslia's chief concerns around Yukon Koyukuk region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.8 Review of Authority to Implement

The Huslia Tribal Council (HTC) is the governing body for Huslia Village, a federally-recognized tribe. The HTC has the authority to implement GHG reduction measures through resolutions passed in HTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, HTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Huslia to reduce GHGs:

1. **Assessment of Whether Expanded Solar PV and BESS Would be Beneficial.** It is recommended that the community assess whether additional solar PV + BESS would further reduce diesel generation or GHG emissions.

2. **Residential Weatherization.** It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings to reduce the cost of heating and lower GHG emissions. Updated weatherization could create significant energy savings and make residents more comfortable.

3. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Huslia is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to

characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

4. **Other Steps:** The community should examine the condition of the current power grid as it may not have been updated since the lines were initially installed.

5 References

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UAF. 2022. A Solar Design Manual for Alaska. 6th Edition. Available online at: A Solar Design Manual for Alaska, Sixth Edition (uaf.edu)

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Huslia (FY2022)

Huslia PCE

Utility: ALASKA VILLAGE ELECTRIC COOP
Reporting Period: 07/01/21 to 06/30/22

Community Population	293
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	101
Community Facility Customers	15
Other Customers (Non-PCE)	40
Fiscal Year PCE Payments	**$166,629**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	434,102	Average Annual PCE Payment per Eligible Customer	$1,436
PCE Eligible kWh - Community Facility Customers	171,542	Average PCE Payment per Eligible kWh	$0.28
Total PCE Eligible kWh	605,644	Last Reported Residential Rate Charged (based on 500 kWh)	$0.56
Average Monthly PCE Eligible kWh per Residential Customer	358	Last Reported PCE Level (per kWh)	$0.31
Average Monthly PCE Eligible kWh per Community Facility Customer	953	Effective Residential Rate (per kWh)	$0.25
Average Monthly PCE Eligible Community Facility kWh per Person	49	PCE Eligible kWh vs Total kWh Sold	56.9%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	1,132,732	Fuel Used (Gallons)	86,443
Non-Diesel kWh Generated	0	Fuel Cost	$266,109
Purchased kWh	0	Average Price of Fuel	$3.08
Total Purchased & Generated	1,132,732	Fuel Cost per kWh sold	$0.25
		Annual Non-Fuel Expenses	$211,551
		Non-Fuel Expense per kWh Sold	$0.20
		Total Expense per kWh Sold	$0.45

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	564,821	Consumed vs Generated (kWh Sold vs Generated-Purchased)	93.9%
Community Facility kWh Sold	247,608	Line Loss (%)	2.7%
Other kWh Sold (Non-PCE)	251,450	Fuel Efficiency (kWh per Gallon of Diesel)	13.10
Total kWh Sold	1,063,879	PH Consumption as % of Generation	3.3%
Powerhouse (PH) Consumption kWh	37,790		
Total kWh Sold & PH Consumption	1,101,669		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Priority Climate Action Plan

Village of Kaltag

Kaltag, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
AVEC	Alaska Village Electric Cooperative
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
KTC	Kaltag Tribal Council
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization

PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Kaltag, a rural and predominantly Alaska Native community of approximately 155 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emission in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Kaltag. GHG production levels and energy costs for Kaltag were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), power generation data from the Alaska Village Electric Cooperative (AVEC), and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Kaltag in 2022 (AEA 2023). Kaltag's 155 residential customers, 11 community facility customers, and 23 other customers required 705,547 kWh of diesel-generated power. A total of 14,644 gallons of fuel were consumed by Kaltag customers in 2022 at a cost of $57,782 ($3.95 per gallon). Assuming 22.38 lbs. CO_2 are produced per gallon of diesel consumed, it can be determined that 327,732 lbs. CO_2 were produced in Kaltag in FY2022.

The average fuel cost per kWh in Kaltag in 2022 was $0.24.The annual non-fuel expenses associated with power generation totaled $131,260 in FY22, resulting in an additional cost of $0.2 per kWh sold. The combined fuel and non-fuel expenses in Kaltag required to produce power in Kaltag were about $0.45 per kWh sold in FY22. The last reported electric rate was $0.56 per kWh; thus, Kaltag's electric rate is three-and-a-half times the national average of $0.16 per kWh. Kaltag was PCE eligible for 50.6% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Kaltag in the amount of $95,917 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,296 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Kaltag. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Kaltag:

- Residential Sector
  - Residual Fuel Oil No. 5 = 409.18 MT CO_2e
  - Wood and Residuals = 14.26 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 144.76 MT CO_2e

- Propane = 11.05 MT CO_2e
- Wood and Wood Residuals = 0.40 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Kaltag was modeled. The analysis indicated that approximately 717.27 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (204.51 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Kaltag, the maximum fraction of existing energy production that could be replaced by renewables is 40%, represented by a 481 kw solar PV and a 633 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic (PV) + Battery Energy Storage System (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Kaltag are:

- Additional Solar PV + BESS array to reduce GHG emissions;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

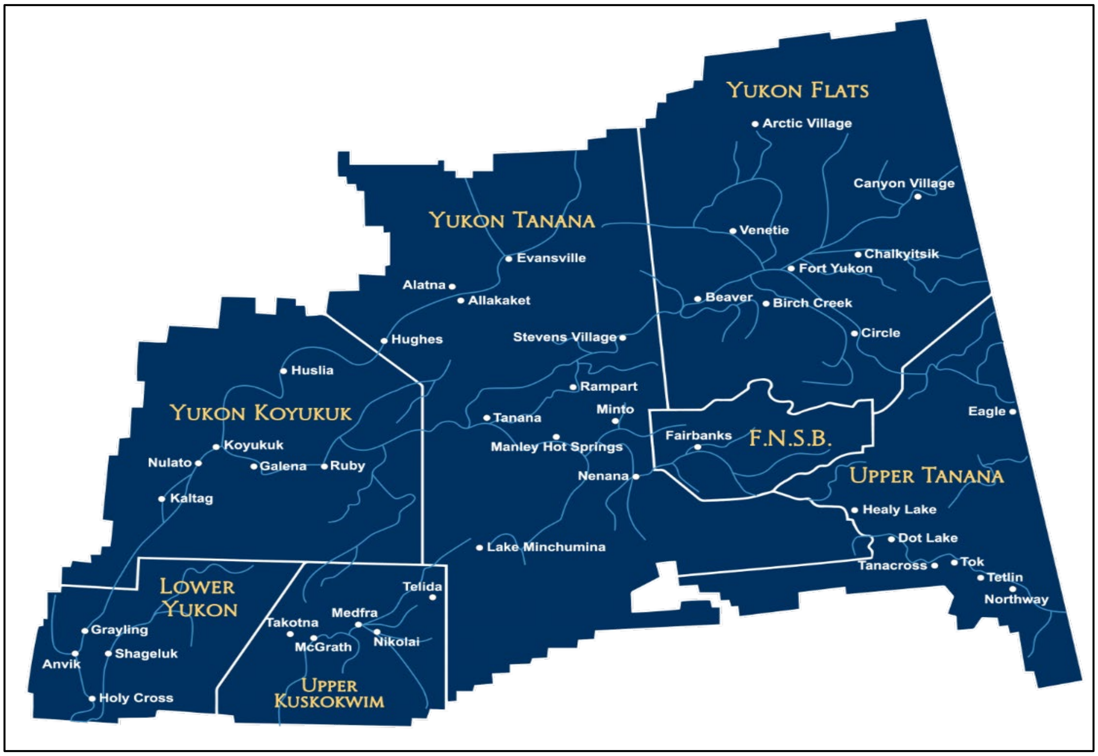
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution.

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Village Electric Cooperative (AVEC), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs, and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

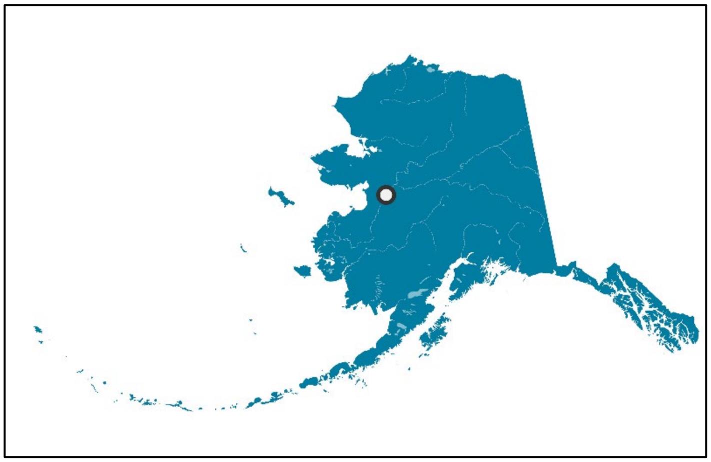
1.4 Scope of this PCAP: The Community of Kaltag

Kaltag is a traditional Yukon Koyukon Athabascan village home to approximately 155 residents. Kaltag is located on the west bank of the Yukon River, 75 miles west of Galena and 335 air miles west of Fairbanks (Figure 2). It is situated on a 35-foot bluff at the base of the Nulato Hills, west of the Innoko National Wildlife Refuge, and access is primarily by plane or barge. Kaltag's power is generated locally at a diesel power plant operated by AVEC.

Kaltag is located in the continental climatic zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. Extreme temperatures ranging from a low of -55°F to a high of 90°F have been measured. Average annual precipitation is 19 inches, and average snowfall of 74 inches.

The U.S. EPA indicates that Kaltag's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Kaltag as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 64% of Kaltag's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Kaltag, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Kaltag. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or

individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Kaltag and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This is not an achievable goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Kaltag's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can

be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

Kaltag installed a small 9.6 kW solar system in 2012 in collaboration with AVEC under a Renewable Energy Fund grant. The shipping container for transport was used for the mounting structure, and the solar system was small enough to act as a negative load, so there were no integration issues. Solar production has fluctuated from 4 kWh to as high as 8 kWh. In 2024 the Department of Energy (DOE) Office of Clean Energy Demonstrations (OCED) awarded TCC clean energy funding for the expansion of solar PVs and BESS in eight tribal communities, including Kaltag. As a part of the grant award, Kaltag's Solar PV and BESS project will include the installation of a 300kW PV, 500kW Inverter, and 450kW BESS

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind

turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Kaltag is estimated to be 6.1 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 155 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high capital cost of designing, mobilizing, constructing, and connecting a wind project in Kaltag is not likely to recover the capital cost in a short or moderate time frame, due to having only a Class 2 wind resource. Furthermore, integrating wind would require upgrades to the grid components.

Because of the marginal wind resource in Kaltag, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Kaltag because of the number of moving parts that must continue operating at very cold temperatures. Should Kaltag decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/kaltag.html

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future.

It is not known whether Kaltag has a biomass project or plans for a future biomass project in the community.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

Kaltag will receive Bipartisan Infrastructure Law 40101(d) Grid Resilience Grant funding through TCC. Kaltag will receive funding for electric grid resiliency (preventing / reducing number of electrical outages). This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no plans for incorporating electrification into Kaltag's waterfront or airport infrastructure at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Kaltag does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Kaltag is situated on the Yukon River. While this available hydrological resource has spurred interest in the potential for hydrokinetic energy systems, there are no plans to pursue a project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Kaltag , it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

It is unknown whether Kaltag has had any significant weatherization upgrades in recent years.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Kaltag in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Kaltag (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Kaltag in 2022 (AEA 2023). Kaltag's 155 residential customers, 11 community facility customers, and 23 other customers required 705,547 kWh of diesel-generated power. A total of 14,644 gallons of fuel were consumed by Kaltag customers in 2022 at a cost of $57,782 ($3.95 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 327,732 lbs CO_2 were produced in Kaltag in FY2022.

The average fuel cost per kWh in Kaltag in 2022 was $0.24. The annual non-fuel expenses associated with power generation totaled $131,260 in FY22, resulting in an additional cost of $0.20 per kWh sold. The combined fuel and non-fuel expenses in Kaltag required to produce power in Kaltag were about $0.44 per kWh sold in FY22. The last reported electric rate was 0.56 kWh; thus, Kaltag's electric rate is nearly three-and-a-half times the national average of $0.16 per kWh. Kaltag was PCE eligible for 50.6% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Kaltag in the amount of $95,917 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,296 (AEA 2023).

PCE data is summarized in Tables 1 and 2, below.

Table 1. Kaltag Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
155	63	11	23

Source: AEA 2023

Table 2. Kaltag Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced [4] (lbs)
705,547	4,212	93.0%	12.54	678,870	56,271	1,259,344

Source: AEA 2023

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 AVEC Power Generation Data

AVEC is the electric utility for eight of the communities in TCC's region, including Kaltag. AVEC provides the following data for Kaltag:

- Diesel Generators:
  - Station 1: Detroit Diesel S60K4 1200, 236 kW
  - Station 2: Detroit Diesel S60K4 1200, 236 kW
  - Station 3: Detroit Diesel S60K4 1800, 363 kW
- Average Load: 79 kW
- Estimated peak load: 170 kW
- Average annual power generated: 705,547 kWh
- Average fuel consumed: 53,673 gallons/year
- Average fuel efficiency: 13 kWh/gallon

3.4 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[5] was created to assess GHGs emitted from 245 communities around Alaska, including Kaltag (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be

[5] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Kaltag. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Kaltag:

- Residential Sector
  - Residual Fuel Oil No. 5 = 409.18 MT CO_2e
  - Wood and Residuals = 14.26 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 144.76 MT CO_2e
  - Propane = 11.05 MT CO_2e
  - Wood and Wood Residuals = 0.40 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Kaltag was modeled. The analysis indicated that approximately 717.27 MWh electricity is used in this capacity and that the resulting emissions all come from diesel in the amount of 204.51 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.5 GHG Reduction Targets

Kaltag may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative

3.6 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommend that the community consider applying for funding to maximize solar PV + BESS capabilities to reduce diesel consumption, generator run time and GHG emissions.

2. **Weatherization of Residential and Public Structures.** It is recommend that the community consider applying for funding for weatherization of residences and tribal / city buildings to lower the cost of heating, reduce the use of heating oil, and lower GHG emissions.

3.7 Benefits Analysis

An analysis was performed under a scenario in which 40% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 481 kW Renewable Solar + 633kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
481 kWh PV; 633 kWh BESS	2.59	1.00	40%	36,576	19,6945	74,553	199,802	200

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHGs emissions.

The rural and remote communities of the Yukon Koyukuk region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Kaltag's chief concerns around Yukon Koyukuk region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.8 Review of Authority to Implement

The Kaltag Tribal Council (KTC) is the governing body for Kaltag Village, a federally recognized tribe. The KTC has the authority to implement GHG reduction measures through resolutions passed in KTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, KTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Kaltag to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommend that the community consider applying for funding to maximize solar PV + BESS capabilities to reduce diesel consumption, generator run time and GHG emissions.

2. **Weatherization of Residential and Public Structures.** It is recommend that the community consider applying for funding for weatherization of residences and tribal / city buildings to lower the cost of heating, reduce the use of heating oil, and lower GHG emissions. It is likely that the several homes, and tribal / city buildings in Kaltag have not had energy efficiency improvements beyond their initial construction. Updated weatherization could create energy savings and make residents more comfortable.

3. **Biomass Project(s):** It is recommended that the community consider applying for a woodchip boiler system to contribute heating to community buildings and homes. The cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally-sourced wood is considered carbon-neutral, so the biomass boiler system decreases the carbon footprint of heating the community buildings.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Kaltag is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** Following planned work to upgrade electrical grid components in Kaltag, the community should assess whether additional upgrade needs remain.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Kaltag (FY2022)

Kaltag PCE

Utility: ALASKA VILLAGE ELECTRIC COOP
Reporting Period: 07/01/21 to 06/30/22

Community Population	155
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	63
Community Facility Customers	11
Other Customers (Non-PCE)	23
Fiscal Year PCE Payments	**$95,917**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	240,824	Average Annual PCE Payment per Eligible Customer	$1,296
PCE Eligible kWh - Community Facility Customers	93,122	Average PCE Payment per Eligible kWh	$0.29
Total PCE Eligible kWh	333,946	Last Reported Residential Rate Charged (based on 500 kWh)	$0.56
Average Monthly PCE Eligible kWh per Residential Customer	319	Last Reported PCE Level (per kWh)	$0.31
Average Monthly PCE Eligible kWh per Community Facility Customer	705	Effective Residential Rate (per kWh)	$0.25
Average Monthly PCE Eligible Community Facility kWh per Person	50	PCE Eligible kWh vs Total kWh Sold	50.6%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	705,547	Fuel Used (Gallons)	56,271
Non-Diesel kWh Generated	4,212	Fuel Cost	$160,968
Purchased kWh	0	Average Price of Fuel	$2.86
Total Purchased & Generated	709,759	Fuel Cost per kWh sold	$0.24
		Annual Non-Fuel Expenses	$131,260
		Non-Fuel Expense per kWh Sold	$0.20
		Total Expense per kWh Sold	$0.44

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	274,318	Consumed vs Generated (kWh Sold vs Generated-Purchased)	93.0%
Community Facility kWh Sold	184,285	Line Loss (%)	4.4%
Other kWh Sold (Non-PCE)	201,499	Fuel Efficiency (kWh per Gallon of Diesel)	12.54
Total kWh Sold	660,102	PH Consumption as % of Generation	2.6%
Powerhouse (PH) Consumption kWh	18,768		
Total kWh Sold & PH Consumption	678,870		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Koyukuk Village

Koyukuk, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	CO_2 equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
HUD	Housing and Urban Development
IPP	Independent Power Producer
IRHA	Interior Regional Housing Authority

KTC	Koyukuk Tribal Council
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Ton
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Koyukuk, a rural and predominantly Alaska Native community of approximately 97 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emission in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Koyukuk. GHG production levels and energy costs for Koyukuk were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Koyukuk in 2022 (AEA 2023). Koyukuk's 53 residential customers, 6 community facility customers, and 8 other customers required 447,178 kWh of diesel-generated. A total of 42,896 gallons of fuel were consumed by Koyukuk customers in 2022 at a cost of $157,068 ($3.66 per gallon). Assuming 22.38 lbs. CO_2 are produced per gallon of diesel consumed, it can be determined that 960,012 lbs. CO_2 were produced in Koyukuk in FY2022.

The average fuel cost per kWh in Koyukuk in 2022 was $0.52. The annual non-fuel expenses associated with power generation totaled $95,888 resulting in an approximate additional cost of $0.30 per kWh sold. Thus, the combined fuel and non-fuel expenses in Koyukuk required to produce power in Koyukuk were $0.82 per kWh sold in FY22. The last reported electric rate was $0.95 kWh. Koyukuk's electric rate is over 5 times the national average of $0.16 per kWh. Koyukuk was PCE eligible for 59.4% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Koyukuk in the amount of $72,211 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,224 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Koyukuk. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Koyukuk:

- Residential Sector
  - Residual Fuel Oil No. 5 = 739.16 MT CO_2e
  - Wood and Residuals = 12.12 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 159.61 MT CO_2e

- o Propane = 12.18 MT CO_2e
- o Wood and Wood Residuals = 0.44 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Koyukuk was modeled. The analysis indicated that approximately 561.93 MWh electricity is used in this capacity in Koyukuk, resulting in emissions all stemming from diesel in the amount of 161.84 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Koyukuk, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 305 kw solar PV and a 492 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic (PV) + Battery Energy Storage System (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Koyukuk are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and develop diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

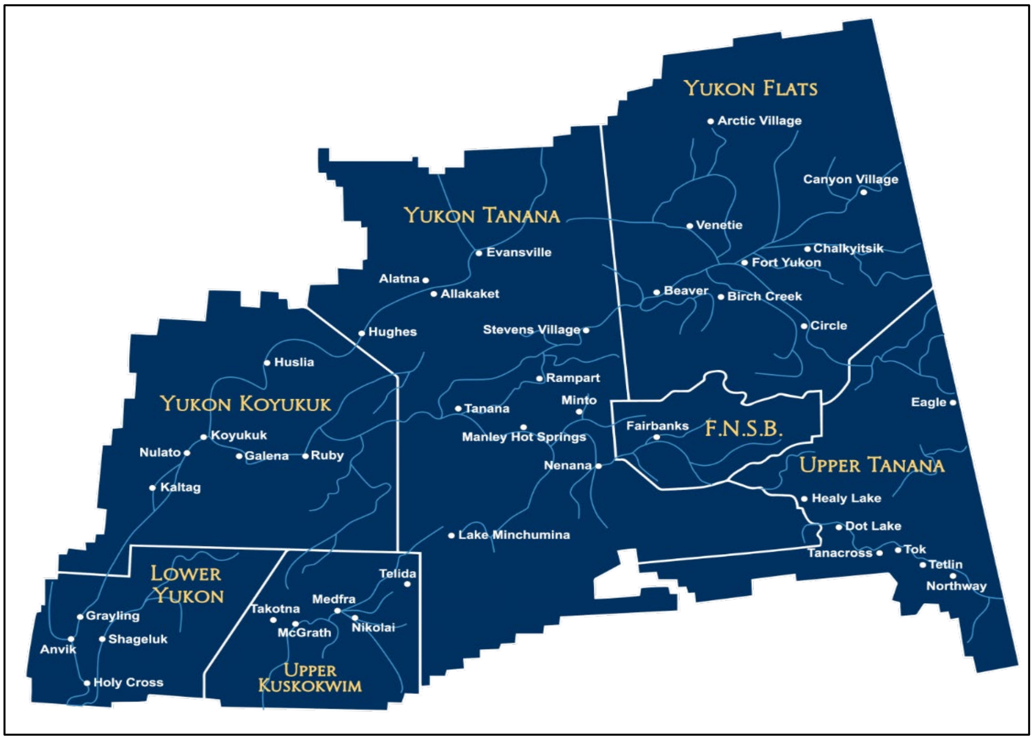
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

and implement ambitious plans for reducing GHG emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

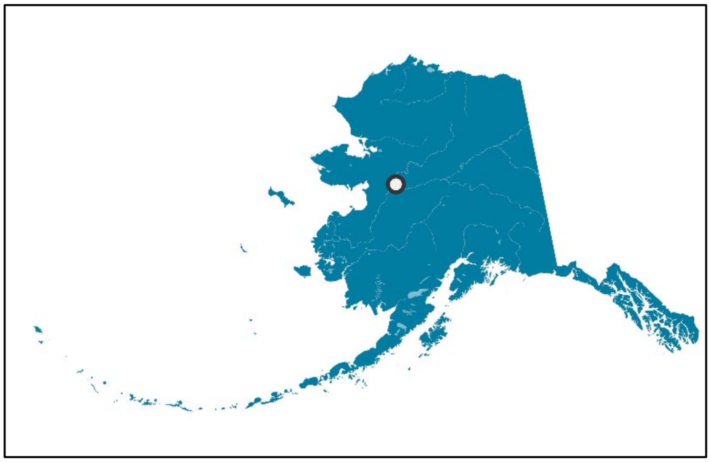
1.4 Scope of this PCAP: The Community of Koyukuk

Koyukuk, Alaska is a traditional Koyukon Athabascan village home to approximately 96 residents. Koyukuk is located on the Yukon River near the mouth of the Koyukuk River, 30 miles west of Galena and 290 air miles west of Fairbanks (Figure 2). It lies adjacent to the Koyukuk National Wildlife Refuge and the Innoko National Wildlife Refuge, access is primarily by plane or barge. Koyukuk's power is generated locally at a diesel power plant operated by Koyukuk Electric Company.

Koyukuk is located in the continental climatic zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. Extreme temperatures ranging from a low of -64°F to a high of 92°F have been measured. Average annual precipitation is 13 inches and average snowfall of 60.

The U.S. EPA indicates that Koyukuk's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Koyukuk as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 92.5% of Koyukuk's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2]. A Community Plan was developed for Koyukuk in 2023 (TCC 2023).

Figure 2. Location of Koyukuk, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Koyukuk. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or

individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Koyukuk and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Koyukuk's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategy for any solar installation should be carefully considered during the design process . Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can

be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable. It is unlikely that Koyukuk has solar PV + BESS infrastructure at this time.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over

solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed Koyukuk is estimated to be 6.9 mph[3] which is a Class 1 wind resource, approaching Class 2. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 97 people, turbines turned by even a Class 2 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Koyukuk and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Koyukuk because of the number of moving parts that must continue operating at very cold temperatures. Should Koyukuk decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project. Currently there are no wind power systems in Koyukuk.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable

[3] Koyukuk Wind Forecast, AK 99754 - WillyWeather

example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.

In 2015, a biomass plant was built in Koyukuk to provide heat to the city office, clinic, and washeteria. Koyukuk collaborated with the Interior Regional Housing Authority (IRHA) and ANTHC on the Koyukuk Biomass Wood Fired Boiler project.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Koyukuk, upgrades to the switchgear, controllers, and transformers are likely due for updating, and a BESS may be needed to regulate ramp rates on the diesel generators. Updating the switchgear and controllers is often a necessary step for proper incorporation of renewables.

Koyukuk received a Bipartisan Infrastructure Law (BIL) 40101(d) Grid Resilience Grant through TCC. Koyukuk will receive funding for electric grid resiliency (preventing / reducing number of electrical outages). This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing. Currently, Koyukuk has no plans to add electrification to its waterfront or airport. However, if a PV and BESS was constructed here, it would be able to tie into the grid.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).

- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Koyukuk does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Koyukuk is situated on the Yukon River at the mouth of the Koyukuk River. These available hydrological resources have spurred interest in the potential for hydrokinetic energy systems, but no project is planned at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Koyukuk, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The last major weatherization effort in Koyukuk was performed by IRHA on city and tribal buildings. This included upgrades to walls, ceilings, floor insulation, windows, and doors. An energy efficient heating system and energy efficient lighting were also included.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Koyukuk in late 2023 to inform to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Koyukuk (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Koyukuk in 2022 (AEA 2023). Koyukuk's 53 residential customers, 6 community facility customers, and 8 other customers required 447,178 kWh of diesel-generated. A total of 42,896 gallons of fuel were consumed by Koyukuk customers in 2022 at a cost of $157,068 ($3.66 per gallon). Assuming 22.38 lbs. CO_2 are produced per gallon of diesel consumed, it can be determined that 960,012 lbs. CO_2 were produced in Koyukuk in FY2022.

The average fuel cost per kWh in Koyukuk in 2022 was $0.52. The annual non-fuel expenses associated with power generation totaled $95,888 resulting in an approximate additional cost of $0.30 per kWh sold. Thus, the combined fuel and non-fuel expenses in Koyukuk required to produce power in Koyukuk were $0.82 per kWh sold in FY22. The last reported electric rate was $0.95 per kWh. Koyukuk's electric rate is over 5 times the national average of $0.16 per kWh. Koyukuk was PCE eligible for 59.4% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Koyukuk in the amount of $72,211 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,224 (AEA 2023).

Table 1. Koyukuk Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
97	58	6	7

Source: AEA 2023

Table 2. Koyukuk Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced [4] (lbs)
357,924	0	65.8%	9.78	254,696	36,585	818,772

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[5] was created to assess GHGs emitted from 245 communities around Alaska, including Koyukuk (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHG gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and

[5] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Koyukuk. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Koyukuk:

- Residential Sector
  - Residual Fuel Oil No. 5 = 739.16 MT CO_2e
  - Wood and Residuals = 12.12 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 159.61 MT CO_2e
  - Propane = 12.18 MT CO_2e
  - Wood and Wood Residuals = 0.44 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Koyukuk was modeled. The analysis indicated that approximately 303.02 MWh electricity is used in this capacity and that the resulting emissions all come from diesel in the amount of 87.27 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Koyukuk may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that would reduce CO_2 emissions;
- A second woodchip boiler that could heat community buildings and further reduce diesel emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;

- Weatherization to retain more heat in buildings, thus producing fewer GHGs; and
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community apply for funding for a solar PV array with BESS to reduce diesel use and resulting GHGs.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for additional funding for weatherization of buildings, including residences to lower heating expenses, heating oil consumption, and GHGs.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 305 kW Renewable Solar + 492kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
305 kW PV; 492 kWh BESS	1.78	1.00	50%	20,122	16,463	62,320	167,018	167

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHGs.

Koyukuk is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon Koyukuk region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Koyukuk's chief concerns around Yukon Koyukuk region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.7 Review of Authority to Implement

The Koyukuk Tribal Council (KTC) is the governing body for Koyukuk Village, a federally-recognized tribe. The KTC has the authority to implement GHG reduction measures through resolutions passed in KTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, K TC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Koyukuk to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should apply for funding for a solar PV array and BESS to reduce fuel consumption and lower GHG emission.
2. **Residential Weatherization.** It is likely that most homes in Koyukuk have not had further weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Koyukuk is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

4. **Other Steps:** Koyukuk will be working with TCC to improve grid resiliency under a grant received from DOE. Following implementation of upgrades to the system, the community should examine whether any needs remain for upgrading switch gear, transformers, and transmission lines that may require additional funding.

5 References

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UL Solutions. 2024. HOMER Pro Microgrid Software. Available online at: HOMER Pro - Microgrid Software for Designing Optimized Hybrid Microgrids (homerenergy.com) .

Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Koyokuk (FY2022)

Koyukuk PCE

Utility: CITY OF KOYUKUK
Reporting Period: 07/01/21 to 06/30/22

Community Population	96
Last Reported Month	June
No. of Monthly Payments Made	5
Residential Customers	58
Community Facility Customers	6
Other Customers (Non-PCE)	7
Fiscal Year PCE Payments	**$25,876**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	56,748	Average Annual PCE Payment per Eligible Customer	$404
PCE Eligible kWh - Community Facility Customers	17,888	Average PCE Payment per Eligible kWh	$0.35
Total PCE Eligible kWh	74,636	Last Reported Residential Rate Charged (based on 500 kWh)	$0.95
Average Monthly PCE Eligible kWh per Residential Customer	196	Last Reported PCE Level (per kWh)	$0.35
Average Monthly PCE Eligible kWh per Community Facility Customer	596	Effective Residential Rate (per kWh)	$0.60
Average Monthly PCE Eligible Community Facility kWh per Person	37	PCE Eligible kWh vs Total kWh Sold	31.7%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	357,924	Fuel Used (Gallons)	36,585
Non-Diesel kWh Generated	0	Fuel Cost	$122,472
Purchased kWh	0	Average Price of Fuel	$3.35
Total Purchased & Generated	357,924	Fuel Cost per kWh sold	$0.52
		Annual Non-Fuel Expenses	$0
		Non-Fuel Expense per kWh Sold	See Comments
		Total Expense per kWh Sold	$0.52

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	121,645	Consumed vs Generated (kWh Sold vs Generated-Purchased)	65.8%
Community Facility kWh Sold	38,105	Line Loss (%)	28.8%
Other kWh Sold (Non-PCE)	75,654	Fuel Efficiency (kWh per Gallon of Diesel)	9.78
Total kWh Sold	235,404	PH Consumption as % of Generation	5.4%
Powerhouse (PH) Consumption kWh	19,292		
Total kWh Sold & PH Consumption	254,696		

Comments

Only 5 months filed. Non-Fuel Exp not reported

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Manley Hot Springs Village

Manley Hot Springs, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	CO_2 equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour

LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Ton
MVC	Manley Village Council
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Manley Hot Springs, a rural and predominantly Alaska Native community of approximately 106 residents in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emissions in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Manley Hot Springs. GHG production levels and energy costs for Manley Hot Springs were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source for producing power and resulting GHG emissions in Manley Hot Springs in 2022 (AEA 2023). The 106 residential customers, 12 community facility customers, and 23 other customers required 593,078 kWh of diesel-generated power. A total of 46,820 gallons of diesel fuel were consumed by Manley Hot Springs customers in 2022 at a cost of $130,558 ($2.79 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,047,832 lbs CO_2 were produced in Manley Hot Springs in FY2022.

The average fuel cost per kWh for Manley Hot Springs in 2022 was $0.26. The annual non-fuel expenses associated with power generation totaled $318,870 in FY22, resulting in an additional cost of $0.65 per kWh sold. Thus, the combined fuel and non-fuel expenses in Manley Hot Springs required to produce power in Manley Hot Springs were $0.91 per kWh sold in FY22. The last reported residential customer rate paid by residents was 1.20 kWh. Manley Hot Springs's electric rate is nearly six times the national average of $0.16 per kWh. Manley Hot Springs was PCE eligible for 35.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to the community in the amount of $133,912 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,522 (AEA 2023) .

Constellation Energy (2024) modeled GHG emission sources and outputs for Manley Hot Springs. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Manley Hot Springs:

- Residential Sector
    - Residual Fuel Oil No. 5 = 197.99 MT CO_2e

- Wood and Residuals = 2.49 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 32.48 MT CO_2e
  - Propane = 2.48 MT CO_2e
  - Wood and Wood Residuals = 0.09 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Manley Hot Springs was also modeled. The analysis indicated that approximately 511.02 MWh electricity is used in this capacity in Manley Hot Springs, resulting in emissions all stemming from diesel in the amount of 147.17 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Manley Hot Springs, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 544 kw solar PV and a 757 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software (UL Solutions 2024) for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs. Manley Hot Springs has recently commissioned a solar photovoltaic array with a capacity of 208 kW PV and a 289 kWh BESS. Following a review of this information preferred options for cleaner, lower cost energy in Manley Hot Springs are:

- Additional Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal / city buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory’s significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP’s GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG) with the main goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

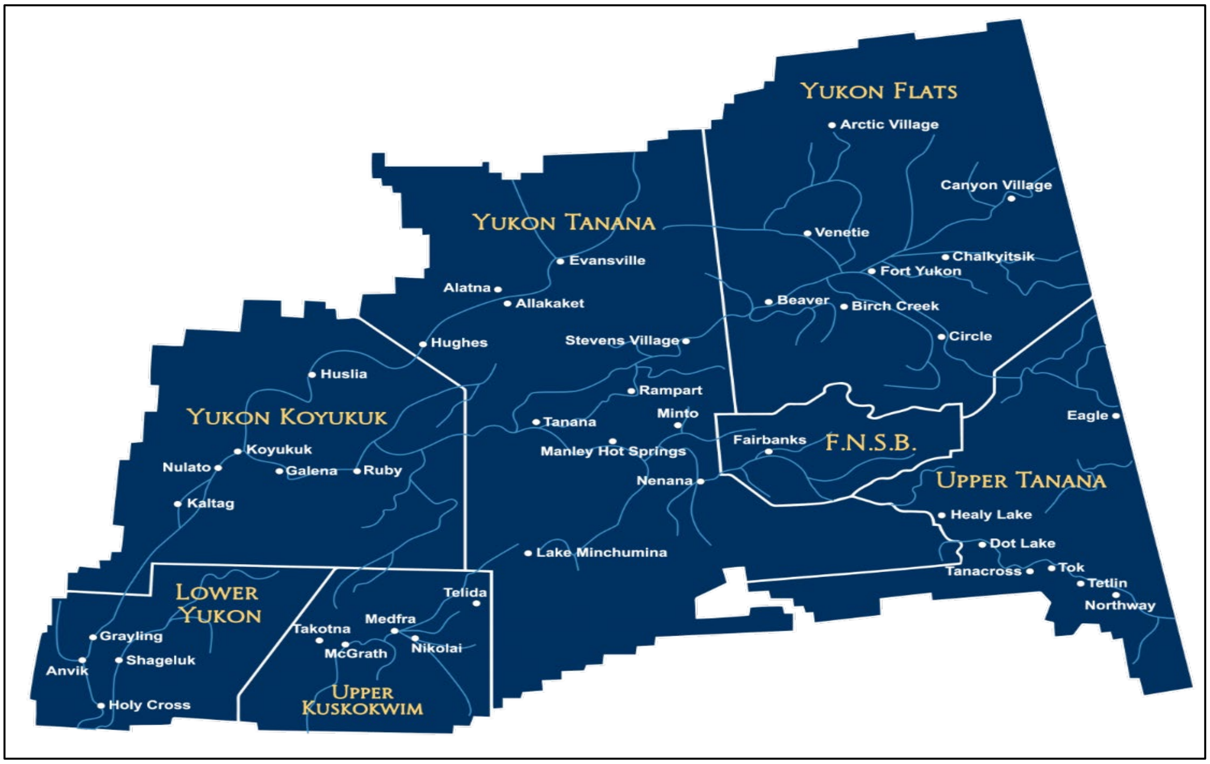
The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

1.2 Tanana Chiefs Conference’s Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the

Interior Alaska Native people. Its region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning and transportation, and infrastructure division including energy projects.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), Alaska Village Electric Consortium (AVEC), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

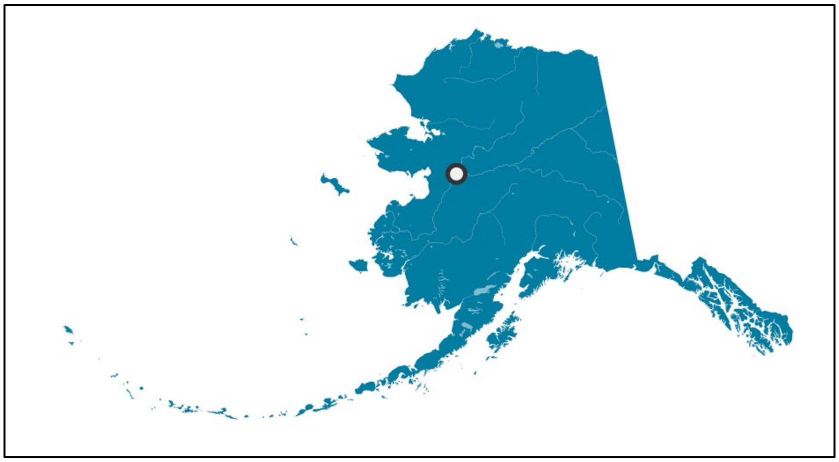
1.4 Scope of this PCAP: The Community of Manley Hot Springs

Manley Hot Springs, Alaska is a rural, primarily Athabascan village home to approximately 106 people in 76 households. Manley Hot Springs is located about 5 miles north of the Tanana River on Hot Springs Slough, at the end of the Elliott Highway, 160 road miles west of Fairbanks. (Figure 2). Access is primarily by plane or road. The Elliott Highway connects the community to Fairbanks, providing a transportation route for supplies and services.

Manley Hot Springs is located in the continental climate zone where winters are cold and summers are warm with extreme temperature differences. In winter, cool air settles in the valley, and ice fog and smoke conditions are common. The average low temperature during December, January, and February is well below 0 °F. The average high temperature during June, July, and August is in the lower 60s °F. Extreme temperatures ranging from a low of -70 to a high of 93 °F have been measured. Average annual precipitation is 15 inches, and annual snowfall averages 59 inches.

Manley Hot Springs's Tribal population is below poverty level classified as a Historically Disadvantaged Community existing in an Area of Persistent Poverty. A significant number of Manley Hot Springs's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[1].

Figure 2. Location of Manley Hot Springs, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026 .

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, tribal communities requires specific considerations for PCAPs, including:

[1] https://www.huduser.gov/portal/icdbg2022/home.html

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery systems allows existing generators to run optimally and avoid excess / waste power generation
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Manley Hot Springs. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of Manley Hot Springs and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Manley Hot Spring's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. There are a number of areas around the village that may be suitable.

Manley Hot Springs has recently commissioned a solar photovoltaic array with a capacity of 208 kW PV and a 289 kWh BESS.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind

turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are the highest. Like solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed Manley Hot Springs is estimated to be 6.0 mph[2] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a small community of 106 residents, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter. The high initial capital cost can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Manley Hot Springs, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Manley Hot Springs because of the number of moving parts that must continue operating at very cold temperatures. Should Manley Hot Springs decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project. There are no known plans to study or implement a wind project in Manley Hot Springs.

[2] https://wind.willyweather.com/ak/yukon--koyukuk-borough/manley-hot-springs.html

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012) .

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future[3].

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[3] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Manley Hot Springs, the transmission lines and switch gear are likely due for upgrade, along with any transformers and other hardware required to maintain the power grid. Grid component upgrades may be needed to accommodate new projects, including alternative means of electrical generation.

Huslia recently received a Bipartisan Infrastructure Law (BIL) 40101(d) Grid Resilience Grant through TCC. Huslia will receive Department of Energy (DOE) funding for electric grid resiliency (preventing / reducing number of electrical outages). This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that could be used in conjunction with a future renewable energy project.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no current plans for Manley Hot Springs to incorporate electrification into its airport.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique

characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

A few EV's have traveled the 100-mile road to Manley Hot Springs, but currently the only charging option is plugging into a 110v outlet. With the opening of the Manley Hot Springs Resort in 2021 and the reopening of the Manley Roadhouse and Lodge in 2023, Manley Hot Springs expects to see an increase in EV visits to the community. However, there are no known plans to construct EV charging stations in Manley Hot Springs at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Manley Hot Springs does not have plans to pursue a hydrokinetic project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Manley Hot Springs, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Manley Hot Springs has not performed a major weatherization project in recent years. The residents of Manley Hot Springs have expressed interest in weatherization efforts for residences and tribal buildings. Residences may also benefit from the installation of setback thermostats, general air tightening, the upgrading of chest freezers and refrigerators to Energy Star appliances. Preliminary modeling indicates that tribal members could save 10-30% on their electrical and heating bills by implementing these weatherization upgrades.

It is not known whether Manley Hot Springs has performed significant weatherization upgrades to tribal or residential building components. Weatherization would substantially reduce heat loss and improve energy efficiency in an area that can reach some of the lowest winter temperatures in Alaska.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory

- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Manley Hot Springs in late 2023 to inform to help inform the PCAP development process was not returned .

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Manley Hot Springs (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and resulting GHG emissions in Manley Hot Springs in 2022 (AEA 2023). The 106 residential customers, 12 community facility customers, and 23 other customers required 593,078 kWh of diesel-generated power. A total of 46,820 gallons of diesel fuel were consumed by Manley Hot Springs customers in 2022 at a cost of $130,558 ($2.79 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,047,832 lbs CO_2 were produced in Manley Hot Springs in FY2022.

The average fuel cost per kWh for Manley Hot Springs in 2022 was $0.26. The annual non-fuel expenses associated with power generation totaled $318,870 in FY22, resulting in an additional cost of $0.65 per kWh sold. Thus, the combined fuel and non-fuel expenses in Manley Hot Springs required to produce power in Manley Hot Springs were $0.91 per kWh sold in FY22. The last reported residential customer rate paid by Manley Hot Springs residents was 1.20 kWh.

Manley Hot Springs 's electric rate is nearly six times the national average of $0.16 per kWh. Manley Hot Springs was PCE eligible for 35.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Manley Hot Springs in the amount of $133,912 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,522 (AEA 2023).

PCE data for Manley Hot Springs is summarized in Tables 1 and 2, below.

Table 1. Manley Hot Springs Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
106	76	12	23

Source: AEA 2023

Table 2. Manley Hot Springs Fuel Consumption and CO2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced [4] (lbs)
593,078	0	83.2%	12.67	521,612	46,820	1,047,831

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool   Manley Hot Springs (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to Scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Manley Hot Springs. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Manley Hot Springs:

- Residential Sector
  - Residual Fuel Oil No. 5 = 197.99.00 MT CO_2e
  - Wood and Residuals = 2.49 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 32.48 MT CO_2e
  - Propane = 2.48 MT CO_2e
  - Wood and Wood Residuals = 0.09 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Manley Hot Springs was also modeled. The analysis indicated that approximately 511.02 MWh electricity is used in this capacity in Manley Hot Springs, resulting in emissions all stemming from diesel in the amount of 147.17 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Manley Hot Springs may pursue reduced GHG emissions through opportunities that would result in:

- An expanded community solar + BESS project that would further reduce CO_2 emissions.
- A woodchip boiler
- Waterfront safety and navigational lighting powered by solar + BSSE;
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** Following commissioning of its solar project, Manley Hot Springs should assess whether additional solar +PV is warranted to maximize this form of renewable energy and further reduce diesel consumption and GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings to reduce the amount of heating oil used and GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 544 kWh Renewable Solar + 757 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
544 kWh PV; 757 kWh BESS	2.94	0.25	50%	25,751	21,070	79,755	213,743	214

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

The rural and remote communities of the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC's and Manley Hot Springs's chief concerns around the region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.7 Review of Authority to Implement

The Manley Village Council (MVC) is the governing body for Manley Hot Springs Village, a federally recognized tribe. The MVC has the authority to implement GHG reduction measures through resolutions passed in MVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, MVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC recommends the following projects should be pursued by Manley Hot Springs to reduce GHGs:

1. **Community Scale Solar PV and BESS.** Following commissioning of its solar project, Manley Hot Springs should assess whether additional solar +PV is warranted to maximize this form of renewable energy and further reduce diesel consumption and GHG emissions.

2. **Weatherization**. It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings to reduce the amount of heating oil used and GHG emissions.

3. **Biomass Project(s):** Manley Hot Springs should consider applying for funds to commission a feasibility study to determine whether a woodchip boiler system would be beneficial for heating community buildings and homes. The cost reduction from decreased fuel oil usage due to support from the biomass boiler system may offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally-sourced wood is considered carbon-neutral, so a biomass boiler system could reduce the carbon footprint of heating community buildings.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Manley Hot Springs is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological

monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The community intends to update switchgear for greater reliability of electrical power under a current grant from DOE. When this work is completed, the community should assess its remaining need with respect to grid resiliency and determine whether additional funding is required to complete electrical grid component upgrades.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Manley Hot Springs (FY2022)

Manley Hot Springs PCE

Utility: TDX MANLEY GENERATING LLC
Reporting Period: 07/01/21 to 06/30/22

Community Population	106
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	76
Community Facility Customers	12
Other Customers (Non-PCE)	23
Fiscal Year PCE Payments	**$133,912**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	147,396	Average Annual PCE Payment per Eligible Customer	$1,522
PCE Eligible kWh - Community Facility Customers	29,870	Average PCE Payment per Eligible kWh	$0.76
Total PCE Eligible kWh	177,266	Last Reported Residential Rate Charged (based on 500 kWh)	$1.20
Average Monthly PCE Eligible kWh per Residential Customer	162	Last Reported PCE Level (per kWh)	$0.76
Average Monthly PCE Eligible kWh per Community Facility Customer	207	Effective Residential Rate (per kWh)	$0.44
Average Monthly PCE Eligible Community Facility kWh per Person	23	PCE Eligible kWh vs Total kWh Sold	35.9%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	593,078	Fuel Used (Gallons)	46,820
Non-Diesel kWh Generated	0	Fuel Cost	$130,558
Purchased kWh	0	Average Price of Fuel	$2.79
Total Purchased & Generated	593,078	Fuel Cost per kWh sold	$0.26
		Annual Non-Fuel Expenses	$318,870
		Non-Fuel Expense per kWh Sold	$0.65
		Total Expense per kWh Sold	$0.91

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	166,519	Consumed vs Generated (kWh Sold vs Generated-Purchased)	83.2%
Community Facility kWh Sold	50,223	Line Loss (%)	12.1%
Other kWh Sold (Non-PCE)	276,557	Fuel Efficiency (kWh per Gallon of Diesel)	12.67
Total kWh Sold	493,299	PH Consumption as % of Generation	4.8%
Powerhouse (PH) Consumption kWh	28,313		
Total kWh Sold & PH Consumption	521,612		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

McGrath Native Village

McGrath, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
AVEC	Alaska Village Electric Cooperative
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour

LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MNVC	McGrath Native Village Council
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of McGrath, a rural and predominantly Alaska Native community of approximately 307 residents in Interior Alaska. McGrath is located on the bank of the Kuskokwim River at its confluence with the Takotna River. This PCAP identifies sources of greenhouse gas (GHG) emission in the community of McGrath and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for McGrath. GHG production levels and energy costs for McGrath were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), and a GHG Emission Inventory Report (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in McGrath in 2022 (AEA 2023). McGrath's 307 residential customers, 14 community facility customers, and 91 other customers required 2,214,682 kWh in diesel-generated power. A total of 155,909 gallons of diesel fuel were consumed by McGrath customers in 2022 at a cost of $538,442 ($3.45 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that McGrath accounted for 3,489,243 lbs CO_2 in FY2022.

The average fuel cost per kWh for McGrath in 2022 was $0.28. The annual non-fuel expenses associated with power generation were not reported in FY22, but typical non-fuel expenses resulted in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and assumed non-fuel expenses in McGrath were approximately $0.48 per kWh sold in FY22. The electric rates in McGrath were three times the national average of $0.16 per kWh. They were PCE eligible for 32.4% of its total kWh sold in Fiscal Year (FY) 2022, resulting in PCE payments to McGrath in the amount of $232,163 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer in McGrath was $1,161 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for McGrath. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in McGrath:

- Residential Sector
  - Residual Fuel Oil No. 5 = 541.17 MT CO_2e
  - Wood and Residuals = 20.67 MT CO_2e
- Commercial Sector

- Distillate Fuel Oil No. 1 = 268.18 MT CO_2e
- Propane = 20.47 MT CO_2e
- Wood and Wood Residuals = 0.74 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for McGrath was also modeled. The analysis indicated that approximately 2,002.07 MWh electricity is used in this capacity in McGrath, resulting in emissions all stemming from diesel in the amount of 576.60 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For McGrath, the maximum fraction of existing energy production that could be replaced by renewables is 30%, represented by a 991 kw solar PV and a 1391 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software (UL Solutions 2024) for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs. Following a review of this information preferred options for cleaner, lower cost energy in McGrath are:

- Solar PV + BESS array to reduce diesel fuel consumption and CO_2 production;
- Weatherization of residences, tribal / city buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

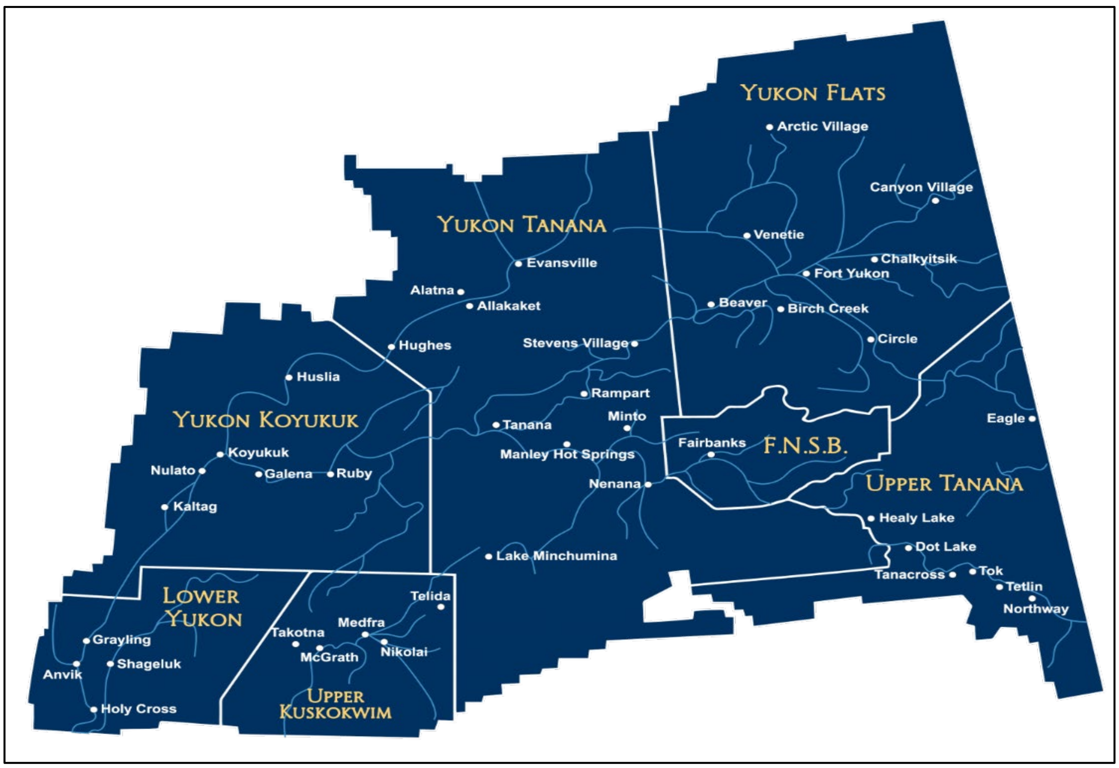
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution.

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Village Electric Cooperative (AVEC), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

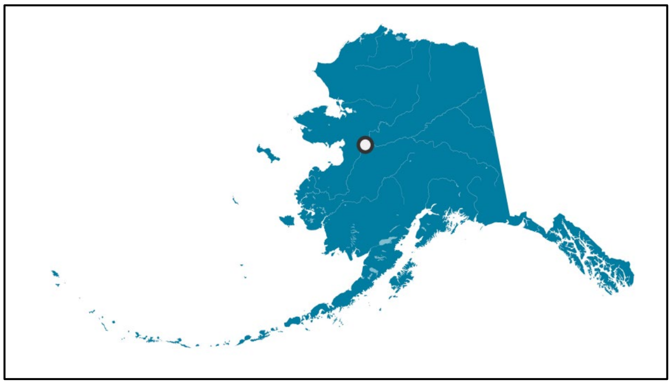
1.4 Scope of this PCAP: The Community of McGrath

McGrath is a traditional Athabascan village home to approximately 307 residents. McGrath is located on the bank of the Kuskokwim River and directly south of its confluence with the Takotna River, 269 air miles southwest of Fairbanks (Figure 2).

McGrath is located in the continental climate zone where winters are cold and summers are warm. In winter, cool air settles in the valley and ice fog and smoke conditions are common. The average low temperature during December, January, and February is -13°F. The average high temperature during June, July, and August is 68°F. Extreme temperatures ranging from a low of -64 to a high of 94°F have been measured. Average annual precipitation is 10 inches, and annual snowfall averages 86 inches.

McGrath is a rural, disadvantaged community that exists in an Area of Persistent Poverty. Approximately 37% of McGrath's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of McGrath, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery systems allows existing generators to run optimally and avoid excess / waste power generation
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for McGrath. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of McGrath and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In McGrath's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been

effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. There are a number of areas around the village that may be suitable.

It is not known whether McGrath has pursued a solar PV + BESS project as an option for reducing energy expenses that could provide energy cost savings and a reduction in GHG emissions.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed McGrath is estimated to be 6.0 mph[3] which is a Class 1 wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a small community, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter. The high initial capital cost can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in McGrath, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like McGrath because of the number of moving parts that must continue operating at very cold temperatures. Should McGrath decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

It is not known whether McGrath has pursued a feasibility study or grant funding for wind energy to reduce energy costs and GHG emissions.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable

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[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/mcgrath.html

example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

Several rural communities in Alaska have commissioned wood chip boilers to reduce diesel fuel consumption and lower heating bills. In 2011, McGrath Native Village Council (MNVC) was awarded a grant from the State of Alaska Renewable Energy Fund, administered by the Alaska Energy Authority (AEA) and developed under a contract between MNVC to TCC Forestry, in support of a proposed biomass energy project.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help to address renewable system

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In McGrath, switchgear, controllers, and transformers are likely due for updating, and a BESS may be needed to regulate ramp rates on the diesel generators. Updating the switchgear and controllers is often a necessary step for proper incorporation of renewables.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

McGrath has no plans to incorporate electrification into its airport and waterfront at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.

- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

McGrath does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

McGrath is situated on the Kuskokwim River. However, the community is not pursuing a hydrokinetic project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In McGrath, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Some weatherization occurred at least 15 years ago, but it is not known whether McGrath has performed a major weatherization effort in recent years.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

McGrath Native Village completed a community survey that was issued to the Tribe by TCC in late 2023. This survey provided the Tribe with an opportunity to comment on their energy priorities and challenges, weatherization and electrical needs, and interest in renewable energy systems. The survey completed by the community of McGrath indicated they currently do not have an energy/economic development plan. Their three top energy priorities are to reduce the cost of home heating, reduce energy costs of public buildings and facilities, and reduce their reliance on diesel fuel. McGrath indicated that it does not have a heat recovery system and does not have any renewable energy projects in their future. The community is interested in the following types of projects for the future:

- Community-scale solar PV systems and BESS
- The possibility of hydrologic energy

McGrath's population and geographic size should allow for the community to provide a high percentage of renewable energy combined with solar, wind, etc. It has been at least 15 years since most of the homes were weatherized in McGrath. The community is interested in cutting costs so it can continue to grow.

McGrath is interested in having an energy audit. They would also be interested in weatherization retrofits for their community buildings. Forty percent of their community buildings do not have basic utilities, including power, water, and sewer. McGrath is interested in applying for EPA CPRGs. Their priorities are applying for energy efficient upgrades along with solar power + BESS to power the community and relieve the reliance on higher cost power.

Their highest priority energy projects from their community plan are renewable energy and energy-healthy homes.

McGrath is interested in an electric assessment to confirm their community's needs. They require assistance in finding and better utilizing wasted energy in the community, cutting fuel costs, and creating energy-healthy homes. McGrath recently purchased new smaller generators to use less fuel, but they continually break down and need replacement parts.

3.2 AEA PCE REPORTS

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in McGrath (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in McGrath in 2022 (AEA 2023). McGrath's 307 residential customers, 14 community facility customers, and 91 other customers required 2,214,682 kWh in diesel-generated power. A total of 155,909 gallons of diesel fuel were consumed by McGrath customers in 2022 at a cost of $538,442 ($3.45 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that McGrath accounted for 3,489,243 lbs CO_2 in FY2022.

The average fuel cost per kWh for McGrath in 2022 was $0.28. The annual non-fuel expenses associated with power generation were not reported in FY22, and typical non-fuel expenses resulted in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and assumed non-fuel expenses in McGrath were approximately $0.48 per kWh sold in FY22. The electric rates in McGrath were three times the national average of $0.16 per kWh. They were PCE eligible for 32.4% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to McGrath in the amount of $232,163 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer in McGrath was $1,161 (AEA 2023).

Table 1. McGrath Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
307	186	14	91

Source: AEA 2023

Table 2. McGrath Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[5] (lbs)
2,214,682	0	87.4%	14.2	2,025,768	155,909	3,489,243

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including McGrath (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for McGrath. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in McGrath:

- Residential Sector
  - Residual Fuel Oil No. 5 = 541.17 MT CO_2e
  - Wood and Residuals = 20.67 MT CO_2e
- Commercial Sector

- Distillate Fuel Oil No. 1 = 268.18 MT CO_2e
- Propane = 20.47 MT CO_2e
- Wood and Wood Residuals = 0.74 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for McGrath was modeled. The analysis indicated that approximately 2,002.07 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (576.60 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

3.4 GHG Reduction Targets

McGrath intends to reduce GHG emissions by pursuing funding opportunities that will pay for:

- A community solar + BESS project that would reduce CO_2 emissions.
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- An assessment of whether wind would be practical or lucrative;
- Funds for weatherization to retain more heat in buildings, thus producing fewer GHGs.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that McGrath pursue a solar array with a BESS to reduce its diesel fuel consumption and lower GHG emissions.
2. **Additional Weatherization.** It is recommended that the community weatherize several community buildings with modern features that would reduce heat escape and lower heating bills, along with GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 30% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 991 kWh PV Renewable Solar + 1,391 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
991 kWh PV 1,391 kWh BESS	5.66	1.00	30%	116,932	38,977	147,545	395,420	395

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

3.7 Review of Authority to Implement

The McGrath Native Tribal Council (MNTC) is the governing body for McGrath Native Village, a federally-recognized tribe. The MNTC has the authority to implement GHG reduction measures through resolutions passed in MNTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, MNTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by McGrath to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that McGrath pursue a solar array with a BESS to reduce its diesel fuel consumption and lower GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings. It is likely that the several homes, and tribal / city buildings have not had energy efficiency improvements beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.

3. **Biomass Project(s):** While a State of Alaska Renewable Energy Grant was awarded to the community in 2011 to explore a biomass heating system, a project was never constructed. Using locally harvested woody biomass could reduce fuel oil usage and result in overall savings to the community. Locally-sourced wood is considered carbon-neutral, so the biomass boiler system decreases the carbon footprint of heating the community buildings. It is recommended that project funding be pursued for this purpose.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around McGrath is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** It is recommended that McGrath assess whether upgrades are required to its electrical grid system, including transformers, transmission lines, and switch gear. The pursuit of funding for these needs may improve reliability of the grid and create opportunities for the tie-in of renewable energy systems.

5 References

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UAF. 2022. A Solar Design Manual for Alaska. 6th Edition. Available online at: A Solar Design Manual for Alaska, Sixth Edition (uaf.edu)

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for McGrath (FY2022)

McGrath PCE

Utility: MCGRATH LIGHT & POWER
Reporting Period: 07/01/21 to 06/30/22

Community Population	307
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	186
Community Facility Customers	14
Other Customers (Non-PCE)	91
Fiscal Year PCE Payments	**$232,163**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	453,996	Average Annual PCE Payment per Eligible Customer	$1,161
PCE Eligible kWh - Community Facility Customers	174,173	Average PCE Payment per Eligible kWh	$0.37
Total PCE Eligible kWh	628,169	Last Reported Residential Rate Charged (based on 500 kWh)	$0.71
Average Monthly PCE Eligible kWh per Residential Customer	203	Last Reported PCE Level (per kWh)	$0.37
Average Monthly PCE Eligible kWh per Community Facility Customer	1,037	Effective Residential Rate (per kWh)	$0.34
Average Monthly PCE Eligible Community Facility kWh per Person	47	PCE Eligible kWh vs Total kWh Sold	32.4%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	2,214,682	Fuel Used (Gallons)	155,909
Non-Diesel kWh Generated	0	Fuel Cost	$538,442
Purchased kWh	0	Average Price of Fuel	$3.45
Total Purchased & Generated	2,214,682	Fuel Cost per kWh sold	$0.28
		Annual Non-Fuel Expenses	$0
		Non-Fuel Expense per kWh Sold	See Comments
		Total Expense per kWh Sold	$0.28

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	520,644	Consumed vs Generated (kWh Sold vs Generated-Purchased)	87.4%
Community Facility kWh Sold	174,173	Line Loss (%)	8.5%
Other kWh Sold (Non-PCE)	1,241,116	Fuel Efficiency (kWh per Gallon of Diesel)	14.20
Total kWh Sold	1,935,933	PH Consumption as % of Generation	4.1%
Powerhouse (PH) Consumption kWh	89,835		
Total kWh Sold & PH Consumption	2,025,768		

Comments

Non-Fuel Costs Not Reported

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Minto Village

Minto, AK

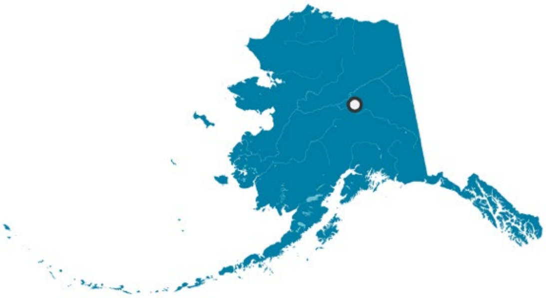


Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
AVEC	Alaska Village Electric Cooperative
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MVC	Minto Village Council
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
START	Strategic Technical Assistance Response Team Program
SOA	State of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States
VEEP	Village Energy Efficiency Program

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Minto, a rural and predominantly Alaska Native community of approximately 155 residents in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emission in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Minto. GHG production levels and energy costs for Minto were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), power generation data from the Alaska Village Electric Cooperative (AVEC), and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Minto in 2022 (AEA 2023), Minto's 76 residential customers, 7 community facility customers, and 18 other customers required 810,145 kWh of diesel-generated power. A total of 65,454 gallons of fuel were consumed by Minto customers in 2022 at a cost of $169,332 ($2.59 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,464,861 lbs CO_2 were produced in Minto in FY2022.

The average fuel cost per kWh in Minto in 2022 was $0.22. The annual non-fuel expenses associated with power generation totaled $154,239 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Minto required to produce power in Minto were $0.42 per kWh sold in FY22. The last reported electric rate was $0.58 per kWh; thus, Minto's electric rate is almost three-and-a-half times the national average of $0.16 per kWh. Minto was PCE eligible for 51.3% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Minto in the amount of $95,953 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1.156 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Minto. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Minto:

- Residential Sector
  - Residual Fuel Oil No. 5 = 475.17 MT CO_2e
  - Wood and Residuals = 5.35 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 140.12 MT CO_2e

- Propane = 10.70 MT CO_2e
- Wood and Wood Residuals = 0.70 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Minto was modeled. The analysis indicated that approximately 782.12 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (225.25 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + Battery Energy Storage System (BESS) scenario to meet this fraction. For Minto, the maximum fraction of existing energy production that could be replaced by renewables is 40%, represented by a 510 kw solar PV and a 1,034 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Minto are:

- Solar PV + BESS projects;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

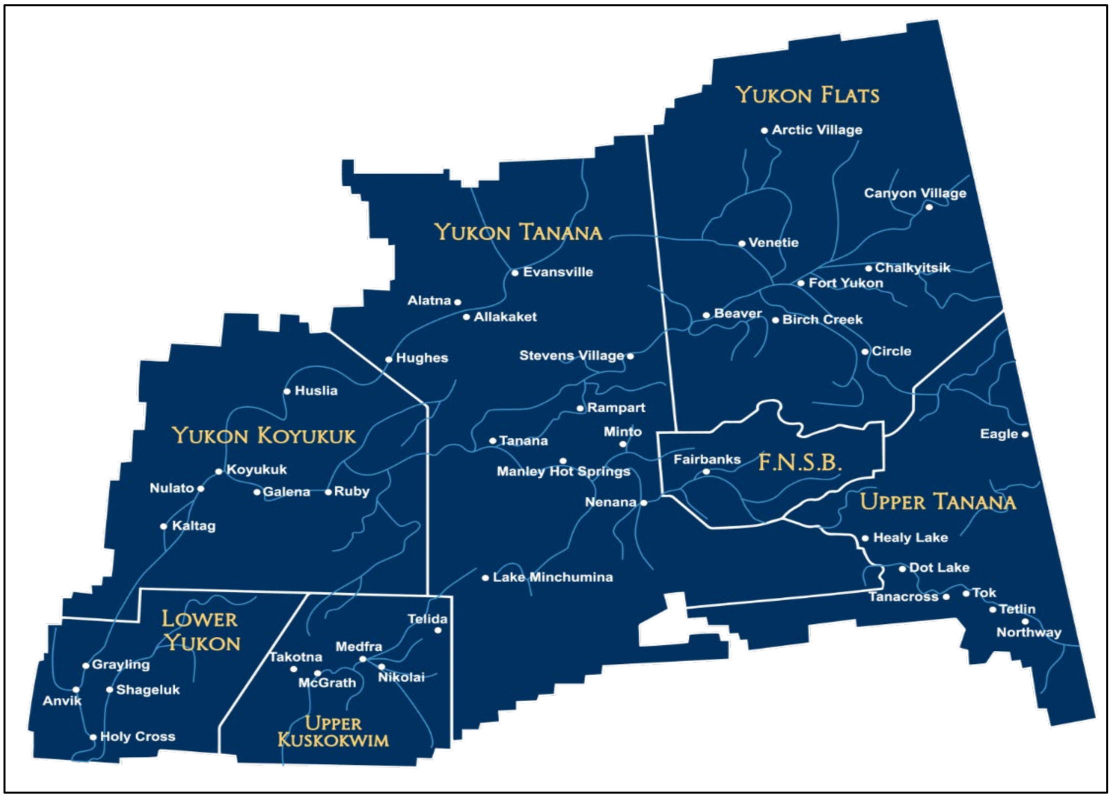
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Village Electric Cooperative (AVEC), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs, and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Minto

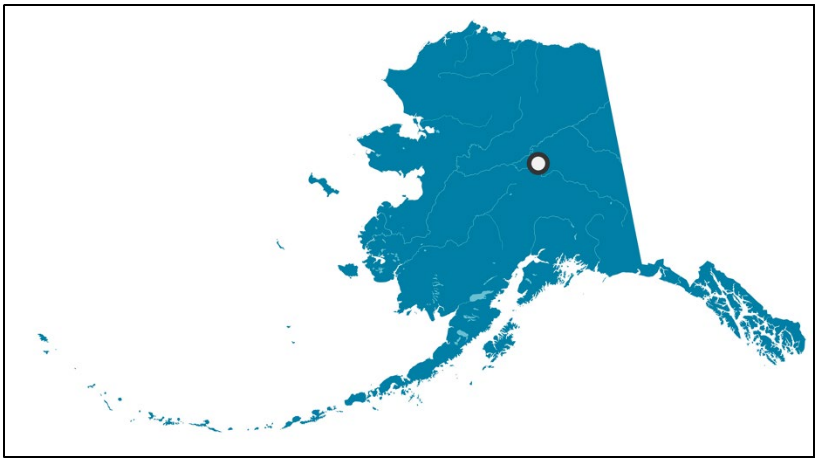
Minto is a traditional Tanana Athabascan village home to approximately 155 people. The Old Minto townsite was located on the banks of the Tanana River, but in 1971 the community relocated to a higher elevation site 25 miles away that was road accessible. Minto is today situated near the west bank of the Tolovana River, 130 air miles northwest of Fairbanks (Figure 2). It lies on an 11-mile spur road off of the Elliott Highway, alongside the Minto Flats State

Game Refuge, and access is primarily by plane or road. Minto's power is generated locally at a diesel power plant operated by the Alaska Village Electric Cooperative (AVEC).

Minto is located in the continental climate zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. Several consecutive days of -40 °F is common each winter. Average annual precipitation is 12 inches, with 50 inches of snowfall.

The U.S. EPA indicates that Minto's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Minto as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 85% of Minto's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Minto, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Minto. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a

broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of Minto and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Minto's case, the Village of Minto completed construction of a heat recovery system to heat the local water treatment plant.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many

remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

Minto recently collaborated with TCC to win a Department of Energy (DOE) Office of Clean Energy Demonstrations
(OCED) grant to develop a community solar and battery project. This project will include a 225 kW PV, a 250 kW Inverter and a 450 kW battery energy storage system (BESS), which will be integrated into the existing AVEC power plant. TCC will serve as an IPP, owning and operating the system and selling power to AVEC on behalf of the community. They predict that solar generation from this project could displace 20,000 gallons of diesel fuel annually and reduce GHG emissions by up to 23%. Generator run time in the community would reduce from 100% to approximately 69.49% of the time, and provide benefits in reduced emissions, noise, maintenance and operating costs, and more open maintenance periods. The revenue from power sales will be redirected into the community.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Minto is estimated to be 6.1 mph[3] which is a Class 1 (light breeze) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 155 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high capital cost of designing, mobilizing, constructing, and connecting a wind project in Minto is not likely to recover the capital cost in a short or moderate time frame, due to having only a Class 1 wind resource. Furthermore, integrating wind would require upgrades to the grid components.

Because of the marginal wind resource in Minto, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Minto because of the number of moving parts that must continue operating at very cold temperatures. Should Minto decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/minto.html

and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future. It is unknown whether Minto has contemplated or pursued funding for a biomass project that could efficiently heat community buildings.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

AVEC was awarded Denali Commission and AEA funding on behalf of Minto that will provide for needed upgrades to the community's switchgear, as well as three new tier-rated powerplant engines with improved fuel efficiency. A BESS may be needed to regulate ramp rates on the diesel generators. Updating the switchgear and controllers is often a necessary step for proper incorporation of renewables. The goal of completion of these improvements is the end of 2025.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no plans for incorporating electrification into Minto's waterfront or airport infrastructure at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Minto does not have plans to incorporate EV charging stations at this time. However, the community is connected to the Alaska road system, so future EV charging stations are not out of the question for the region.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

As noted above, the Old Minto townsite was located on the banks of the Tanana River, but in 1971 the community relocated to a site 25 miles away near the Tolovana River that was road accessible. The new townsite is set higher above and at a greater distance away from the river, which may make a hydrokinetic project would not necessarily be practicable.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In 2012 Village of Minto completed construction of a heat recovery system to heat the local water treatment plant.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The last major weatherization effort in Minto was performed through the Strategic Technical Assistance Response Team (START) Program in 2013-2015, under which the Lakeview Lodge which is home to the main tribal offices as well as many other elder and school programs. The lodge received upgraded insulation and air leakage repairs. Residents and individuals of Minto received energy efficiency education and LED lighting from some homes. As a result of the START award, the community was also granted funding from the SOA Village Energy Efficiency Program (VEEP) for additional weatherization and upgrades to the Minto fire hall. However, that was over ten years ago and the residents of Minto have expressed interest in further weatherization efforts for residences and tribal buildings.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis

- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Minto Community Survey

A community survey offered to Minto in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Minto (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Minto in 2022 (AEA 2023), Minto's 76 residential customers, 7 community facility customers, and 18 other customers required 810,145 kWh of diesel-generated power. A total of 65,454 gallons of fuel were consumed by Minto customers in 2022 at a cost of $169,332 ($2.59 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,464,861 lbs CO_2 were produced in Minto in FY2022.

The average fuel cost per kWh in Minto in 2022 was $0.22. The annual non-fuel expenses associated with power generation totaled $154,239 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Minto required to produce power in Minto were $0.42 per kWh sold in FY22. The last reported electric rate was $0.58 per kWh; thus, Minto's electric rate is almost three-and-a-half times the national average of $0.16 per kWh. Minto was PCE eligible for 51.3% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Minto in the amount of $95,953 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1.156 (AEA 2023). PCE data is summarized in Tables 1 and 2, below.

Table 1. Minto Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
155	76	7	18

Source: AEA 2023

Table 2. Minto Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
810,145	0	95.7%	12.38	785,445	65,454	1,464,860

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 AVEC Power Generation Data

AVEC is the electric utility for eight of the communities in TCC's region, including Minto. AVEC provides the following data for Minto:

- Diesel Generators:
  - Station 1: Cummins LTA10 1200, 168 kW
  - Station 2: Detroit Diesel S60K4 1200, 236 kW
  - Station 3: Cummins LTA10 1800, 250 kW
- Average Load: 88 kW

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

- Estimated peak load: 170 kW
- Average annual power generated: 770,391 kWh
- Average fuel consumed: 61,240 gallons/year
- Average fuel efficiency: 13 kWh/gallon

3.4 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[5] was created to assess GHGs emitted from 245 communities around Alaska, including Minto (Constellation Energy 2024). The inventory tool is based off modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with

[5] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Minto. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Minto:

- Residential Sector
  - Residual Fuel Oil No. 5 = 475.17 MT CO_2e
  - Wood and Residuals = 5.35 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 140.12 MT CO_2e
  - Propane = 10.70 MT CO_2e
  - Wood and Wood Residuals = 0.39 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Minto was modeled. The analysis indicated that approximately 782.12 MWh electricity is used in this capacity and that the resulting emissions all come from diesel in the amount of 225.25 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.5 GHG Reduction Targets

Minto may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;

- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative.

3.6 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for additional funding to reach maximum GHG reduction with for a total of 510kWh PV solar array project along with 1,034kWh BESS. Electric generation created through solar will reduce diesel fuel consumption and generator run time.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings to reduce heating oil and wood burning resulting in reduced GHGs.

3.7 Benefits Analysis

An analysis was performed under a scenario in which 40% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 510 kWh Renewable Solar + 1,034 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
510 kWh PV: 1,034 kWh BESS	2.91	1.00	40%	42,545	22,909	86,720	232,408	232.41

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

The rural and remote communities of the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Minto's chief concerns around the Yukon Tanana region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.8 Review of Authority to Implement

The Minto Village Council (MVC) is the governing body for Minto Village, a federally recognized tribe. The MVC has the authority to implement GHG reduction measures through resolutions passed in MVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, MVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Minto to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community apply for additional funding to maximize solar PV + BESS to help meet energy demands and further reduce CO_2 emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for additional weatherization of residences and tribal / city buildings. It is likely that the several homes, and tribal / city buildings in Minto have not had energy efficiency improvements in over a decade. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** It is recommended that the community consider applying for funding to study and/or implement a woodchip boiler system to contribute heating to community buildings and homes. The cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community.

Locally sourced wood is considered carbon-neutral, so the biomass boiler system decreases the carbon footprint of heating the community buildings.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Minto is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** Following planned work to upgrade electrical grid components in Minto over the next two years, the community should assess whether additional upgrade needs remain. If additional needs remain, the community should work with its partners to apply for additional funding.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Minto (FY2022)

Minto PCE

Utility: ALASKA VILLAGE ELECTRIC COOP
Reporting Period: 07/01/21 to 06/30/22

Community Population	155
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	76
Community Facility Customers	7
Other Customers (Non-PCE)	18
Fiscal Year PCE Payments	**$95,953**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	267,821	Average Annual PCE Payment per Eligible Customer	$1,156
PCE Eligible kWh - Community Facility Customers	130,200	Average PCE Payment per Eligible kWh	$0.24
Total PCE Eligible kWh	398,021	Last Reported Residential Rate Charged (based on 500 kWh)	$0.58
Average Monthly PCE Eligible kWh per Residential Customer	294	Last Reported PCE Level (per kWh)	$0.32
Average Monthly PCE Eligible kWh per Community Facility Customer	1,550	Effective Residential Rate (per kWh)	$0.25
Average Monthly PCE Eligible Community Facility kWh per Person	70	PCE Eligible kWh vs Total kWh Sold	51.3%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	810,145	Fuel Used (Gallons)	65,454
Non-Diesel kWh Generated	0	Fuel Cost	$169,332
Purchased kWh	0	Average Price of Fuel	$2.59
Total Purchased & Generated	810,145	Fuel Cost per kWh sold	$0.22
		Annual Non-Fuel Expenses	$154,239
		Non-Fuel Expense per kWh Sold	$0.20
		Total Expense per kWh Sold	$0.42

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	346,797	Consumed vs Generated (kWh Sold vs Generated-Purchased)	95.7%
Community Facility kWh Sold	343,947	Line Loss (%)	3.0%
Other kWh Sold (Non-PCE)	84,915	Fuel Efficiency (kWh per Gallon of Diesel)	12.38
Total kWh Sold	775,659	PH Consumption as % of Generation	1.2%
Powerhouse (PH) Consumption kWh	9,786		
Total kWh Sold & PH Consumption	785,445		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Nenana Native Village

Nenana, AK

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
GVEA	Golden Valley Electric Association
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode

Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
NNTC	Nenana Native Tribal Council
NNV	Nenana Native Village
PCAP	Priority Climate Action Plan
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for Nenana, a community of approximately 408 residents with strong Alaska Native representation in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emission in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

The PCAP identifies several Energy Focus Areas for Interior Alaska communities, and specifically, for Nenana. It evaluates existing GHG production levels and energy costs by first incorporating data from Golden Valley Electric Association (GVEA) statistics, a GHG Emission Inventory Report for Nenana (Constellation Energy 2024), and other sources. The PCAP then models reductions in generator-produced power and fuel costs under a scenario in which a portion of a similar community's energy infrastructure is converted to the most likely renewable system: solar photovoltaic (PV) with battery energy storage system (BESS). Finally, the PCAP recommends specific strategies for Nenana to become more energy efficient with the aim of lowering both GHG emissions and operational costs for the community.

Generally, GVEA, which serves Fairbanks, North Pole, Nenana, and other communities, has about 100,000 customers. Consumers of Golden Valley Electric purchase residential electricity for, on average, $0.31 cents per kilowatt hour. This rate is almost double the national average of $0.16 cents per kilowatt hour. In 2022 the company had retail sales of 1,244,414 megawatt hours and wholesale sales of 1,244,414 megawatt hours, with the majority of these being in the Fairbanks area.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar PV + BESS scenario to meet this fraction. For Nenana, the maximum fraction of existing energy production that could be replaced by renewables is 30%, represented by a 2,172 kw solar PV and a 3,301 kWh BESS.

Constellation Energy (2024) modeled GHG emission sources and outputs for Nenana. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Nenana:

- Residential Sector
    - Residual Fuel Oil No. 5 = 1,082.34 MT CO_2e
    - Wood and Residuals = 23.11 MT CO_2e

- Natural Gas = 23.11 MT CO_2e

- Commercial Sector
  - Bituminous Coal = 2,579.53 MT CO_2e
  - Distillate Fuel Oil No. 1 = 322.07 MT CO_2e
  - Propane = 24.51 MT CO_2e
  - Wood and Wood Residuals = 0.89 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Nenana was modeled. The analysis indicated that approximately 11,150.32 MWh electricity is used in this capacity. The subcategories for electricity used and their resulting emissions modeled through this exercise were:

- Coal = 4,794.64 MWh resulting in 1,535.72 MT CO_2e
- Wind = 446.01 MWh resulting in 0.00 MT CO_2e
- Hydro = 669.02 MWh resulting in 0.00 MT CO_2e
- Diesel = 669.02 MWh resulting in 192.68 MT CO_2e
- Petroleum = 3,010.59 MWh resulting in 867.05 MT CO_2e
- Natural Gas = 1,672.55 MWh resulting in 343.21 MT CO_2e

Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic (PV) + Battery Energy Storage System (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Nenana are:

- Solar PV + BESS array;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

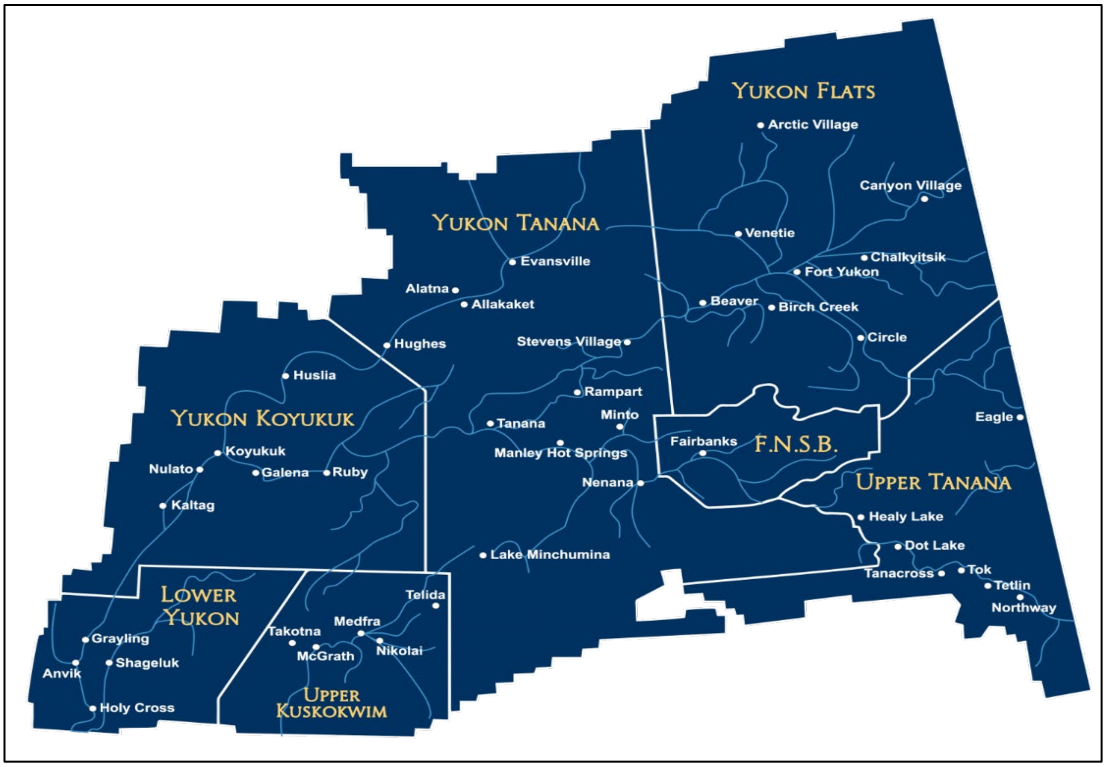
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs, and alternative energies .

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Nenana

Nenana is a predominately Koyukon Athabascan village home to approximately 408 residents. Nenana is located on the south bank of the Tanana River, 55 road miles southwest of Fairbanks, at mile 412 of the Alaska Railroad (Figure 2). Nenana is connected to the Alaska's road and rail systems. Nenana's power is generated by Golden Valley Electric Association, which owns and operates coal plants and the Eva Creek Wind Farm to generate electricity. The Nenana Coal Field near Healy (south of Nenana) operated by Usibelli is currently the only active coal producing field in the State of Alaska. GVA has approximately 100,00 customers but plans to shutter at least one of the coal plants, as well as expand wind resource projects and upgrade its BESS.

Nenana has a cold, continental climate with an extreme temperature range. The average daily maximum during summer months is 65 to 70 °F; the daily minimum during winter is well below 0 °F. The highest temperature ever recorded is 98 °F; the lowest is -69 °F. Average annual precipitation is 11.4 inches, with 48.9 inches of snowfall. The river is ice-free from mid-May to mid-October.

The U.S. EPA indicates that Nenana's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Nenana as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. At least 52.5% of Nenana's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Nenana, Alaska

Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation ;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Nenana. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a

broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

A Nenana solar farm and smaller solar projects have been proposed or considered, but there are no known solar projects operating in Nenana at this time.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital cost of wind can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource. However, if capital costs are offset by grants, wind systems can be affordable and incorporated into a community's portfolio of power production.

Average wind speed in Nenana is estimated to be 6.1 mph[3] which is a Class 1 (light breeze) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 408 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

Eva Creek Wind Farm just north of Healy Alaska has been producing power into GVEA's grid for over a decade. The wind farm, approximately 40 miles south of Nenana, is a project scaled to just under 25 megawatts. Eva Creek is the largest wind project in Alaska and the first by any Railbelt utility. The project cost $93M and consists of 12 Senvion turbine units that are 262 feet tall from base to turbine hub.[4]

Because of the marginal wind resource in Nenana, and the higher capital cost associated with wind, further study is required before pursuing a wind project directly in Nenana. There is hesitancy around wind for Interior Alaska communities like Nenana because of the number of moving parts that must continue operating at very cold temperatures; however, this has not been an issue for the aforementioned Eva Creek Wind Farm which lies just 40 miles south of Nenana. Should Nenana decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

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[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/nenana.html
[4] Eva Creek Wind – Golden Valley Electric Assn (gvea.com)

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.

The U.S. Department of Agriculture (USDA) recently awarded Nenana $680,000 in funding to purchase and install a Biomass District Heat System that will supply heat for multiple community buildings.[5] The project received past funding from the U.S. Forest Service's Community Wood Energy and Wood Innovation Grant Program, including a $167,745 award made in 2021 to support the installation of a biomass boiler and a $689,110 award in 2022 to support development of the district heating system.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation. Nenana is connected to the GVEA electric grid.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

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[5] USDA funding supports Alaskan district heating project (districtenergy.org)

Nenana Native Association will receive Bipartisan Infrastructure Law 40101(d) Grid Resilience Grant funding through TCC. The community will receive funding for electric grid resiliency, in particular for preventing or reducing number of electrical outages. This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no plans for incorporating electrification into Nenana's waterfront or airport infrastructure at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.

- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Nenana recently made an agreement with Tesla for the installation of eight EV charging stations to be constructed in 2024.[6] These charging stations will be located at the corner of Main and First Street. As part of the agreement, Tesla will cover the cost of the equipment, installation, and long-term maintenance for these EV charging stations.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do

[6] Tesla charging stations coming to Nenana | News | youralaskalink.com

not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

A hydrokinetic project was studied in detail circa 2009 by ORPC Alaska, which aimed to study the ability of RiverGen hydrokinetic units to generate power using the gravitational flow of the Tanana River at Nenana.[7] In 2014-2015, AEA, through funding from the Emerging Technology Fund, tested the Oceana Hydrokintetic Turbine design in the Tanana River. During the Tanana River testing the turbine was exposed to high sediment concentrations and surface debris. Still, in 12.4 hours of testing, during which high-quality river velocity data were collected, the system generated 36 kWh of energy. Peak power output was 3.43 kW from a river velocity of 2.1 m/s. The system demonstrated a peak efficiency of 28%.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization

[7] https://energy-alaska.wdfiles.com/local--files/nenana-hydrokinetic-turbine/Project%20Background%20Presentation.pdf

measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

In 2022 Nenana applied for funding from the Denali Commission Village Energy Efficiency Program (VEEP). In 2023, Nenana received $900k for an Energy Assessment and Efficiency Program Development for Rural Public Buildings.[8] Nenana, Alaska and seven other rural, disadvantaged communities in Alaska teamed up with the Alaska Municipal League to conduct energy assessments and develop an energy efficiency and conservation plan for public facilities in eight rural, disadvantaged communities. By the close of the first year, each district will have an energy plan and completed energy audits for at least three buildings. At the end of the project period, each city government will have prioritized energy efficiency and conservation actions and initiated progress toward at least one in each community.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

[8] Nenana, AK | Energy Assessment and Efficiency Program Development for Rural Public Buildings

3.1 Community Survey

A community survey offered to Nenana in late 2023 to help inform the PCAP development process was not returned.

3.2 GVEA Statistics

GVEA has about 100,000 customers from Healy to Fairbanks (including Nenana), North Pole, and Delta Junction. As noted above, Nenana's power is generated by Golden Valley Electric Association, which owns and operates coal plants and the Eva Creek Wind Farm to generate electricity. Consumers of Golden Valley Electric purchase residential electricity for, on average, $0.31 cents per kilowatt hour. This rate is almost double the national average of $0.16 cents per kilowatt hour. In 2022 the company had retail sales of 1,244,414 megawatt hours and wholesale sales of 1,244,414 megawatt hours, with the majority of these being in the Fairbanks area.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[9] was created to assess GHGs emitted from 245 communities around Alaska, including Nenana (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and

[9] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Nenana. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Nenana:

- Residential Sector
    - Residual Fuel Oil No. 5 = 1,082.34 MT CO_2e
    - Wood and Residuals = 23.11 MT CO_2e
    - Natural Gas = 23.11 MT CO_2e
- Commercial Sector
    - Bituminous Coal = 2,579.53 MT CO_2e
    - Distillate Fuel Oil No. 1 = 322.07 MT CO_2e
    - Propane = 24.51 MT CO_2e
    - Wood and Wood Residuals = 0.89 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Nenana was modeled. The analysis indicated that approximately 11,150.32 MWh electricity is used in this capacity. The subcategories for electricity used and their resulting emissions modeled through this exercise were:

- Coal = 4,794.64 MWh resulting in 1,535.72 MT CO_2e
- Wind = 446.01 MWh resulting in 0.00 MT CO_2e
- Hydro = 669.02 MWh resulting in 0.00 MT CO_2e
- Diesel = 669.02 MWh resulting in 192.68 MT CO_2e
- Petroleum = 3,010.59 MWh resulting in 867.05 MT CO_2e
- Natural Gas = 1,672.55 MWh resulting in 343.21 MT CO_2e

Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Nenana may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that would reduce CO_2 emissions significantly.
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that Nenana consider applying for funding for solar PV + BESS funding to reach maximum energy cost savings through renewables, and in doing so, lower CO2 emissions reduction.
2. **Additional Weatherization.** Energy audits and plans are currently being developed. Following these assessments, the community may wish to consider options for weatherizing community buildings and residences with modern features that would

reduce heat escape, lower electric bills, and reduce heating fuel consumption and CO_2 emissions further.

3.6 Benefits Analysis

An analysis was performed for Nenana using surrogate data from an analysis performed for the community of Galena / Lauden Village. The two communities are of similar population size (Galena has approximately 460 residents, Nenana has approximately 408 residents), both have a history of military influence (Galena no longer has one), and both have some industrial or commercial presence.

The surrogate analysis performed for Galena and applied here to Nenana was done so under a scenario in which 30% of typical energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 1. TCC Community Modeling: 2,172 kWh PV Renewable Solar + 3,301 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Mill. $)	Utility Improvements (Mill. $)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
2,172 kWh PV; 3,301 kWh BESS	12.9	1.00	30%	294,260	98,087	371,299	995,080	996

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions. The rural and remote communities of the Yukon-Tanana region experience exceptionally high energy costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Fuel prices are subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC is assisting Yukon Tanana communities like Galena to improve their electrical infrastructure, including finding ways to create more affordable and reliable electricity. The high cost and price variability of fuels in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.7 Review of Authority to Implement

The Nenana Village Tribal Council (NVTC) is the governing body for Nenana Village, a federally recognized tribe. The NVTC has the authority to implement GHG reduction measures through resolutions passed in NVTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, NVTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Nenana to reduce GHGs:

Community Scale Solar PV and BESS. It is recommended that Nenana pursue a solar array with a BESS to maximize this reliable renewable energy source for the community.

Additional Weatherization. Energy audits and plans are currently being developed. Following these assessments, the community may wish to consider options for weatherizing community buildings and residences with modern features that would reduce heat escape, lower electric bills, and reduce heating fuel consumption and CO_2 emissions further.

Biomass Project(s): Following installation and operation of the biomass heating system mentioned above, Nenana should consider whether additional funding should be pursued to secure more or expanded systems that will use a local, renewable fuel source for heat.

Wind Energy Study: A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Nenana is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

Other Steps: Nenana has received a DOE Grid Resilience Grant and will use this to begin upgrading some of its existing hardware. It is recommended that at the completion of these upgrades, Nenana assess whether additional needs remain with respect to grid components, including transformers, transmission lines, and switch gear. The pursuit of funding for these additional needs may improve reliability of the grid and create opportunities for the tie-in of renewable energy systems.

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Tanana Chiefs Conference

Priority Climate Action Plan

Nikolai Village

Nikolai, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour

LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
NTC	Nikolai Tribal Council
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States
VEEP	Village Energy Efficiency Program

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Nikolai, a rural and predominantly Alaska Native community of approximately 81 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emission in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Nikolai. GHG production levels and energy costs for Nikolai were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Nikolai in 2022 (AEA 2023). Nikolai's 40 residential customers, 8 community facility customers, and 11 other customers required 532,152 kWh of diesel-generated power. A total of 55,378 gallons of fuel were consumed by Nikolai customers in 2022 at a cost of $267,558 ($4.83 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,239,360 lbs CO_2 were produced in Nikolai in FY2022.

The average fuel cost per kWh in Nikolai in 202 was $0.66. The annual non-fuel expenses associated with power generation totaled $12,000 in FY22, resulting in an additional cost of $0.03 per kWh sold. The combined fuel and non-fuel expenses in Nikolai required to produce power in Nikolai were about $0.69 per kWh sold in FY22. The last reported electric rate was $0.56 per kWh; thus, Nikolai's electric rate is at least 3.5 times the national average of $0.16 per kWh. Nikolai was PCE eligible for 40.2% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Nikolai in the amount of $79,664 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,660 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Nikolai. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Nikolai:

- Residential Sector
  - Residual Fuel Oil No. 5 = 92.39 MT CO_2e
  - Wood and Residuals = 17.82 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 79.80 MT CO_2e

- Propane = 6.09 MT CO_2e
- Wood and Wood Residuals = 0.22 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Nikolai was modeled. The analysis indicated that approximately 355.94 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (102.51 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + Battery Energy Storage System (BESS) scenario to meet this fraction. For Nikolai, the maximum fraction of existing energy production that could be replaced by renewables is 40%, represented by a 335 kw solar PV and a 504 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Nikolai are:

- Additional Solar PV + BESS array;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories identify sources of greenhouse gas (GHG) emissions in their communities and develop diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

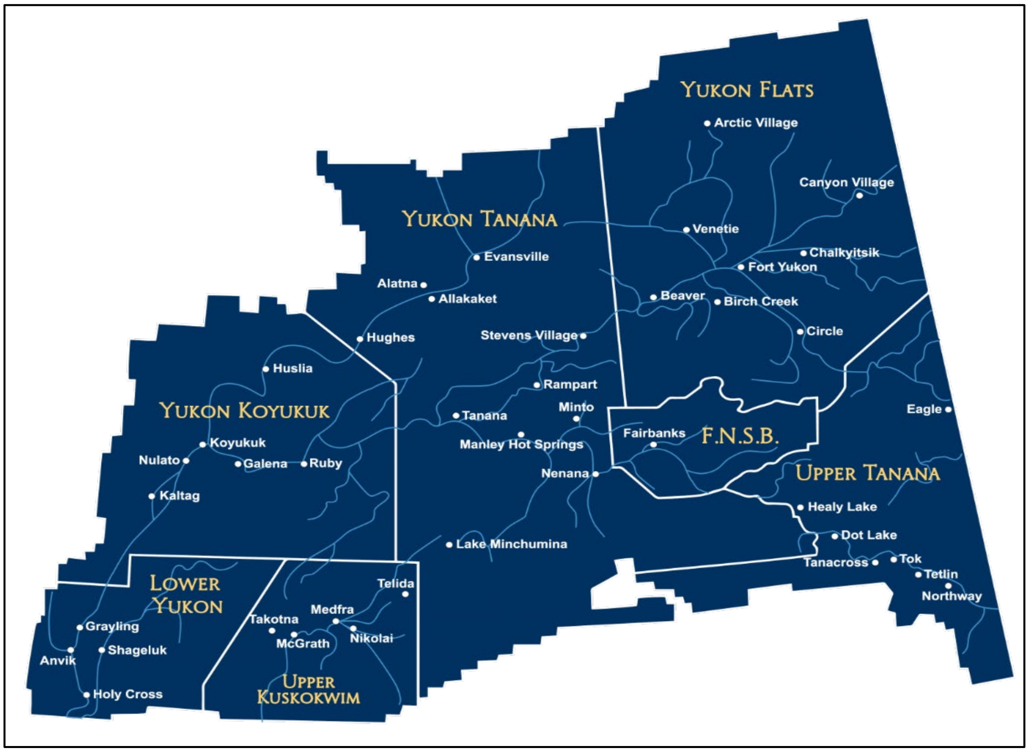
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs, and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

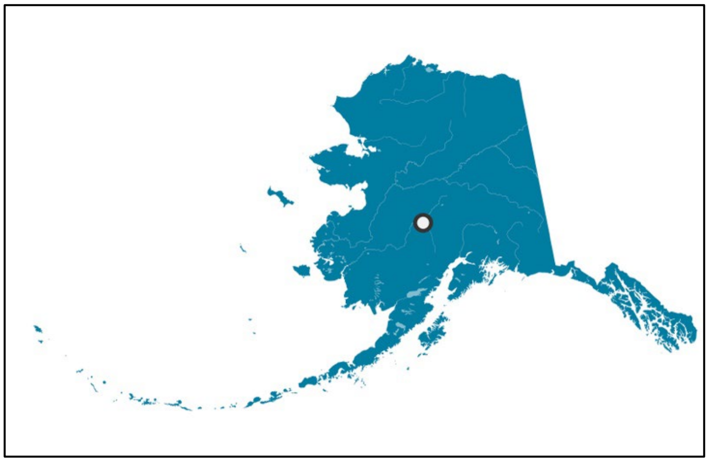
1.4 Scope of this PCAP: The Community of Nikolai

Nikolai is a traditional Athabascan village home to approximately 81 people. Nikolai is located on the south fork of the Kuskokwim River, 46 air miles east of McGrath (Figure 2). Access is primarily by plane or barge.

Nikolai is located in the continental climate zone where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 80s °F in summer. The lowest recorded temperature in Nikolai is -62°F. Several consecutive days of -40 °F is common each winter. Average annual precipitation is 16 inches, with 56 inches of snowfall. The Kuskokwim River is generally ice-free from June through October.

The U.S. EPA indicates that Nikolai's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Nikolai as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 71.7% of Nikolai's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Nikolai, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- o Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels to experience differential movement, risking the success of a project (ANTHC 2024)

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery systems allows existing generators to run optimally and avoid excess / waste power generation
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Nikolai. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or

individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of Nikolai and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Nikolai's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can

be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over

solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Nikolai is estimated to be 6.6[3] mph which is a Class 1 (light breeze) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 81 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high capital cost of designing, mobilizing, constructing, and connecting a wind project in Nikolai is not likely to recover the capital cost in a short or moderate time frame, due to having only a Class 1 wind resource. Furthermore, integrating wind would require upgrades to the grid components.

Because of the marginal wind resource in Nikolai, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Nikolai because of the number of moving parts that must continue operating at very cold temperatures. Should Nikolai decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

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[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/nikolai.html

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages, including Nikolai (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future.

Despite the study performed by TCC for Nikolai (TCC 2012), it is unlikely that funds have been secured to construct a biomass project in the community. It is not known whether Nikolai has a biomass project or plans for a future biomass project in the community.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community’s transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system

intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Nikolai, upgrades to the switchgear, controllers, and transformers are likely due for updating, and a Battery Energy Storage System (BESS) may be needed to regulate ramp rates on the diesel generators. Updating the switchgear and controllers is often a necessary step for proper incorporation of renewables.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no plans for incorporating electrification into Nikolai's waterfront or airport infrastructure at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).

- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Nikolai does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components

of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Nikolai is bordered by Kuskokwim River. This available hydrological resource has spurred interest in the potential for hydrokinetic energy systems. Nikolai does not have plans to pursue a project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Nikolai, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes

weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The last major weatherization effort in Nikolai was performed in 2010-2011 through an AEA Village Energy Efficiency Program (VEEP) grant. The VEEP grant allowed multiple city buildings and residences to receive needed weatherization upgrades, including weather stripping, insulation, programable thermostats, T8 lighting upgrades and new street lights. However, that was over ten years ago and the residents of Nikolai have expressed interest in further weatherization efforts for residences and tribal buildings.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Nikolai Community Survey

A community survey offered to Nikolai in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Nikolai (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel,

including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Nikolai in 2022 (AEA 2023). Nikolai's 40 residential customers, 8 community facility customers, and 11 other customers required 532,152 kWh of diesel-generated. A total of 55,378 gallons of fuel were consumed by Nikolai customers in 2022 at a cost of $267,558 ($4.83 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,239,360 lbs CO_2 were produced in Nikolai in FY2022.

The average fuel cost per kWh in Nikolai in 202 was $0.66. The annual non-fuel expenses associated with power generation totaled $12,000 in FY22, resulting in an additional cost of $0.03 per kWh sold. The combined fuel and non-fuel expenses in Nikolai required to produce power in Nikolai were about $0.69 per kWh sold in FY22. The last reported electric rate was $0.56 per kWh; thus, Nikolai's electric rate is at least 3.5 times the national average of $0.16 per kWh. Nikolai was PCE eligible for 40.2% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Nikolai in the amount of $79,664 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,660 (AEA 2023).

Table 1. Nikolai Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
81	40	8	11

Source: AEA 2023

Table 2. Nikolai Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
532,152	0	76.0%	9.61	428,774	55,378	1,239,359

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[5] was created to assess GHGs emitted from 245 communities around Alaska, including Nikolai (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion

leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Nikolai. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Nikolai:

- Residential Sector
  - Residual Fuel Oil No. 5 = 93.39 MT CO_2e
  - Wood and Residuals = 17.82 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 79.80 MT CO_2e
  - Propane = 6.09 MT CO_2e
  - Wood and Wood Residuals = 0.22 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Nikolai was modeled. The analysis indicated that approximately 355.94 MWh electricity is used in this capacity and that the resulting emissions all come from diesel in the amount of 102.51 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Nikolai intends to reduce GHG emissions by pursuing funding opportunities that will pay for:

- A community solar + BESS project that would reduce diesel fuel consumption and CO_2 emissions;

- Consideration of a biomass system for renewable heating;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- An assessment of whether wind energy would be practical or lucrative;
- Funds for weatherization to retain more heat in buildings, thus producing fewer GHGs.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for additional funding to reach maximum GHG reductions. Electric generation created through solar will reduce diesel fuel consumption and generator run time.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings. Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. Weatherization will reduce heating oil usage and wood burning.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 40% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 355 kWh Renewable Solar + 504 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
355 kWh PV; 504 kWh BESS	1.91	0.50	40%	35,996	19,383	73,370	196,361	197

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

The rural and remote communities of the Upper Kuskokwim region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Nikolai's chief concerns around Upper Kuskokwim region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.7 Review of Authority to Implement

The Nikolai Tribal Council (NTC) is the governing body for Nikolai Village, a federally recognized tribe. The NTC has the authority to implement GHG reduction measures through resolutions passed in NTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, NTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Nikolai to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for additional funding to reach maximum CO_2 emissions reductions.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings. Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community.

3. **Wind Energy Study**: A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Nikolai is considered

marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

4. **Other Steps**: The community should examine the condition of the current power grid and pursue funding for grid resiliency if upgrades are required.

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Appendix A

Alaska Energy Authority’s Power Cost Equalization Program
Statistical Report for Nikolai (FY2022)

Nikolai PCE

Utility: CITY OF NIKOLAI
Reporting Period: 07/01/21 to 06/30/22

Community Population	81
Last Reported Month	June
No. of Monthly Payments Made	11
Residential Customers	40
Community Facility Customers	8
Other Customers (Non-PCE)	11
Fiscal Year PCE Payments	**$79,664**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	117,946	Average Annual PCE Payment per Eligible Customer	$1,660
PCE Eligible kWh - Community Facility Customers	44,596	Average PCE Payment per Eligible kWh	$0.49
Total PCE Eligible kWh	162,542	Last Reported Residential Rate Charged (based on 500 kWh)	$0.90
Average Monthly PCE Eligible kWh per Residential Customer	268	Last Reported PCE Level (per kWh)	$0.51
Average Monthly PCE Eligible kWh per Community Facility Customer	507	Effective Residential Rate (per kWh)	$0.39
Average Monthly PCE Eligible Community Facility kWh per Person	50	PCE Eligible kWh vs Total kWh Sold	40.2%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	532,152	Fuel Used (Gallons)	55,378
Non-Diesel kWh Generated	0	Fuel Cost	$267,558
Purchased kWh	0	Average Price of Fuel	$4.83
Total Purchased & Generated	532,152	Fuel Cost per kWh sold	$0.66
		Annual Non-Fuel Expenses	$12,000
		Non-Fuel Expense per kWh Sold	$0.03
		Total Expense per kWh Sold	$0.69

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	168,127	Consumed vs Generated (kWh Sold vs Generated-Purchased)	76.0%
Community Facility kWh Sold	47,590	Line Loss (%)	19.4%
Other kWh Sold (Non-PCE)	188,536	Fuel Efficiency (kWh per Gallon of Diesel)	9.61
Total kWh Sold	404,253	PH Consumption as % of Generation	4.6%
Powerhouse (PH) Consumption kWh	24,521		
Total kWh Sold & PH Consumption	428,774		

Comments

Only 11 months filed; Reported non-fuel expense = 4 months

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Priority Climate Action Plan

Northway Village

Northway, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode

Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
NTC	Northway Tribal Council
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Northway, a rural and predominantly Alaska Native community of approximately 251 residents in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emissions in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Northway. GHG production levels and energy costs for Northway were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Northway in 2022 (AEA 2023). Northway's 92 residential customers, 6 community facility customers, and 38 other customers required 1,091,200 kWh of diesel-generated power. A total of 86,661 gallons of diesel fuel were consumed at a cost of $261,133 ($3.01 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,939,473 lbs CO_2 were produced in Northway in FY2022.

The average fuel cost per kWh in Northway in 2022 was $0.26. The annual non-fuel expenses associated with power generation totaled $193,512 in FY22, resulting in an additional cost of $0.19 per kWh sold. The combined fuel and non-fuel expenses in Northway required to produce power in Northway were $0.46 per kWh sold in FY22. The last reported electric rate was $0.83 per kWh; thus, Northway's electric rate is over five times the national average of $0.16 per kWh. Northway was PCE eligible for 36.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Northway in the amount of $142,633 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,455 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Northway. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Northway:

- Residential Sector
  - Residual Fuel Oil No. 5 = 303.58 MT CO_2e
  - Wood and Residuals = 13.90 MT CO_2e
- Commercial Sector

- Distillate Fuel Oil No. 1 = 282.10 MT CO_2e
- Propane = 21.54 MT CO_2e
- Wood and Wood Residuals = 0.78 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Northway was modeled. The analysis indicated that approximately 1,044.69 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (300.87 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic (PV) + Battery Energy Storage System (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Northway are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories identify sources of greenhouse gas (GHG) emissions in their communities and develop diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

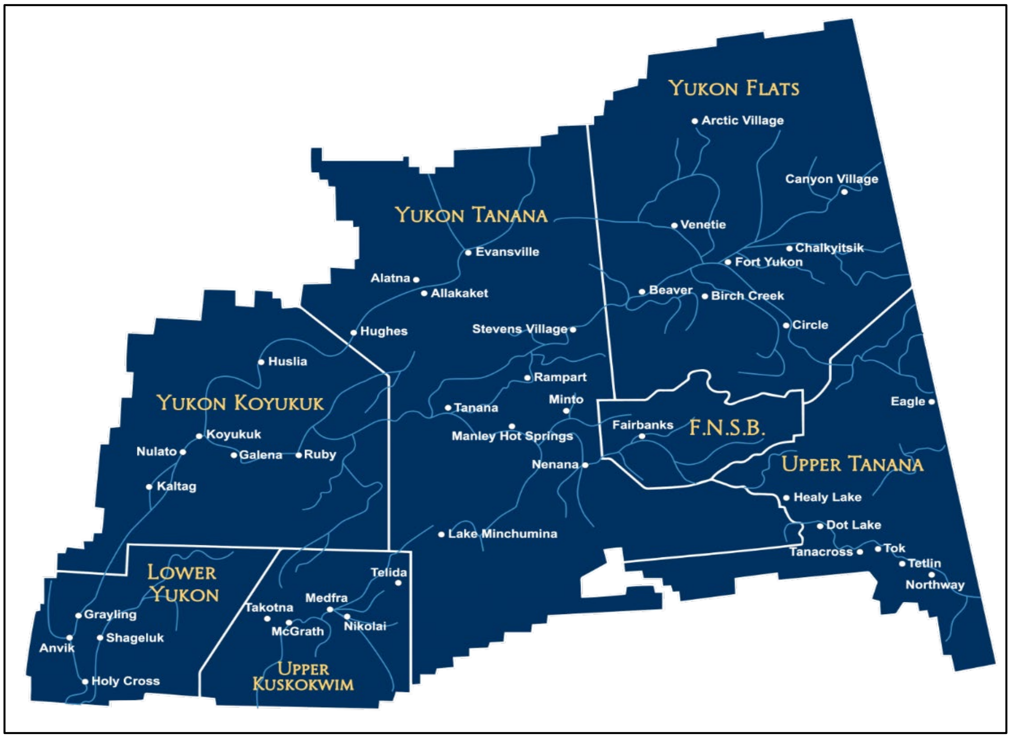
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure division and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalizatoin (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs, and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

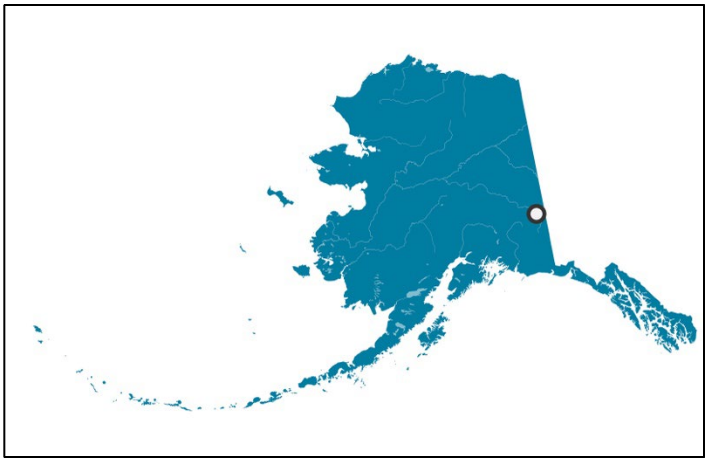
1.4 Scope of this PCAP: The Community of Northway

Northway is a predominantly Koyukon Athabascan village home to approximately 251 residents. Northway is located on the east bank of the Nebesna Slough, 50 miles southeast of Tok(Figure 2). It lies off the Alaska Highway on a 9-mile spur road, on the east bank of the Nabesna River, and access is primarily by road.

Northway is located in the continental climate zone, where winters are cold , and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. The lowest recorded temperature in Northway is -72°F, and the highest recorded temperature is 91°F. Several consecutive days of -40 °F is common each winter. Average annual precipitation is 10 inches, with 30 inches of snowfall. Northway way has year-round road access.

The U.S. EPA indicates that Northway's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Northway as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 72.9% of Northway's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Northway, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar

[2] https://www.huduser.gov/portal/icdbg2022/home.html

panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery systems allows existing generators to run optimally and avoid excess / waste power generation
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Northway. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies northwest of Northway and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Northway's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

The Village of Northway implemented an energy efficiency project in 2019 which installed 6 kW solar arrays in three community buildings in Northway. This was done in collaboration with the Department of Energy (DOE) – Office of Indian Energy Policy Programs, the Northway Tribal Council (NTC), TCC and ANTHC. The small project is operating and successfully reducing community electric bills and lowering GHG emissions.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Northway is estimated to be 5.3 mph[3] which is a Class 2 (light breeze) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 251 people, turbines turned by even a Class 2 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high capital cost of designing, mobilizing, constructing, and connecting a wind project in Northway is not likely to recover the capital cost in a short or moderate time frame, due to having only a Class 2 wind resource. Furthermore, integrating wind would require upgrades to the grid components.

Because of the marginal wind resource in Northway, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Northway because of the number of moving parts that must continue operating at very cold temperatures. Should Northway decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed

[3] https://wind.willyweather.com/ak/southeast-fairbanks-borough/northway.html

by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions. TCC has produced a report exploring woody biomass sources for some Interior Alaska villages (TCC 2012).

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future.

Northway is surrounded by forest, which provides an excellent biomass resource. Clearly, the resource is able to support biomass projects. Additional wood harvest could also help to improve forest health and reduce forest fire hazard.

In nearby Tok, Tok Wood Fuels, LLC is turning wood residue from a local mill into high-density logs for use in wood stoves and boilers. These wood stoves and boilers can have four times the heat output of regular wood and burn cleaner, producing less smoke and other pollutants (USDA 2023). Another benefit is hazardous fuels reduction. Tok Wood Fuels partners with the Native Village of Tetlin, also nearby Northway, to conduct targeted wood harvesting, which helps reduce the risk of wildfire (USDA 2023).

Northway Village has studied and designed a biomass chip boiler heating system. The project is under construction (USDA 2023) and is intended to serve the Northway School, the garage, and the teacher housing duplex. The project is estimated to offset approximately 90% of fuel usage for these buildings and save up to $56,000 annually.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Nikolai, upgrades to the switchgear, controllers, and transformers are likely due for updating, and a BESS may be needed to regulate ramp rates on the diesel generators. Updating the switchgear and controllers is often a necessary step for proper incorporation of renewables.

Northway will receive Bipartisan Infrastructure Law 40101(d) Grid Resilience Grant funding through TCC. This funding will improve electric grid resiliency, preventing or reducing the number of electrical outages. This funding is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing. There are currently no known plans for Northway to incorporate electrification to its airport or at waterfront areas.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of

multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Northway does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Northway is situated nearby the Tanana River. This available hydrological resource has spurred interest in the potential for hydrokinetic energy systems. However, there are no known plans for a hydrokinetic project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. In Northway, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The last major weatherization effort in Northway was performed by TCC in 2016, under which the community hall, washateria, and water sewer garage all received weatherization upgrades, including new doors and windows, chinking, LED lights, programmable thermostats, high-efficiency pumps, and individual solar arrays. However, weatherization efforts were limited to select community facilities and several homes, and the work was done over eight years ago. The residents of Northway have expressed interest in further weatherization efforts for residences and tribal buildings.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

Northway Village completed a community survey that was issued to the Tribe by TCC in late 2023. This survey provided the Tribe with an opportunity to comment on their energy priorities and challenges, weatherization and electrical needs, and interest in renewable energy systems.

The survey completed by the community of Northway indicated they do not currently have an energy/economic development plan. Their three top energy priorities are to reduce the cost of home heating, reduce the cost of electricity, and reduce the energy costs of public buildings and facilities.

Northway indicated that the community is interested in the following types of projects for the future:

- Community-scale solar PV systems
- The possibility of thermal energy
- Home insulation

Northway's population and geographic size should allow for the community to provide a high percentage of renewable energy combined with solar, wind, etc. In 2016, TCC weatherized three of the community buildings and many of the homes in Northway. They are interested in upgrading the insulation on the homes in Northway.

Northway is interested in having an energy audit. They would also be interested in weatherization retrofits for their community buildings. Twenty percent of their community buildings do not have basic utilities, including power, water, and sewer.

Northway is not interested in applying for EPA CPRGs. Their most urgent need is for energy efficiency upgrades, along with additional solar power + BESS to power the community and relieve the reliance on higher cost power.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Northway (AEA 2023). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Northway in 2022 (AEA 2023). Northway's 92 residential customers, 6 community facility customers, and 38 other customers required 1,091,200 kWh of diesel-generated power. A total of 86,661 gallons of diesel fuel were consumed at a cost of $261,133 ($3.01 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 1,939,473 lbs CO_2 were produced in Northway in FY2022.

The average fuel cost per kWh in Northway in 2022 was $0.26. The annual non-fuel expenses associated with power generation totaled $193,512 in FY22, resulting in an additional cost of $0.19 per kWh sold. The combined fuel and non-fuel expenses in Northway required to produce power in Northway were $0.46 per kWh sold in FY22. The last reported electric rate was $0.83 per kWh; thus, Northway's electric rate is over five times the national average of $0.16 per kWh. Northway was PCE eligible for 36.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Northway in the amount of $142,633 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,455 (AEA 2023).

Table 1. Northway Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
251	92	6	38

Source: AEA 2023

Table 2. Northway Fuel Consumption and CO2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
1,091,200	0	90.9%	12.59	1,005,099	86,661	1,939,473

Source: AEA 2023

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Northway (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion

leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Northway. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Northway:

- Residential Sector
  - Residual Fuel Oil No. 5 = 303.58 MT CO_2e
  - Wood and Residuals = 13.90 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 282.10 MT CO_2e
  - Propane = 21.54 MT CO_2e
  - Wood and Wood Residuals = 0.78 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Northway was modeled. The analysis indicated that approximately 1,044.69 MWh electricity is used in this capacity and that the resulting emissions all come from diesel in the amount of 300.87 MT CO_2e. Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Northway may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;

- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative;

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommend that the community consider applying for funding for additional solar PV + BESS to maximize renewable energy systems for reducing CO_2 emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for additional weatherization of more community buildings and other residences to improve energy efficiency and reduce GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 30% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 644 kW Renewable Solar PV + 688k kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
644 kW PV; 688 kWh BESS	3.32	1.00	30%	64,996	21,665	82,012	219,792	220

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

The rural and remote communities of the Upper Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Northway's chief concerns around Upper Tanana region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity or further developing the local economy.

3.7 Review of Authority of Intent to Implement

The NTC is the governing body for Northway Village, a federally recognized tribe. The NTC has the authority to implement GHG reduction measures through resolutions passed in NTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, NTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Northway to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommend that the community consider applying for funding for additional solar PV + BESS to maximize renewable energy systems for reducing CO_2 emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for additional weatherization of more community buildings and other residences to improve energy efficiency and reduce GHG emissions.
3. **Wind Energy Study**: A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Northway is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The

economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

4. **Other Steps:** The community should examine the condition of the current power grid as it may not have received many major upgrades since initial construction. It is recommended that the community apply for grid resilience funding to meet current and future needs.

5 References

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program
Statistical Report for Northway (FY2022)

Northway; Northway Village PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	251
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	92
Community Facility Customers	6
Other Customers (Non-PCE)	38
Fiscal Year PCE Payments	**$142,633**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	288,675	Average Annual PCE Payment per Eligible Customer	$1,455
PCE Eligible kWh - Community Facility Customers	77,935	Average PCE Payment per Eligible kWh	$0.39
Total PCE Eligible kWh	366,610	Last Reported Residential Rate Charged (based on 500 kWh)	$0.83
Average Monthly PCE Eligible kWh per Residential Customer	261	Last Reported PCE Level (per kWh)	$0.51
Average Monthly PCE Eligible kWh per Community Facility Customer	1,082	Effective Residential Rate (per kWh)	$0.32
Average Monthly PCE Eligible Community Facility kWh per Person	26	PCE Eligible kWh vs Total kWh Sold	36.9%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	1,091,200	Fuel Used (Gallons)	86,661
Non-Diesel kWh Generated	0	Fuel Cost	$261,133
Purchased kWh	0	Average Price of Fuel	$3.01
Total Purchased & Generated	1,091,200	Fuel Cost per kWh sold	$0.26
		Annual Non-Fuel Expenses	$193,512
		Non-Fuel Expense per kWh Sold	$0.19
		Total Expense per kWh Sold	$0.46

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	344,466	Consumed vs Generated (kWh Sold vs Generated-Purchased)	90.9%
Community Facility kWh Sold	77,935	Line Loss (%)	7.9%
Other kWh Sold (Non-PCE)	570,026	Fuel Efficiency (kWh per Gallon of Diesel)	12.59
Total kWh Sold	992,427	PH Consumption as % of Generation	1.2%
Powerhouse (PH) Consumption kWh	12,672		
Total kWh Sold & PH Consumption	1,005,099		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Nulato Village

Nulato, AK

Table of Contents

List of Figures

Lis of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
AVEC	Alaska Village Electric Cooperative
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
NTC	Nulato Tribal Council
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States
VPSO	Village Public Safety Officer
WTP	Water Treatment Plant

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Nulato, a rural and predominantly Alaska Native community of approximately 233 residents in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emission in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Nulato. GHG production levels and energy costs for Nulato were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), Alaska Village Electric Cooperative (AVEC) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Nulato in 2022 (AEA 2023). Nulato's 105 residential customers, 15 community facility customers, and 21 other customers required 1,0074,094 kWh of diesel-generated. A total of 90,274 gallons of fuel were consumed by Nulato customers in 2022 at a cost of $271,898 ($3.01 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 2,020,332 lbs CO_2 were produced in Nulato in FY2022.

The average fuel cost per kWh in Nulato in 2022 was $0.27. The annual non-fuel expenses associated with power generation totaled $197,470 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Nulato required to produce power in Nulato were $0.47 per kWh sold in FY22. The cost of power production in Nulato is approximately 3 times or more than the national average of $0.16 per kWh. Nulato was PCE eligible for 57.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Nulato in the amount of $165,644 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,380 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Nulato. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Nulato:

- Residential Sector
    - Residual Fuel Oil No. 5 = 673.16 MT CO_2e
    - Wood and Residuals = 12.47 MT CO_2e
- Commercial Sector

- Distillate Fuel Oil No. 1 = 212.50 MT CO_2e
- Propane = 16.22 MT CO_2e
- Wood and Wood Residuals = 0.59 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Nulato was modeled. The analysis indicated that approximately 986.02 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (283.98 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + Battery Energy Storage System (BESS) scenario to meet this fraction. For Nulato, the maximum fraction of existing energy production that could be replaced by renewables is 30%, represented by a 481 kW solar PV and a 689 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic (PV) + Battery Energy Storage System (BESS) array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Nulato are:

- Additional Solar PV + BESS array;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Wind Energy Study; and
- Biomass energy systems (e.g., wood chip boilers).

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and develop ingv diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

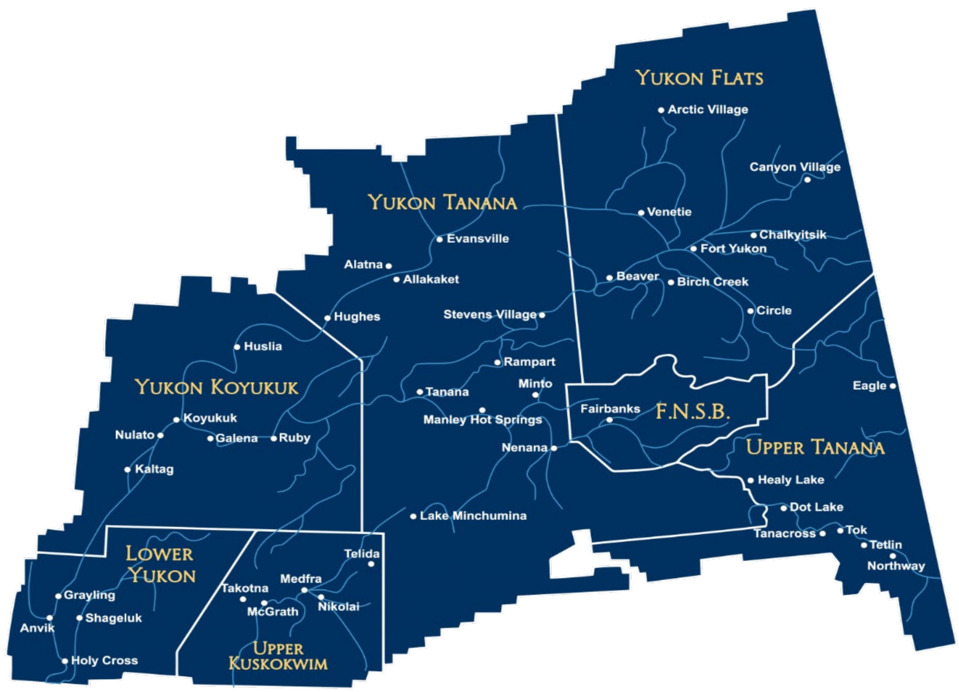
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. TCC

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

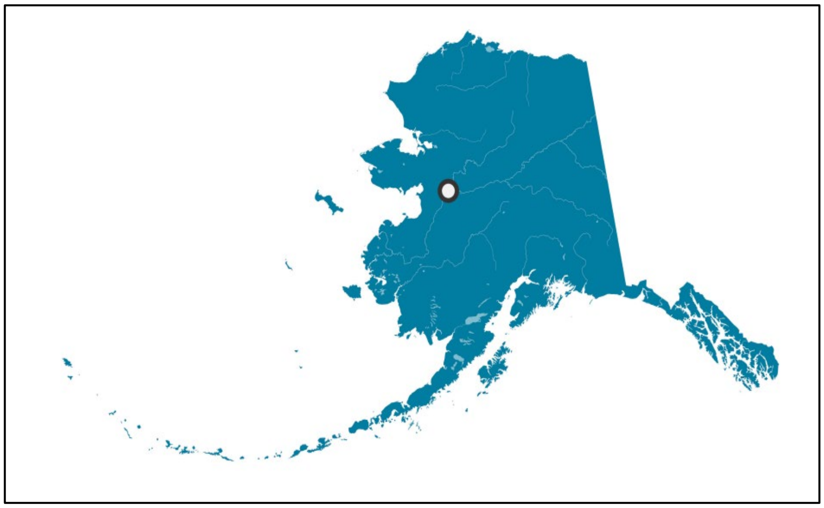
1.4 Scope of this PCAP: The Community of Nulato

Nulato is a traditional Koyukon Athabascan village home to approximately 233 people in 89 households. Nulato is located on the west bank of the Yukon River, 35 miles west of Galena and 310 air miles west of Fairbanks (Figure 2). It lies in the Nulato Hills, across the river from the Innoko National Wildlife Refuge, and access is primarily by plane or barge. Nulato's power is generated locally at a diesel power plant operated by AVEC.

Nulato is located in the continental climate zone, where winters are cold, and summer are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. The lowest recorded temperature in Nulato is -55°F, and the highest recorded temperature is 90°F. Several consecutive days of -40°F is common each winter. Average annual precipitation is 16 inches, with 74 inches of snowfall.

The U.S. EPA indicates that Nulato's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Nulato as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 77.5% of Nulato's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Nulato, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar battery arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Nulato. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or

individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of Nulato and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Nulato's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can

be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

Nulato was recently awarded a Department of Energy (DOE) Office of Clean Energy Demonstrations (OCED) for to reduce emissions and establish a solar / battery array in the community. Nulato will work with its partner, TCC, to have this system constructed, which will reduce diesel fuel consumption, generator operating costs and run time, and GHG emissions in the community.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Nulato is estimated to be 6.1 mph[3] which is a Class 1 (light breeze) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 233 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high capital cost of designing, mobilizing, constructing, and connecting a wind project in Nulato is not likely to recover the capital cost in a short or moderate time frame, due to having only a Class 1 wind resource. Furthermore, integrating wind would require upgrades to the grid components.

Because of the marginal wind resource in Nulato, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Nulato because of the number of moving parts that must continue operating at very cold temperatures. Should Nulato decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project. Nulato has expressed interest in a wind project to compliment a forthcoming solar PV + BESS project and provide additional power in winter; however, a full feasibility study should first be completed.

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/nulato.html

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. It is unknow whether Nulato has contemplated or pursued funding for a biomass project that could efficiently heat community buildings.

Nulato Village has received full funding to design and construct a biomass chip boiler district heating system that will serve the Andrew K. Demoski school and the lower water treatment plant (WTP), which are abutting each other. The project is projected to be constructed in 2025 and will save the community approximately 22,000 gallons of fuel oil annually that would typically be required to heat the school and the WTP. This results in approximately $150,000 in savings for the community and creates two new jobs.

Nulato has also expressed interest in constructing a biomass district heating loop in the upper town site. Several buildings have been considered for this project including the upper WTP, the city shop, city office, liquor store, tribal office, Village Public Safety Officer (VPSO) building, multipurpose building, clinic, courthouse, and elder housing. Due to permafrost in the area, the building would most likely need to be built on a pile foundation to avoid degradation of underlying permafrost. Heat distribution piping would likely be aboveground, arctic pipe, with the exceptions of road crossings which would be below grade (ANTHC 2024).

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

Nulato will receive Bipartisan Infrastructure Law 40101(d) Grid Resilience Grant funding through TCC. This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating

renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Nulato has applied for grants to upgrade its port infrastructure, including solar-powered lighting for safety and navigational aid at the waterfront. It is possible that platforms, a wharf, warehouses, and residential / commercial docking infrastructure will one day be established in Nulato; solar PV + BESS could be a big part of powering future lighting, navigational safety beacons, and buildings at the waterfront.

Nulato's airport is several miles from town, so it is unlikely that solar PVs would be established alongside the cleared ROW adjacent to it. Some electrification could be added in the future for isolated airport needs, but this is unlikely. It is more likely that solar PVs would be placed in town.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.

- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Nulato does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Nulato is bordered by three flowing waterbodies: the Nulato River, the Yukon River, and Mukluk Slough. These available hydrological resources have spurred interest in the potential for hydrokinetic energy systems. Mukluk Slough could potentially serve in this regard as it has a shallow grade. It would require locating a water diversion structure several miles upstream, then routing a penstock that entire distance. The resulting costs of such a project may be prohibitively high (ANTHC 2024). If capital costs are grant funded, however, it could lower long-term operating costs if maintenance does not become and issue. Currently, there are no plans for a hydrokinetic project in Nulato.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Nulato, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project. There are no known heat recovery project planned for Nulato at this time.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The last major weatherization effort in Nulato was performed by TCC in 2010-2011, under which 80 households received weatherization upgrades. However, that was over ten years ago and the residents of Nulato have expressed interest in further weatherization efforts for residences and tribal buildings. The community has indicated that the Nulato Power Plant and surrounding buildings' most pressing upgrade needs include adding battery insulation between floor joists, LED upgrades, and boiler and furnace tuning. Residences may also benefit from the installation of setback thermostats, general air tightening, and the upgrading of chest freezers and refrigerators to Energy Star appliances. Tribal members could save 10-30% on their electrical and heating bills by implementing these weatherization upgrades.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Nulato in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA's PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Nulato (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Nulato in 2022 (AEA 2023). Nulato's 105 residential customers, 15 community facility customers, and 21 other customers required 1,0074,094 kWh of diesel-generated. A total of 90,274 gallons of fuel were consumed by Nulato customers in 2022 at a cost of $271,898 ($3.01 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 2,020,332 lbs CO_2 were produced in Nulato in FY2022.

The average fuel cost per kWh in Nulato in 2022 was $0.27. The annual non-fuel expenses associated with power generation totaled $197,470 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Nulato required to produce power in Nulato were $0.47 per kWh sold in FY22. The cost of power production in Nulato is approximately 3 times or more than the national average of $0.16 per kWh. Nulato was PCE eligible for 57.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Nulato in the amount of $165,644 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,380 (AEA 2023).

Table 1. Nulato Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
233	105	15	21

Source: AEA 2023

Table 2. Nulato Fuel Consumption and CO2 Emissions

Diesel **kWh Generated**	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced [4] (lbs)
1,074,094	0	92.5%	11.9	1,012,382	90,274	4,033.69

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the

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[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 AVEC Power Generation Data

AVEC is the electric utility for eight of the communities in TCC's region, including Nulato. AVEC provides the following data for Nulato:

- Diesel Generators:
  - Station 1: Cummins K19G2 1800, 397 kW
  - Station 2: Detroit Diesel S60D3 1200, 229 kW
  - Station 3: Detroit Diesel S60K4C 1800, 363 kW
- Average Load: 118 kW
- Estimated peak load: 293 kW
- Average annual power generated: 1,023,392 kWh
- Average fuel consumed: 76,352 gallons/year
- Average fuel efficiency: 13.5 kWh/gallon

3.4 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[5] was created to assess GHGs emitted from 245 communities around Alaska, including Nulato (Constellation Energy 2024). The inventory tool is based off modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and

[5] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed “market-based” accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings’ heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations’ buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Nulato. The contribution of GHGs by fuel type to each sector’s overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Nulato:

- Residential Sector
    - Residual Fuel Oil No. 5 = 673.16 MT CO_2e
    - Wood and Residuals = 12.47 MT CO_2e
- Commercial Sector

- Distillate Fuel Oil No. 1 = 212.50 MT CO_2e
- Propane = 16.22 MT CO_2e
- Wood and Wood Residuals = 0.59 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Nulato was modeled. The analysis indicated that approximately 986.02 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (283.98 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.5 GHG Reduction Targets

Nulato intends to reduce GHG emissions by pursuing funding opportunities that will pay for:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- Activities pertaining to acquiring woody biomass for the new woodchip boiler that will heat the school and lower WTP and thereby reduce emissions;
- A second woodchip boiler;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- An assessment of whether wind would be practical or lucrative;
- Waterfront safety and navigational lighting powered by solar + BSSE.

3.6 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** While a solar PV + BESS project is going to be constructed under a DOE OCED grant in Nulato in the near future, it is recommended that the community consider assessing what additional GHG reduction could occur by adding more solar capacity. The community should consider applying for additional funding to expand solar PV + BESS to reach maximum GHG reduction. Electric generation created through solar will reduce diesel fuel consumption/generator run time.

2. **Additional Weatherization.** The community has successfully weatherized several community buildings, but it is recommended that Nulato pursue weatherization of additional buildings and residences with modern features thatf would reduce heat escape and lower heating bills and GHGs further. Weatherization will reduce heating oil usage and wood burning.

3.7 Benefits Analysis

An analysis was performed under a scenario in which 30% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 481 kWh Renewable Solar + 689 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
481 kWh PV; 689 kWh BESS	2.77	0.75	30%	67,706	22,569	85,431	228,995	229

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

The rural and remote communities of the Yukon Koyukuk region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Nulato's chief concerns around Yukon Koyukuk region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.8 Review of Authority to Implement

The Nulato Tribal Council (NTC) is the governing body for Nulato Village, a federally recognized tribe. The NTC has the authority to implement GHG reduction measures through resolutions passed in NTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, NTC meetings, and letters of support. A schedule of milestones will be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Nulato to reduce GHGs:

1. **Community Scale Solar PV and BESS.** While a solar PV + BESS project is going to be constructed under a DOE OCED grant in Nulato in the near future, it is recommended that the community consider assessing what additional GHG reduction could occur by adding more solar capacity. The community should consider applying for additional funding to expand solar PV + BESS to reach maximum CO_2 emissions reduction.

2. **Additional Weatherization.** The community has successfully weatherized several community buildings, but weatherization of additional buildings and residences with modern features would reduce heat escape and lower heating bills and CO_2 emissions further.

3. **Biomass Expansion:** Following the installation and successful operation of Nulato's first funded biomass boiler system at the lower townsite, Nulato should consider applying for a second biomass heating system for buildings and facilities at the upper townsite.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Nulato is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** Following planned work to upgrade electrical grid components in Nulato over the next two years, the community should assess whether additional upgrade needs remain. If additional needs remain, the community should work with its partners to apply for additional funding.

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Appendix A

Alaska Energy Authority’s Power Cost Equalization Program
Statistical Report for Nulato (FY2022)

Nulato PCE

Utility: ALASKA VILLAGE ELECTRIC COOP
Reporting Period: 07/01/21 to 06/30/22

Community Population	233
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	105
Community Facility Customers	15
Other Customers (Non-PCE)	21
Fiscal Year PCE Payments	**$165,644**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	382,640	Average Annual PCE Payment per Eligible Customer	$1,380
PCE Eligible kWh - Community Facility Customers	191,852	Average PCE Payment per Eligible kWh	$0.29
Total PCE Eligible kWh	574,492	Last Reported Residential Rate Charged (based on 500 kWh)	$0.58
Average Monthly PCE Eligible kWh per Residential Customer	304	Last Reported PCE Level (per kWh)	$0.33
Average Monthly PCE Eligible kWh per Community Facility Customer	1,066	Effective Residential Rate (per kWh)	$0.25
Average Monthly PCE Eligible Community Facility kWh per Person	69	PCE Eligible kWh vs Total kWh Sold	57.9%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	1,074,094	Fuel Used (Gallons)	90,274
Non-Diesel kWh Generated	0	Fuel Cost	$271,898
Purchased kWh	0	Average Price of Fuel	$3.01
Total Purchased & Generated	1,074,094	Fuel Cost per kWh sold	$0.27
		Annual Non-Fuel Expenses	$197,470
		Non-Fuel Expense per kWh Sold	$0.20
		Total Expense per kWh Sold	$0.47

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	462,099	Consumed vs Generated (kWh Sold vs Generated-Purchased)	92.5%
Community Facility kWh Sold	319,736	Line Loss (%)	5.7%
Other kWh Sold (Non-PCE)	211,232	Fuel Efficiency (kWh per Gallon of Diesel)	11.90
Total kWh Sold	993,067	PH Consumption as % of Generation	1.8%
Powerhouse (PH) Consumption kWh	19,315		
Total kWh Sold & PH Consumption	1,012,382		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Rampart Village

Rampart, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour

LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
RVC	Rampart Village Council
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Rampart, a rural and predominantly Alaska Native community of approximately 92 residents in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emission in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Rampart. GHG production levels and energy costs for Rampart were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in rampart in 2022 (AEA 2023). Rampart's 31 residential customers, 5 community facility customers, and 10 other customers required 263,770 kWh of diesel generated. A total of 25,134 gallons of fuel were consumed by Rampart customers in 2022 at a cost of $84,013 ($3.34 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 562,499 lbs CO_2 were produced in Rampart in FY2022.

The average fuel cost per kWh in Rampart in 2022 was $0.39. The annual non-fuel expenses associated with power generation totaled $48,010 in FY22, resulting in an additional cost of $0.22 per kWh sold. The combined fuel and non-fuel expenses in Rampart required to produce power in Rampart were $0.61 per kWh sold in FY22. The last reported Electric rate was $0.81 per kWh; thus, Rampart's electric rate is about five times the national average of $0.16 per kWh. Rampart was PCE eligible for 63.3% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Rampart in the amount of $66,298 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,842 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Rampart. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Rampart:

- Residential Sector
    - Residual Fuel Oil No. 5 = 26.40 MT CO_2e
    - Wood and Residuals = 5.35 MT CO_2e
- Commercial Sector
    - Distillate Fuel Oil No. 1 = 62.17 MT CO_2e

- o Propane = 4.75 MT CO_2e
- o Wood and Wood Residuals = 0.17 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Rampart was modeled. The analysis indicated that approximately 222.18 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (63.99 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + Battery Energy Storage System (BESS) scenario to meet this fraction. For Rampart, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 230 kW solar PV and a 354 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Rampart that would reduce GHG emissions are:

- Additional Solar PV + BESS array;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

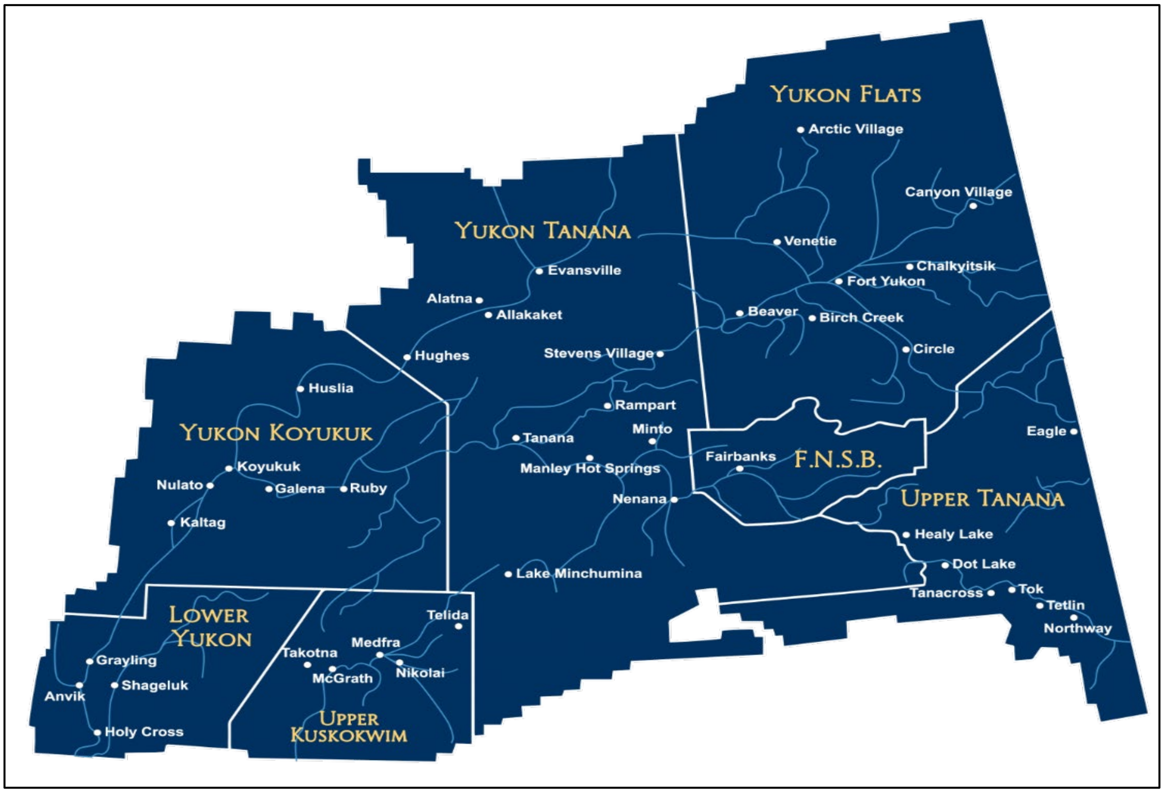
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison

- Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs, and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

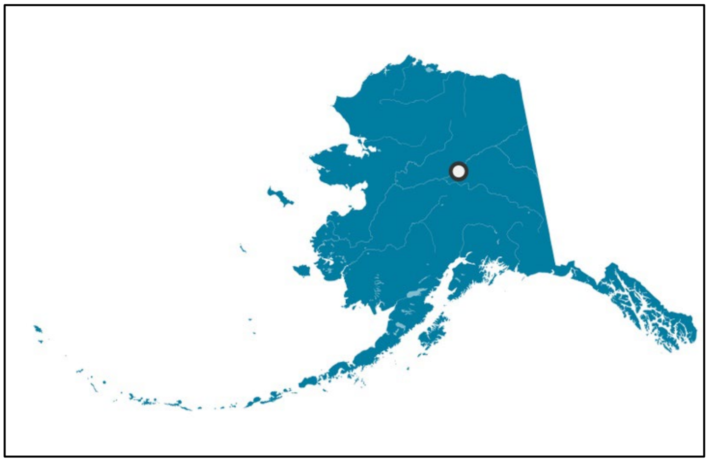
1.4 Scope of this PCAP: The Community of Rampart

Rampart a traditional Koyukon Athabascan village home to approximately 92 residents. Rampart is located on the south bank of the Yukon River, 75 miles upstream from its junction with the Tanana River and 100 air miles west of Fairbanks (Figure 2). Access is primarily by plane or barge. Rampart's power is generated locally at a diesel power plant operated by Rampart Electric Company.

Rampart is located in the continental climate zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. The lowest recorded temperature in Rampart is -60°F, and the highest recorded temperature is 97°F. Several consecutive days of -40 °F is common each winter. Average annual precipitation is 7 inches, with 43 inches of snowfall.

Rampart's Tribal population is below poverty level and is classified as a Historically Disadvantaged Community existing in an Area of Persistent Poverty. Most of Rampart's Tribal residents likely meet the criteria for low or middle income, but there is currently no data available from the U.S. Department of Housing and Urban Development (HUD) for the community[2].

Figure 2. Location of Rampart, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Rampart. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a

broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of Rampart and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Rampart's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many

remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more

difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Rampart is estimated to be 6.0 mph[3] which is a Class 1 (light breeze) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 92 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high capital cost of designing, mobilizing, constructing, and connecting a wind project in Rampart is not likely to recover the capital cost in a short or moderate time frame, due to having only a Class 1 wind resource. Furthermore, integrating wind would require upgrades to the grid components.

Because of the marginal wind resource in Rampart, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Rampart because of the number of moving parts that must continue operating at very cold temperatures. Should Rampart decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/rampart.html

by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future. It is unknow whether Rampart has contemplated or pursued funding for a biomass project that could efficiently heat community buildings.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community’s transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system

intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

Rampart will receive Bipartisan Infrastructure Law 40101(d) Grid Resilience Grant funding through TCC. Rampart will receive funding for electric grid resiliency, such as preventing or reducing the number of electrical outages. This grant is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no plans for incorporating electrification into Rampart's waterfront or airport infrastructure at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).

- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Rampart does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components

of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Rampart is situated on the Yukon River. While this available hydrological resource has spurred interest in the potential for hydrokinetic energy systems, there are no plans to pursue a project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Rampart, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes

weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

It is not known whether Rampart has undergone significant weatherization efforts in recent years; it is likely that the community buildings and residences in Rampart require modification to improve energy efficiency and reduce consumption of heating oil.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Rampart Community Survey

A community survey offered to Rampart in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Rampart (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in rampart in 2022 (AEA 2023). Rampart's 31 residential customers, 5 community facility customers, and 10 other customers required 263,770 kWh of diesel-generated. A total of 25,134 gallons of fuel were consumed by Rampart customers in 2022 at a cost of $84,013 ($3.34 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 562,499 lbs CO_2 were produced in Rampart in FY2022.

The average fuel cost per kWh in Rampart in 2022 was $0.39. The annual non-fuel expenses associated with power generation totaled $48,010 in FY22, resulting in an additional cost of $0.22 per kWh sold. The combined fuel and non-fuel expenses in Rampart required to produce power in Rampart were $0.61 per kWh sold in FY22. The last reported Electric rate was $0.81 per kWh; thus, Rampart's electric rate is about five times the national average of $0.16 per kWh. Rampart was PCE eligible for 63.3% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Rampart in the amount of $66,298 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,842 (AEA 2023). PCE data are shown, below, in Tables 1 and 2.

Table 1. Rampart Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
92	31	5	10

Source: AEA 2023

Table 2. Rampart Fuel Consumption and CO2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
263,770	0	82.4%	10.49	246,110	25,134	562,498

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[5] was created to assess GHGs emitted from 245 communities around Alaska, including Rampart (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity

[5] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Rampart. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Rampart:

- Residential Sector
  - Residual Fuel Oil No. 5 = 26.40 MT CO_2e
  - Wood and Residuals = 5.35 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 62.17 MT CO_2e
  - Propane = 4.75 MT CO_2e
  - Wood and Wood Residuals = 0.17 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Rampart was modeled. The analysis indicated that approximately 222.18 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (63.99 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Rampart may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that would reduce CO_2 emissions by 50%.
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;

- Waterfront safety and navigational lighting powered by solar + BSSE;
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that Rampart pursue a solar array with a BESS for greater energy efficiency and reduced GHG emissions. Electric generation through solar will reduce diesel fuel consumption/generator run time.
2. **Additional Weatherization.** The community has successfully weatherized several community buildings, but it is recommended that Rampart pursue weatherization of additional buildings and residences with modern features that would reduce heat escape, lower fuel oil consumption, and reduce GHG emissions. Weatherization will reduce the use of heating oil and wood burning.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 230 kWh Renewable Solar + 354 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
230 kWh PV; 354 kWh BESS	1.38	1.00	50%	13,824	11,310	42,814	114,742	115

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

The rural and remote communities of the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Rampart's chief concerns around Yukon Tanana region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.7 Review of Authority to Implement

The Rampart Village Council (RVC) is the governing body for Rampart Village, a federally recognized tribe. The RVC has the authority to implement GHG reduction measures through resolutions passed in RVC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, RVC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Rampart to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that Rampart pursue funding for a solar array with a BESS for greater energy efficiency and reduced GHG emissions.
2. **Additional Weatherization.** The community has successfully weatherized several community buildings, but weatherization of additional buildings and residences with modern features that would reduce heat escape, lower fuel oil consumption, and reduce GHG emissions.
3. **Biomass Project(s):** It is recommended that the community consider applying for funding for a woodchip boiler system to contribute heating to community buildings and homes. The cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally-sourced wood is

considered carbon-neutral, so the biomass boiler system decreases the carbon footprint of heating the community buildings.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Rampart is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The DOE has funded updates to the electric grid in Rampart. It is recommended that following these updates, Rampart assess whether further upgrades to hardware are required, including transformers, transmission lines, and switch gear. The pursuit of additional funding for these needs may further improve reliability of the grid and create opportunities for the tie-in of renewable energy systems.

5 References

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Appendix A

Alaska Energy Authority’s Power Cost Equalization Program
Statistical Report for Rampart (FY2022)

Rampart PCE

Utility: RAMPART VILLAGE COUNCIL
Reporting Period: 07/01/21 to 06/30/22

Community Population	92
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	31
Community Facility Customers	5
Other Customers (Non-PCE)	10
Fiscal Year PCE Payments	**$66,298**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	65,625	Average Annual PCE Payment per Eligible Customer	$1,842
PCE Eligible kWh - Community Facility Customers	71,950	Average PCE Payment per Eligible kWh	$0.48
Total PCE Eligible kWh	137,575	Last Reported Residential Rate Charged (based on 500 kWh)	$0.81
Average Monthly PCE Eligible kWh per Residential Customer	176	Last Reported PCE Level (per kWh)	$0.49
Average Monthly PCE Eligible kWh per Community Facility Customer	1,199	Effective Residential Rate (per kWh)	$0.33
Average Monthly PCE Eligible Community Facility kWh per Person	65	PCE Eligible kWh vs Total kWh Sold	63.3%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	263,770	Fuel Used (Gallons)	25,134
Non-Diesel kWh Generated	0	Fuel Cost	$84,013
Purchased kWh	0	Average Price of Fuel	$3.34
Total Purchased & Generated	263,770	Fuel Cost per kWh sold	$0.39
		Annual Non-Fuel Expenses	$48,010
		Non-Fuel Expense per kWh Sold	$0.22
		Total Expense per kWh Sold	$0.61

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	75,661	Consumed vs Generated (kWh Sold vs Generated-Purchased)	82.4%
Community Facility kWh Sold	91,757	Line Loss (%)	6.7%
Other kWh Sold (Non-PCE)	49,867	Fuel Efficiency (kWh per Gallon of Diesel)	10.49
Total kWh Sold	217,285	PH Consumption as % of Generation	10.9%
Powerhouse (PH) Consumption kWh	28,825		
Total kWh Sold & PH Consumption	246,110		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Ruby Village

Ruby, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour

LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
RTC	Ruby Tribal Council
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Ruby, a rural and predominantly Alaska Native community of approximately 145 residents in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emission in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Ruby. GHG production levels and energy costs for Ruby were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), power generation data from the Alaska Village Electric Cooperative (AVEC), and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Ruby in 2022 (AEA 2023). Ruby's 114 residential customers, 16 community facility customers, and 27 other customers required 724,043 kWh of diesel-generated power. A total of 96,933 gallons of fuel were consumed by Ruby customers in 2022 at a cost of $466,350 ($4.81 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 2,169,361 lbs CO_2 were produced in Ruby in FY2022.

The average fuel cost per kWh in Ruby in 2022 was $0.70. The annual non-fuel expenses associated with power generation totaled $199,376 in FY22, resulting in an additional cost of $0.30 per kWh sold. The combined fuel and non-fuel expenses in Ruby required to produce power in Ruby were $1.00 per kWh sold in FY22. The last reported electric rate was $0.75 per kWh; thus, Ruby's electric rate is over 4.5 times the national average of $0.16 per kWh. Ruby was PCE eligible for 49.8% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Ruby in the amount of $133,429 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,026 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Ruby. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Ruby:

- Residential Sector
    - Residual Fuel Oil No. 5 = 422.37 MT CO_2e
    - Wood and Residuals = 11.05 MT CO_2e
- Commercial Sector
    - Distillate Fuel Oil No. 1 = 125.27 MT CO_2e

- Propane = 9.56 MT CO_2e
- Wood and Wood Residuals = 0.35 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Ruby was modeled. The analysis indicated that approximately 662.75 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (190.87 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + Battery Energy Storage System (BESS) scenario to meet this fraction. For Ruby, the maximum fraction of existing energy production that could be replaced by renewables is 40%, represented by a 485 kW solar PV and a 642 kWh BESS.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar PV + BESS scenario to meet this fraction. For Ruby, the maximum fraction of existing energy production that could be replaced by renewables is 40%, represented by a 485 kw solar PV and a 642 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar photovoltaic PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Ruby are:

- Solar PV + BESS array;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

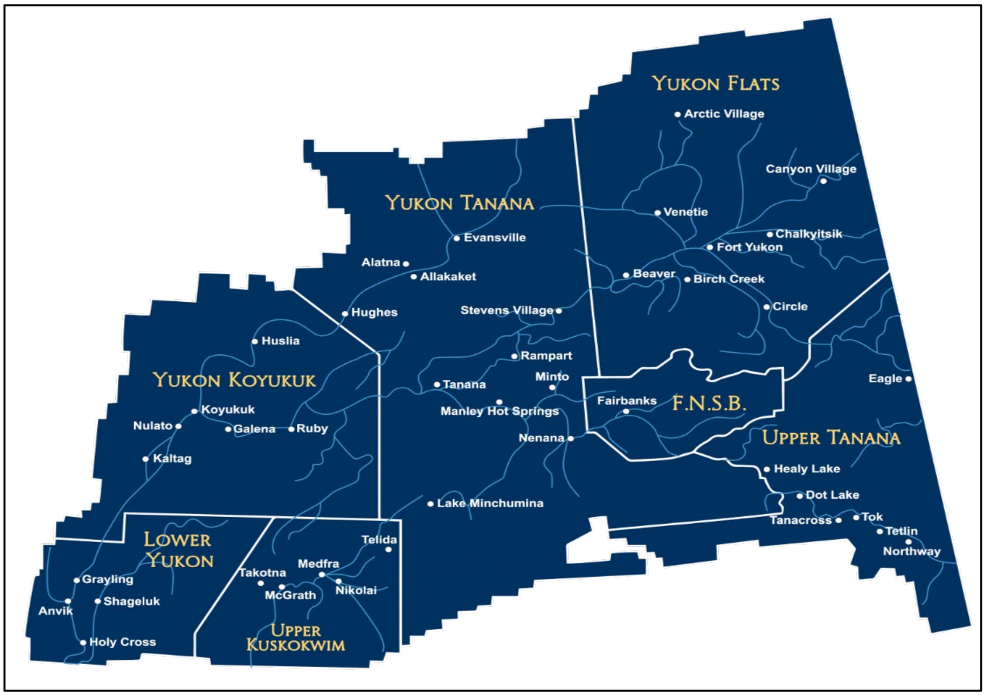
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

and implement ambitious plans for reducing GHG emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning and transportation, and infrastructure division including energy projects.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates.
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs, and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

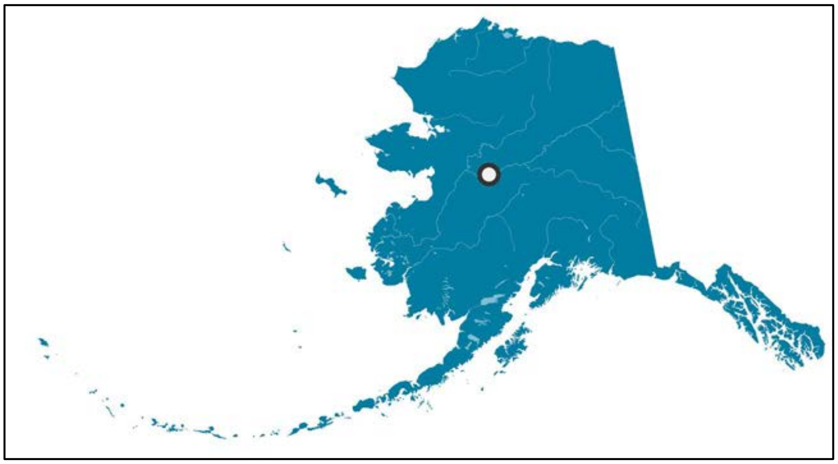
1.4 Scope of this PCAP: The Community of Ruby

Ruby a traditional Koyukon Athabascan village home to approximately 145 residents. Ruby is located on the south bank of the Yukon River, 50 miles west of Galena and 230 air miles west of Fairbanks (Figure 2). It lies in the Kilbuck-Kuskokwim Mountains, adjacent to the Nowitna National Wildlife Refuge, and access is primarily by plane or barge. Ruby's power is generated locally at a diesel power plant operated by the City of Ruby.

Ruby is located in the continental climate zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. The lowest recorded temperature in Ruby is -53°F, and the highest recorded temperature is 98°F. Several consecutive days of -40 °F is common each winter. Average annual precipitation is 17 inches, with 66 inches of snowfall.

The U.S. EPA indicates that Ruby's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Ruby as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 80.2% of Ruby's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Ruby, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Ruby. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or

individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of Ruby and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Ruby's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can

be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over

solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Ruby is estimated to be 7.7 mph[3] which is a Class 1 wind resource, approaching Class 2. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 145 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high capital cost of designing, mobilizing, constructing, and connecting a wind project in Ruby is not likely to recover the capital cost in a short or moderate time frame, due to having only a Class 1 wind resource. Furthermore, integrating wind would require upgrades to the grid components.

Because of the marginal wind resource in Ruby, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Ruby because of the number of moving parts that must continue operating at very cold temperatures. Should Ruby decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project..

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/ruby.html

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country’s transition to a more sustainable and low-carbon energy future. It is unknown whether Ruby has contemplated or pursued funding for a biomass project that could efficiently heat community buildings.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community’s transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions.

Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

Ruby will receive Bipartisan Infrastructure Law 40101(d) Grid Resilience Grant funding through TCC for improving electric grid resiliency targeted at preventing or reducing number of electrical outages. This is for investment in existing electric utility infrastructure only, but may include some renewable tie-ins, such as buying batteries, switch gear, or transformers that can be used in conjunction with solar and wind.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no plans for incorporating electrification into Ruby's waterfront or airport infrastructure at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).

- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Ruby does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components

of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Ruby is situated on the Yukon River. While this available hydrological resource has spurred interest in the potential for hydrokinetic energy systems, there are no plans to pursue a project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Ruby, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes

weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The last weatherization or retrofitting effort in Ruby was performed by TCC in 2017-2018. Streetlights were upgraded with energy efficient LED bulbs, and a community-wide LED lighting retrofit occurred. A refrigerator / freezer swap also took place. However, this effort was limited in scope, and the residents of Ruby have expressed interest in further weatherization efforts for residences and tribal buildings.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Ruby Community Survey

A community survey offered to Ruby in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Ruby (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel,

including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Ruby in 2022 (AEA 2023). Ruby's 114 residential customers, 16 community facility customers, and 27 other customers required 724,043 kWh of diesel-generated power. A total of 96,933 gallons of fuel were consumed by Ruby customers in 2022 at a cost of $466,350 ($4.81 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 2,169,361 lbs CO_2 were produced in Ruby in FY2022.

The average fuel cost per kWh in Ruby in 2022 was $0.70. The annual non-fuel expenses associated with power generation totaled $199,376 in FY22, resulting in an additional cost of $0.30 per kWh sold. The combined fuel and non-fuel expenses in Ruby required to produce power in Ruby were $1.00 per kWh sold in FY22. The last reported electric rate was $0.75 kWh; thus, Ruby's electric rate is over 4.5 times the national average of $0.16 per kWh. Ruby was PCE eligible for 49.8% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Ruby in the amount of $133,429 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,026 (AEA 2023). PCE data is summarized in Tables 1 and 2, below.

Table 1. Ruby Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
145	114	16	27

Source: AEA 2023

Table 2. Ruby Fuel Consumption and CO2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
724,043	0	92.2%	7.47	692,751	96,933	2,169,360

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[5] was created to assess GHGs emitted from 245 communities around Alaska, including Ruby (Constellation Energy 2024). The inventory tool is based off modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in

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[5] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Ruby. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Ruby:

- Residential Sector
  - Residual Fuel Oil No. 5 = 422.37 MT CO_2e
  - Wood and Residuals = 11.05 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 125.27 MT CO_2e
  - Propane = 9.56 MT CO_2e
  - Wood and Wood Residuals = 0.35 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Ruby was modeled. The analysis indicated that approximately 662.75 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (190.87 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Ruby intends to reduce GHG emissions by pursuing funding opportunities that will pay for:

- A community solar + BESS project that would reduce CO_2 emissions.

- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- An assessment of whether wind would be practical or lucrative;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that Ruby pursue a solar array with a BESS to reduce diesel fuel consumption, generator run time, and GHG emissions.
2. **Additional Weatherization.** It is recommended that Ruby pursue weatherization of community buildings and residences with modern features that would reduce heat escape, heating oil / wood burning usage, and energy bills, and GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 40% of the community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 485 kW Renewable Solar + 642 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
485 kW PV; 642 kWh BESS	2.62	1.00	40%	63,006	33,927	128,426	344,181	344

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

The rural and remote communities of the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Ruby's chief concerns around the region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.7 Review of Authority to Implement

The Ruby Tribal Council (RTC) is the governing body for Ruby Village, a federally recognized tribe. The RTC has the authority to implement GHG reduction measures through resolutions passed in RTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, RTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Ruby to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that Ruby pursue a solar array with a BESS to reduce diesel fuel consumption, generator run time, and GHG emissions.
2. **Additional Weatherization.** It is recommended that Ruby pursue weatherization of community buildings and residences with modern features that would reduce heat escape, heating oil / wood burning usage, and energy bills, and GHG emissions.
3. **Biomass Project(s):** It is recommended that the community consider applying for a woodchip boiler system to contribute heating to community buildings and homes. The cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally-sourced wood is considered carbon-neutral, so the biomass boiler system decreases the carbon footprint of heating the community buildings.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Ruby is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** Following work scheduled to be performed under a DOE Grid Resilience Grant in Ruby, is recommended that the community assess whether further upgrades are required to its electrical grid system, including transformers, transmission lines, and switch gear. The pursuit of funding for these needs may improve reliability of the grid and create opportunities for the tie-in of renewable energy systems.

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Priority Climate Action Plan

Shageluk Native Village

Shageluk, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
AVEC	Alaska Village Electric Cooperative
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
OCED	Office of Clean Energy Demonstrations
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
SNV	Shageluk Native Village
STC	Shageluk Tribal Council
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Shageluk, a rural and predominantly Alaska Native community of approximately 85 residents in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emission in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Shageluk. GHG production levels and energy costs for Shageluk were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), Alaska Village Electric Cooperative (AVEC) power generation data, and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Shageluk in 2022 (AEA 2023). Shageluk's 36 residential customers, 8 community facility customers, and 17 other customers required 434,034 kWh of diesel-generated power. A total of 34,047 gallons of fuel were consumed by Shageluk customers in 2022 at a cost of $96,123 ($2.82 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 761,972 lbs CO_2 were produced in Shageluk in FY2022.

The average fuel cost per kWh in Shageluk in 2022 was $0.24. The annual non-fuel expenses associated with power generation totaled $78,982 in FY22, resulting in an additional cost of $0.20 per kWh sold. The combined fuel and non-fuel expenses in Shageluk required to produce power in Shageluk were $0.44 per kWh sold in FY22. The last reported electric rate was $0.54 kWh; this, Shageluk's electric rate is nearly 3.5 times the national average of $0.16 per kWh. Shageluk was PCE eligible for 42.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Shageluk in the amount of $48,773 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,108 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Shageluk. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Shageluk:

- Residential Sector
  - Residual Fuel Oil No. 5 = 184.79 MT CO_2e
  - Wood and Residuals = 1.43 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 90.94 MT CO_2e

- Propane = 6.94 MT CO_2e
- Wood and Wood Residuals = 0.25 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Shageluk was modeled. The analysis indicated that approximately 425.70 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (122.60 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + Battery Energy Storage System (BESS) scenario to meet this fraction. For Shageluk, the maximum fraction of existing energy production that could be replaced by renewables is 40%, represented by a 267 kW solar PV and a 423 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Shageluk are:

- Solar PV + BESS array;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process. The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

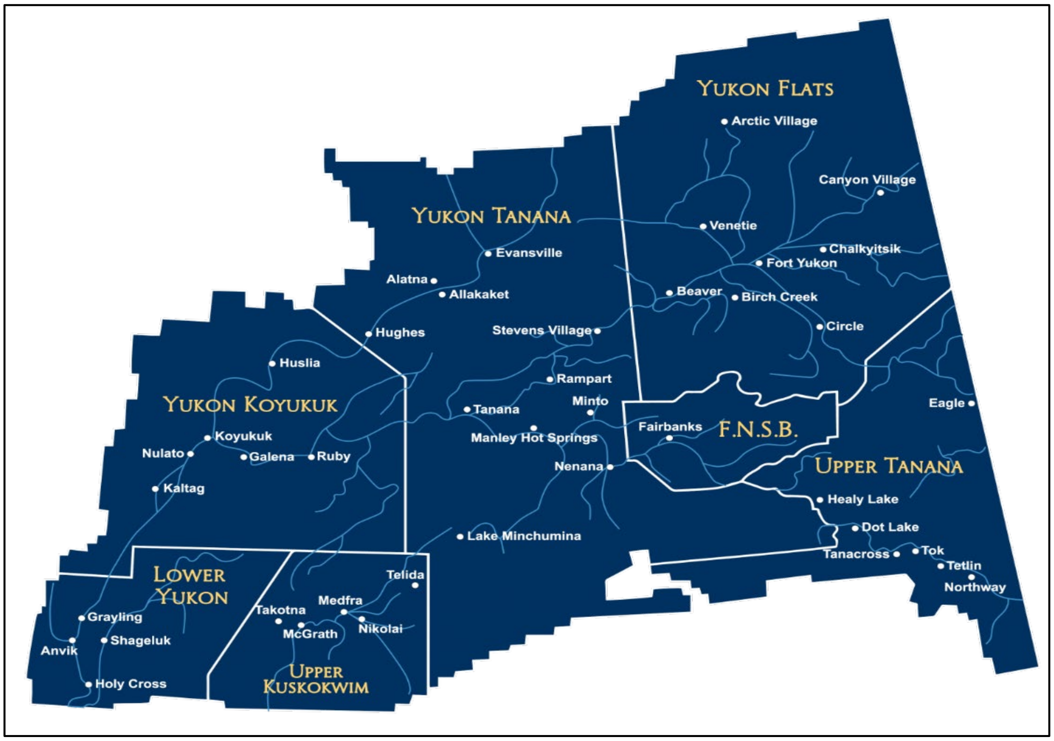
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. Its region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning and transportation, and infrastructure division including energy projects.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
    - Dave Messier – Infrastructure Director
    - Jason Paskvan – Project Manager and Community Liaison
    - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates.
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Village Electric Cooperative (AVEC), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs, and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and

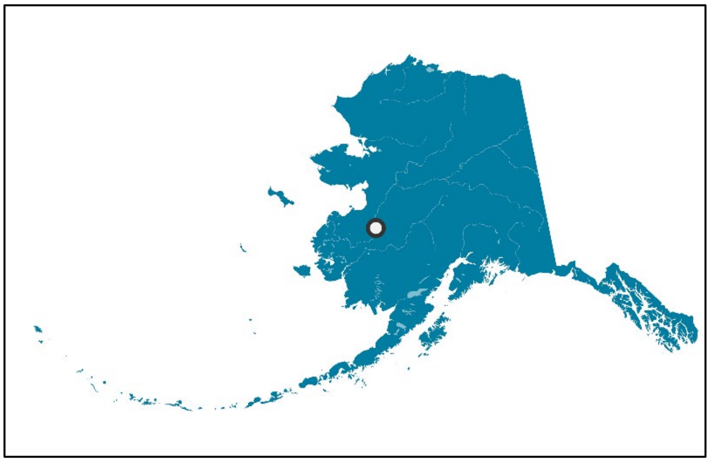
1.4 Scope of this PCAP: The Community of Shageluk

Shageluk is a traditional Athabascan village home to approximately 85 people in 36 households. Shageluk is located on the east bank of the Innoko River, 34 miles east of Anvik and 34 miles northeast of Holy Cross (Figure 2). The Innoko River is a tributary of the Yukon River, and access is primarily by plane or barge. Shageluk's power is generated locally at a diesel power plant operated by AVEC.

Shageluk is located in the continental climate zone, where winters are cold, and summers are warm. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. The lowest recorded temperature in Shageluk is -62°F, and the highest recorded temperature is 91°F. Several consecutive days of -40 °F is common each winter. Average annual precipitation is 67 inches, with 110 inches of snowfall. The Innoko River is generally ice-free from June through October.

Shageluk is not connected to a road system or major power. The U.S. EPA indicates that Shageluk's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Shageluk as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. At least 56.4% of Shageluk's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Shageluk, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;

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[2] https://www.huduser.gov/portal/icdbg2022/home.html

- o Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels to experience differential movement, risking the success of a project (ANTHC 2024)

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery systems allows existing generators to run optimally and avoid excess / waste power generation
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Shageluk. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or

individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of Shageluk and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Shageluk's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can

be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Additionally, there are a number of other areas around the village that may be suitable.

Shageluk recently collaborated with TCC to win a Department of Energy (DOE) Office of Clean Energy Demonstrations (OCED) grant to develop a community solar and battery project. This project will include a 225 kW PV, a 250 kW Inverter and a 350 kWh battery energy storage system (BESS), which will be integrated into the existing AVEC power plant. TCC will serve as an IPP, owning and operating the system and selling power to AVEC on behalf of the community. It is predicted that solar generation from this project could displace 13,000 gallons of diesel fuel annually and reduce GHG emissions by up to 21%. Generator run time in the community would reduce from 100% to approximately 67.08% of the time, and provide benefits in reduced emissions, noise, maintenance and operating costs, and more open maintenance periods. The revenue from power sales will be redirected into the community.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Shageluk is estimated to be 8.7 mph[3] which is a Class 1 (approaching class 2) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 85 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high capital cost of designing, mobilizing, constructing, and connecting a wind project in Shageluk is not likely to recover the capital cost in a short or moderate time frame, due to having only a Class 1 wind resource. Furthermore, integrating wind would require upgrades to the grid components.

Because of the marginal wind resource in Shageluk, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Shageluk because of the number of moving parts that must continue operating at very cold temperatures. Should Shageluk decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/shageluk.html

grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. It is unknow whether Shageluk has contemplated or pursued funding for a biomass project that could efficiently heat community buildings.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Shageluk, upgrades to the switchgear, controllers, and transformers are likely due for updating, and a BESS may be needed to regulate ramp rates on the diesel generators. Updating the switchgear and controllers is often a necessary step for proper incorporation of renewables.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

There are no plans for incorporating electrification into Shageluk's waterfront or airport infrastructure at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Shageluk does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Shageluk is bordered by two flowing waterbodies: the Innoko River and Hamilton Slough. While this available hydrological resource has spurred interest in the potential for hydrokinetic energy systems, there are no plans to pursue a project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Shageluk, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

The last major weatherization effort in Shageluk was 2015, under which many households received weatherization upgrades including new windows, doors, insulation, wood and Toyo stoves. Several community facilities have also received energy efficiency upgrades with new windows and LED lighting. However, that was almost ten years ago, and the residents of Shageluk have expressed interest in further weatherization efforts for residences and tribal buildings.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Shageluk in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Shageluk (AEA 2023). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Shageluk in 2022 (AEA 2023). Shageluk's 36 residential customers, 8 community facility customers, and 17 other customers required 434,034 kWh of diesel-generated power. A total of 34,047 gallons of fuel were consumed by Shageluk customers in 2022 at a cost of $96,123 ($2.82 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 761,972 lbs CO_2 were produced in Shageluk in FY2022.

The average fuel cost per kWh in Shageluk in 2022 was $0.24. The annual non-fuel expenses associated with power generation totaled $78,982 in FY22, resulting in an additional cost of $0.20 per kWh sold. The combined fuel and non-fuel expenses in Shageluk required to produce power in Shageluk were $0.44 per kWh sold in FY22. The last reported electric rate was $0.54 kWh; this, Shageluk's electric rate is nearly 3.5 times the national average of $0.16 per kWh. Shageluk was PCE eligible for 42.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Shageluk in the amount of $48,773 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,108 (AEA 2023).

Table 1. Shageluk Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
85	36	8	17

Source: AEA 2023

Table 2. Shageluk Fuel Consumption and CO2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
434,034	0	91.5%	12.75	409,449	34,047	761,971

Source: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 AVEC Power Generation Data

AVEC is the electric utility for eight of the communities in TCC's region, including Shageluk. AVEC provided the following data for Shageluk:

- Diesel Generators:
  - Station 1: Cummins LTA10 1200, 168 kW
  - Station 2: Cummins 6BTA5.9-G1, 100 kW
  - Station 3: Cummins LTA10 1200, 168 kW
- Average Load: 56 kW
- Estimated peak load: 74 kW
- Average annual power generated: 434,034 kWh
- Average fuel consumed: 34,047 gallons/year
- Average fuel efficiency: 12 kWh/gallon

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

3.4 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[5] was created to assess GHGs emitted from 245 communities around Alaska, including Shageluk (Constellation Energy 2024). The inventory tool is based off of modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

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[5] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Shageluk. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Shageluk:

- Residential Sector
  - Residual Fuel Oil No. 5 = 184.79 MT CO_2e
  - Wood and Residuals = 1.43 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 90.94 MT CO_2e
  - Propane = 6.94 MT CO_2e
  - Wood and Wood Residuals = 0.25 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Shageluk was modeled. The analysis indicated that approximately 425.70 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (122.60 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector

3.5 GHG Reduction Targets

Shageluk may pursue reduced GHG emissions through opportunities that would result in:

- Community solar + BESS to reduce diesel consumption and GHG emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative.

3.6 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for funding for a solar / battery array to reduce diesel fuel consumption, generator run time, and GHG emissions.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for additional funding for weatherization of residences and tribal / city buildings to reduce fuel oil consumption, wood burning and GHG emissions.

3.7 Benefits Analysis

An analysis was performed under a scenario in which 40% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 267 kWh Renewable Solar + 423 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
267 kW kWh; 423 kWh BESS	1.56	0.75	40%	22,131	11,916	45,109	120,891	121

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

The rural and remote communities the Yukon-Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Shageluk's chief concerns around Yukon Koyukuk region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.8 Review of Authority to Implement

The Shageluk Tribal Council (STC) is the governing body for Shageluk Village, a federally recognized tribe. The STC has the authority to implement GHG reduction measures through resolutions passed in STC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, STC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Shageluk to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community and TCC were recently awarded funding through the DOE OCED grant for solar a PV and BESS project to be constructed. It is recommended that the community consider whether an expansion of this project and maximization of this renewable energy system would further reduce diesel fuel consumption and GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings. It is likely that the several homes, and tribal / city buildings have not had energy efficiency improvements beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** It is recommended that the community consider applying for funding for a woodchip boiler system to contribute heating to community buildings and homes. The cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally-sourced wood is considered carbon-neutral, so a biomass boiler system would reduce fuel oil consumption and would likely lower GHG emissions.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around

Shageluk is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** It is recommended that Shageluk assess whether upgrades are required to its electrical grid system, including transformers, transmission lines, and switch gear. The pursuit of funding for these needs may improve reliability of the grid and create opportunities for the tie-in of renewable energy systems.

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Appendix A

Alaska Energy Authority’s Power Cost Equalization Program
Statistical Report for Shageluk (FY2022)

Shageluk PCE

Utility: ALASKA VILLAGE ELECTRIC COOP
Reporting Period: 07/01/21 to 06/30/22

Community Population	85
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	36
Community Facility Customers	8
Other Customers (Non-PCE)	17
Fiscal Year PCE Payments	**$48,773**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	113,579	Average Annual PCE Payment per Eligible Customer	$1,108
PCE Eligible kWh - Community Facility Customers	56,945	Average PCE Payment per Eligible kWh	$0.29
Total PCE Eligible kWh	170,524	Last Reported Residential Rate Charged (based on 500 kWh)	$0.54
Average Monthly PCE Eligible kWh per Residential Customer	263	Last Reported PCE Level (per kWh)	$0.29
Average Monthly PCE Eligible kWh per Community Facility Customer	593	Effective Residential Rate (per kWh)	$0.25
Average Monthly PCE Eligible Community Facility kWh per Person	56	PCE Eligible kWh vs Total kWh Sold	42.9%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	434,034	Fuel Used (Gallons)	34,047
Non-Diesel kWh Generated	0	Fuel Cost	$96,123
Purchased kWh	0	Average Price of Fuel	$2.82
Total Purchased & Generated	434,034	Fuel Cost per kWh sold	$0.24
		Annual Non-Fuel Expenses	$78,982
		Non-Fuel Expense per kWh Sold	$0.20
		Total Expense per kWh Sold	$0.44

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	134,612	Consumed vs Generated (kWh Sold vs Generated-Purchased)	91.5%
Community Facility kWh Sold	85,928	Line Loss (%)	5.7%
Other kWh Sold (Non-PCE)	176,655	Fuel Efficiency (kWh per Gallon of Diesel)	12.75
Total kWh Sold	397,195	PH Consumption as % of Generation	2.8%
Powerhouse (PH) Consumption kWh	12,254		
Total kWh Sold & PH Consumption	409,449		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Priority Climate Action Plan

Native Village of Stevens

Stevens Village, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour

LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Ton
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
SVIRAC	Stevens Village IRA Council
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Stevens Village, a rural and predominantly Alaska Native community of approximately 50 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Stevens Village. GHG production levels and energy costs for Stevens Village were first evaluated by incorporating the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024). Next, the impact of future renewable energy systems in the community was evaluated using modeled reductions in generator-produced power and fuel costs with HOMER Pro software (UL Solutions) under a scenario in which a representative community's energy infrastructure would be converted to the most likely renewable energy system: solar photovoltaic (PV) with battery energy storage system (BESS). Finally, recommendations were provided for specific strategies for Stevens Village to become more energy efficient with the aim of lowering GHG emissions and operational costs for the community.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Stevens Village in 2022 (AEA 2023). Stevens Village's 13 residential customers, 3 community facility customers, and 6 other customers required 49,995 kWh of diesel-generated power produced by the Stevens Village IRA Council (SVIRAC) utility. A total of 6,312 gallons of diesel fuel were consumed by Stevens Village customers in 2022 at a cost of $22,216 ($3.52 per gallon). Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that the SVIRAC utility produced approximately 141,262 lbs of CO_2 in FY2022.

The average fuel cost per kWh in Stevens Village in 2022 of $0.67. The annual non-fuel expenses associated with power generation totaled $56,281 in FY22, resulting in an additional cost of $1.71 per kWh sold. Thus, the combined fuel and non-fuel expenses required to produce power in Stevens Village were $2.38 per kWh sold in FY22; this is the electric rate paid by customers. Stevens Village's electric rate is nearly fifteen times the national average of $0.16 per kWh. Stevens Village was PCE eligible for 56.8% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Stevens Village in the amount of $10,400 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $650 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Stevens Village. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Stevens Village:

- Residential Sector
  - Wood and Residuals = 1.43 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 8.35 MT CO_2e
  - Propane = 0.64 MT CO_2e
  - Wood and Wood Residuals = 0.02 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Stevens Village was modeled. The analysis indicated that approximately 2.94 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (0.85 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Stevens Village are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

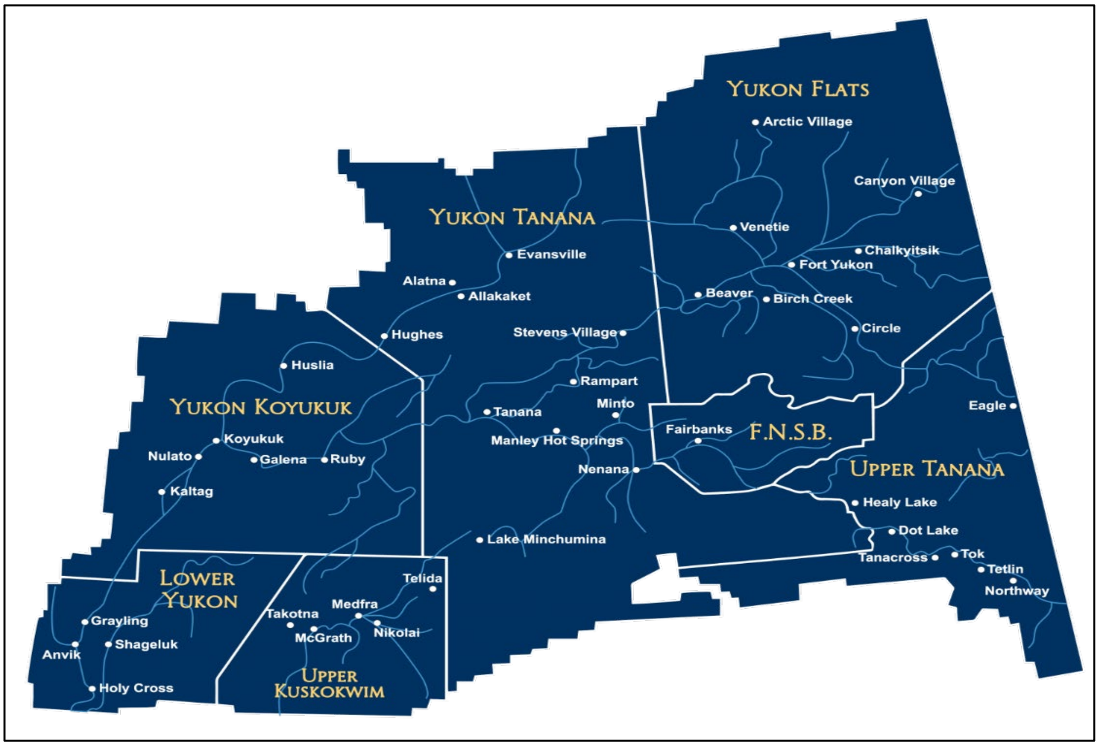
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure, and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Stevens Village

Stevens Village is home to approximately 61 predominately Kutchin Native residents. Stevens Village is located on the north bank of the Yukon River 17 miles upstream of the Dalton Highway bridge crossing and 90 air miles northwest of Fairbanks (Figure 2).

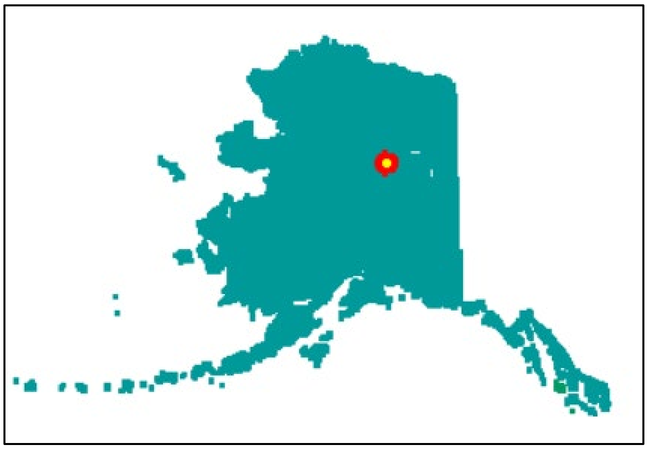
Stevens Village is located in the continental climatic zone, where winters are long and cold, and summers are short and warm. After freeze-up, the plateau is a source of cold, continental arctic air. Daily minimum temperatures between November and March are usually below 0° F.

Extended periods of -50 to -60° F are common. Summer high temperatures range between 65 to 72° F with a high of 97° F recorded once. Average annual precipitation is 7 inches, and annual snowfall averages 43 inches.

Stevens Village is not connected to the road system or a major power grid. Power is generated locally by a diesel power plant equipped with 4 diesel generators with a combined capacity of 260 kW. Heat from the cooling system is used to heat the power plant building and is pumped through insulated pipes to the nearby washeteria (U.S Department of Energy, 2005).

The U.S. EPA indicates that Stevens Village Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Stevens Village as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 92% of Stevens Village Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Stevens Village, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
- Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Stevens Village. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Stevens Village and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Stevens Village's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many

remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Stevens Village's airstrip is less than a mile from the village and would provide ample room for a solar array. The power grid would likely need to be upgraded in order to accommodate a solar array.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a lengthier process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Stevens Village is estimated to be 2.4 m/s (5.4 mph)[3] which is a Class 1 (light breeze) wind resource. Class 3 wind resources are considered to be excellent wind resources. Still, for a community of only about 61 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Stevens Village and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Stevens Village because of the number of moving parts that must continue operating at very cold temperatures. Should Stevens Village decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues,

[3] https://wind.willyweather.com/ak/yukon--koyukuk-borough/stevens-village.html

as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

Stevens Village has a small population living in less than 20 homes. The village is surrounded by woodlands, so biomass resources are plentiful. However, it is unknown whether Stevens Village intends to pursue funding to study or implement a biomass project.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

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[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

The Stevens Village power plant was constructed in 2003, but it is likely due for maintenance along with transformers and other hardware required to maintain the power grid. Should Stevens Village explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Stevens Village Airport could operate off a solar array if installed on the airport facility for village use.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.

- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Stevens Village does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Stephens Village is located on the north bank of the Yukon River; however, they currently do not have plans to pursue a hydropower project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

Stephens Village uses a heat recovery system to heat the power plant and the nearby washeteria, resulting in some energy savings for the community.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

It is unknown whether Stevens Village has pursued any recent weatherization efforts for community buildings or residences. Weatherization of housing and building components in Stephens Village would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Stevens Village in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Stevens Village (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Stevens Village in 2022 (AEA 2023). Stevens Village's 13 residential customers, 3 community facility customers, and 6 other customers required 49,995 kWh of diesel-generated power produced by the Stevens Village IRA Council (SVIRAC) utility. A total of 6,312 gallons of diesel fuel were consumed by Stevens Village customers in 2022 at a cost of $22,216 ($3.52 per gallon). Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that the SVIRAC utility produced approximately 141,262 lbs of CO_2 in FY2022.

The average fuel cost per kWh in Stevens Village in 2022 of $0.67. The annual non-fuel expenses associated with power generation totaled $56,281 in FY22, resulting in an additional cost of $1.71 per kWh sold. Thus, the combined fuel and non-fuel expenses required to produce power in Stevens Village were $2.38 per kWh sold in FY22; this is the electric rate paid by customers. Stevens Village's electric rate is nearly fifteen times the national average of $0.16 per kWh. Stevens Village was PCE eligible for 56.8% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Stevens Village in the amount of $10,400 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $650 (AEA 2023).

Table 1. Stevens Village Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
50	13	3	6

Source: AEA 2023

Table 2. Stevens Village Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ Gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO2 produced[5] (lbs)
49,995	0	66%	7.92	38,259	6,312	141,262

Sources: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[6] was created to assess GHGs emitted from 245 communities around Alaska, including Stevens Village (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

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[6] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Stevens Village. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Stevens Village:

- Residential Sector
  - Wood and Residuals = 1.43 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 8.35 MT CO_2e
  - Propane = 0.64 MT CO_2e
  - Wood and Wood Residuals = 0.02 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Stevens Village was modeled. The analysis indicated that approximately 2.94 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (0.85 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Stevens Village may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project to reduce GHG emissions;
- A woodchip boiler that could heat community buildings and reduce GHG emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

3.6 Benefits Analysis

For most TCC communities, an analysis could be performed under a scenario in which a typical Interior Alaska rural community's energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power for several communities. Unfortunately, results were not available for Stevens Village at the time of this report.

3.7 Review of Authority to Implement

The Stevens Village IRA Council (SVIRC) is the governing body for Stevens Village, a federally recognized tribe. The SVIRC has the authority to implement GHG reduction measures through resolutions passed in SVIRC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, SVIRC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Stevens Village to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should consider applying for funding for a solar PV array + BESS to reduce diesel fuel consumption, energy costs, and GHG emissions.
2. **Residential Weatherization.** It is likely that several community buildings and homes in Stevens Village have not had weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** Stevens Village is surrounded by woodlands. Since the village has a small population and a small number of homes, they could easily be individually heated with wood burning stoves. Larger biomass boilers could be considered for community buildings.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around

Stevens Village is considered light, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** The community should examine the condition of the current power grid as it likely has not been updated since initial installation.

5 References

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Appendix A

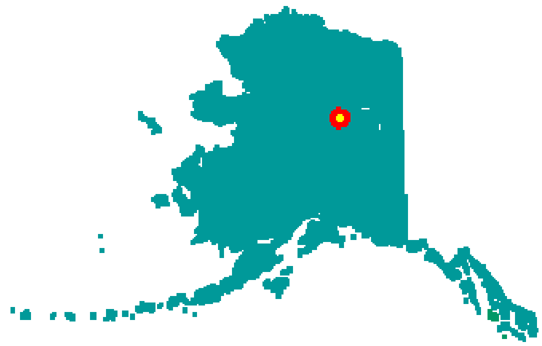
Alaska Energy Authority’s Power Cost Equalization Program
Statistical Report for Stevens Village (FY2022)

Stevens Village PCE

Utility: STEVENS VILLAGE IRA COUNCIL

Reporting Period: 07/01/18..06/30/19

Community Population	50
Last Reported Month	October
No. of Monthly Payments Made	4
Residential Customers	13
Community Facility Customers	3
Other Customers (Non-PCE)	6
Fiscal Year PCE Payments	**$10,400**



PCE Statistical Data			
PCE Eligible kWh - Residential Customers	9,489	Average Annual PCE Payment per Eligible Customer	$650
PCE Eligible kWh - Community Facility Customers	9,258	Average PCE Payment per Eligible kWh	$0.55
Total PCE Eligible kWh	*18,747*	Last Reported Residential Rate Charged (based on 500 kWh)	$1.07
Average Monthly PCE Eligible kWh per Residential Customer	182	Last Reported PCE Level (per kWh)	$0.56
Average Monthly PCE Eligible kWh per Community Facility Customer	772	Effective Residential Rate (per kWh)	$0.51
Average Monthly PCE Eligible Community Facility kWh per Person	46	PCE Eligible kWh vs Total kWh Sold	56.8%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	49,995	Fuel Used (Gallons)	6,312
Non-Diesel kWh Generated	0	Fuel Cost	$22,216
Purchased kWh	0	Average Price of Fuel	$3.52
Total Purchased & Generated	*49,995*	Fuel Cost per kWh sold	$0.67
		Annual Non-Fuel Expenses	$56,281
		Non-Fuel Expense per kWh Sold	$1.71
		Total Expense per kWh Sold	$2.38

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	10,078	Consumed vs Generated (kWh Sold vs Generated-Purchased)	66.0%
Community Facility kWh Sold	10,277	Line Loss (%)	23.5%
Other kWh Sold (Non-PCE)	12,650	Fuel Efficiency (kWh per Gallon of Diesel)	7.92
Total kWh Sold	*33,005*	PH Consumption as % of Generation	10.5%
Powerhouse (PH) Consumption kWh	5,254		
Total kWh Sold & PH Consumption	*38,259*		

Comments

Only 4 monthly reports submitted.

**The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.*

Tanana Chiefs Conference

Priority Climate Action Plan

Takotna Village

Takotna, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Ton
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
TTC	Takotna Tribal Council
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Takotna, a rural and predominantly Alaska Native community of approximately 67 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Takotna. GHG production levels and energy costs for Takotna were first evaluated by incorporating the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Takotna in 2022 (AEA 2023). Takotna's 28 residential customers, 4 community facility customers, and 12 other customers required 162,857 kWh of diesel-generated power. A total required 17,534 gallons of diesel fuel were consumed by Takotna customers in 2022 at a cost of $67,310 ($3.84 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 392,411 lbs CO_2 were produced in Takotna in FY2022.

The average fuel cost per kWh in Takotna was $0.51. The annual non-fuel expenses associated with power generation totaled were not reported in FY22. Without the non-fuel expenses reported, the actual electric rate in Takotna cannot be calculated; however, even at $0.51 per kWh, energy costs are over three times the national average of $0.16 per kWh. Takotna was PCE eligible for 45.7% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Takotna in the amount of $26,507 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $828.

Constellation Energy (2024) modeled GHG emission sources and outputs for Takotna. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Takotna:

- Residential Sector
  - Residual Fuel Oil No. 5 = 145.19 MT CO_2e
  - Wood and Residuals = 0.36 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 53,82 MT CO_2e
  - Propane = 4.11 MT CO_2e

- Wood and Wood Residuals = 0.15 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Takotna was modeled. The analysis indicated that approximately 193.89 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (55.84 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + Battery Energy Storage System (BESS) scenario to meet this fraction. For Takotna, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 208 kW solar PV and a 289 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information, the preferred options for cleaner, lower cost energy in Takotna are:

- Solar PV + BESS array to reduce diesel fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

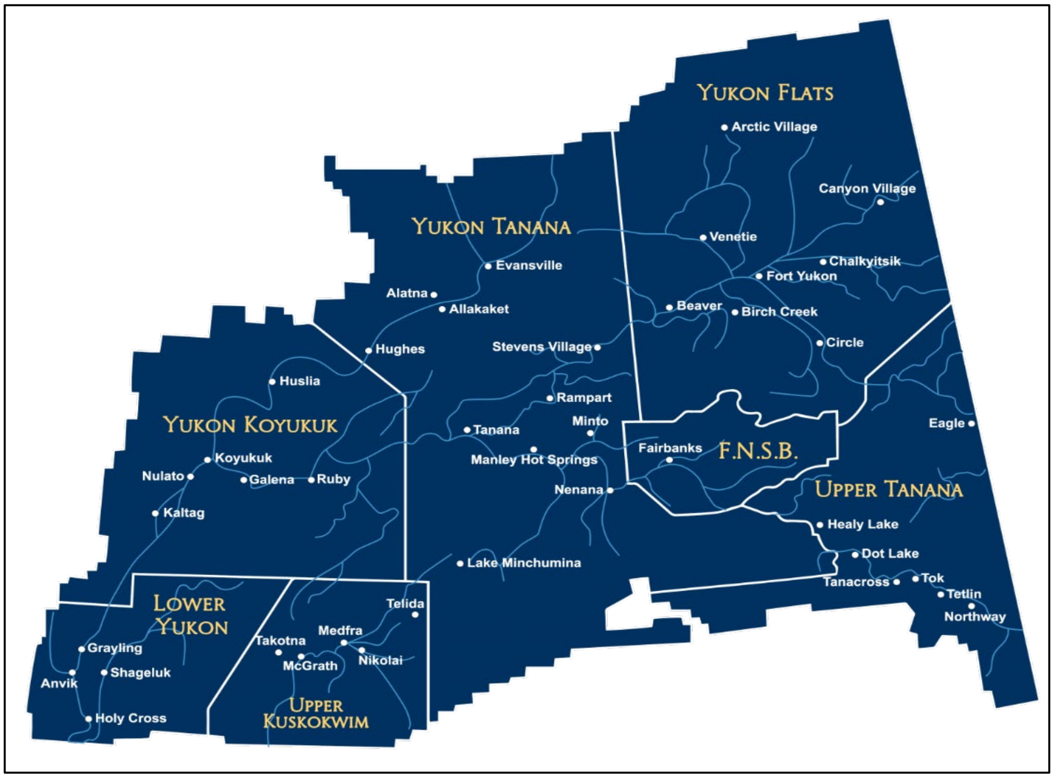
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

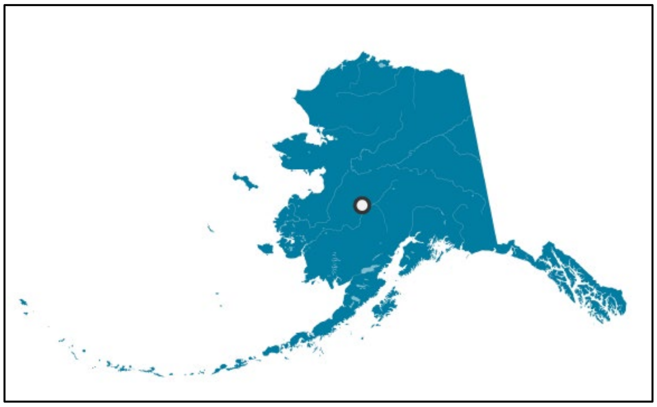
1.4 Scope of this PCAP: The Community of Takotna

Takotna is an Upper Kuskokwim traditional Athabascan village that is home to approximately 67 residents. It is located on the north bank of the Takotna River, 17 air miles west of McGrath in the Kilbuck-Kuskokwim Mountains (Figure 2). It lies south of the Tanana River. Takotna's power is supplied by the Takotna Community Association, Inc.

Takotna is located in the continental climatic zone, where winters are cold, and summers are warm. In winter temperatures range from -42 to 0 °F. Summer temperatures range from 42 to 80 °F. The Takotna River is generally ice free from June through October.

The U.S. EPA indicates that Takotna's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Takotna as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 76% of Takotna's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD).

Figure 2. Location of Takotna, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;

- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Takotna. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Takotna and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Takotna's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska

Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Takotna's airstrip is less than a mile from the village, so it could provide a reasonable location for a solar array. Upgrades to the power grid would likely need to be made in order to incorporate solar power in Takotna.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Takotna is estimated to be 5.1 mph[2] which is a Class 1 (light breeze) wind resource. Class 3 wind resources are considered to be excellent wind resources. Still, for a

[2] Takotna Wind Forecast, AK 99627 - WillyWeather

community of only about 67 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Takotna and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Takotna because of the number of moving parts that must continue operating at very cold temperatures. Should Takotna decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [3]

A 2008 case study by the Cooperative Extension Service at the University of Alaska Fairbanks (UAF 2008) focused on Takotna's use of a Garn wood-fired boiler with a heat exchanger that is used in conjunction with an oil-fired boiler to heat 8 homes in the community. The initial cost was less than $70,000, and operating costs are fairly low since the fuel is harvested locally. The USDA recognized this wood fired project as an example of the successful use of woody biomass energy.

Takotna has a relatively small population and around 50 structures to heat. The village is surrounded by woodlands, so a biomass project could be a feasible alternative to diesel.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Takotna, the transmission lines are likely due for upgrades and/or maintenance along with any transformers and other hardware required to maintain the power grid. Should Takotna explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

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[3] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with a weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Takotna's airport energy needs could be satisfied by a solar array if one were installed for village use. However, there are currently no plans for electrification at the airport or at the waterfront.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Takotna does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are

required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Takotna is located on the north bank of the Takotna River; however, they currently do not have plans to pursue a hydrokinetic project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Takotna, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

It is unknown whether significant weatherization to tribal or other community buildings has occurred in recent years. Weatherization of buildings and homes in Takotna would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Takotna in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Takotna (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Takotna in 2022 (AEA 2023). Takotna's 28 residential customers, 4 community facility customers, and 12 other customers required 162,857 kWh of diesel-generated power. A total required 17,534 gallons of diesel fuel were consumed by Takotna customers in 2022 at a cost of $67,310 ($3.84 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 392,411 lbs CO_2 were produced in Takotna in FY2022.

The average fuel cost per kWh in Takotna was $0.51. The annual non-fuel expenses associated with power generation totaled were not reported in FY22. Without the non-fuel expenses reported, the actual electric rate in Takotna cannot be calculated; however, even at $0.51 per kWh, energy costs are over three times the national average of $0.16 per kWh. Takotna was PCE eligible for 45.7% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Takotna in the amount of $26,507 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $828. PCE data are summarized in Tables 1 and 2, below.

Table 1. Takotna Population and Customer Base

Communit y Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
67	28	4	12

Source: AEA 2023

Table 2. Takotna Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[4] (lbs)
162,857	0	81.4%	9.29	152,146	17,534	392,411

Sources: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Takotna (Constellation Energy 2024). The inventory tool was

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Takotna. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Takotna:

- Residential Sector
  - Residual Fuel Oil No. 5 = 145.19 MT CO_2e
  - Wood and Residuals = 0.36 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 53,82 MT CO_2e
  - Propane = 4.11 MT CO_2e
  - Wood and Wood Residuals = 0.15 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Takotna was modeled. The analysis indicated that approximately 193.89 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (55.84 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

3.4 GHG Reduction Targets

Takotna may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions significantly;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for funding for a solar / battery array to reduce diesel fuel consumption, generator run time, and GHG emissions.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for additional funding for weatherization of residences and tribal / city buildings to reduce fuel oil consumption, wood burning and GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 50% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Capital expenditures (CAPEX) and operational expenditures (OPEX) of the system were also modeled, along with annual generator fuel costs and operation and maintenance (O&M) costs under this scenario. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 208 kW PV Renewable Solar + 289 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Mill. $)	Utility Improvements (Mill. $)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
208 kW PV; 289 kWh BESS	1.13	$1.00	50%	9,644	7,890	29,868	80,046	80

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

The rural and remote communities the Upper Kuskokwim region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Takotna's chief concerns around Upper Kuskokwim region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.7 Review of Authority to Implement

The Takotna Tribal Council (TTC) is the governing body for Takotna Village, a federally recognized tribe. The TTC has the authority to implement GHG reduction measures through resolutions passed in TTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, TTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Takotna to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that the community apply for funding for a solar PV + BESS project.

2. **Residential Weatherization.** It is likely that most buildings and homes in Takotna have not had further weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.

3. **Biomass Project(s):** It is recommended that the community consider applying for funding for a woodchip boiler system to contribute heating to community buildings and homes. The cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally-sourced wood is considered carbon-neutral, so a biomass boiler system would reduce fuel oil consumption and would likely lower GHG emissions.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Takotna is considered light, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

5. **Other Steps:** It is recommended that Takotna assess whether upgrades are required to its electrical grid system, including transformers, transmission lines, and switch gear. The pursuit of funding for these needs may improve reliability of the grid and create opportunities for the tie-in of renewable energy systems.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Takotna (FY2022)

Takotna PCE

Utility: TAKOTNA COMMUNITY ASSOC INC
Reporting Period: 07/01/21 to 06/30/22

Community Population	67
Last Reported Month	June
No. of Monthly Payments Made	8
Residential Customers	28
Community Facility Customers	4
Other Customers (Non-PCE)	12
Fiscal Year PCE Payments	**$26,507**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	46,442	Average Annual PCE Payment per Eligible Customer	$828
PCE Eligible kWh - Community Facility Customers	14,121	Average PCE Payment per Eligible kWh	$0.44
Total PCE Eligible kWh	60,563	Last Reported Residential Rate Charged (based on 500 kWh)	$1.02
Average Monthly PCE Eligible kWh per Residential Customer	207	Last Reported PCE Level (per kWh)	$0.46
Average Monthly PCE Eligible kWh per Community Facility Customer	441	Effective Residential Rate (per kWh)	$0.56
Average Monthly PCE Eligible Community Facility kWh per Person	26	PCE Eligible kWh vs Total kWh Sold	45.7%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	162,857	Fuel Used (Gallons)	17,534
Non-Diesel kWh Generated	0	Fuel Cost	$67,310
Purchased kWh	0	Average Price of Fuel	$3.84
Total Purchased & Generated	162,857	Fuel Cost per kWh sold	$0.51
		Annual Non-Fuel Expenses	$0
		Non-Fuel Expense per kWh Sold	See Comments
		Total Expense per kWh Sold	$0.51

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	55,516	Consumed vs Generated (kWh Sold vs Generated-Purchased)	81.4%
Community Facility kWh Sold	14,121	Line Loss (%)	6.6%
Other kWh Sold (Non-PCE)	63,002	Fuel Efficiency (kWh per Gallon of Diesel)	9.29
Total kWh Sold	132,639	PH Consumption as % of Generation	12.0%
Powerhouse (PH) Consumption kWh	19,507		
Total kWh Sold & PH Consumption	152,146		

Comments

Only 8 months filed; Non-fuel exp not reported

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Native Village of Tanana

Tanana, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
TPC	Tanana Power Company
TLC	Tanana Tribal Council
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Tanana, a rural and predominantly Alaska Native community of approximately 190 residents in Interior Alaska. This identifies sources of greenhouse gas (GHG) emissions in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Tanana. GHG production levels and energy costs for Tanana were first evaluated by incorporating the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023), and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel is the primary energy source of power and GHG emissions in Tanana in 2022 (AEA 2023). Tanana's 105 residential customers, 7 community facility customers, and 46 other customers required 1,325,712 kWh of diesel-generated power. A total of 92,283 gallons of diesel fuel were consumed by Tanana customers in 2022 at a cost of $259,857 ($2.82 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 2,065,294 lbs CO_2 were produced in Tanana in FY2022.

The average fuel cost per kWh in Tanana in 2022 was $0.22. The annual non-fuel expenses associated with power generation totaled $443,333 in FY22, resulting in an additional cost of $0.38 per kWh sold. Thus, the combined fuel and non-fuel expenses required to produce power in Tanana were $0.60 per kWh sold in FY22; this is the electric rate paid by customers. Tanana's electric rate is about four times the national average of $0.16 per kWh. Tanana was PCE eligible for 37% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Tanana in the amount of $130,573 to offset its high energy costs; the average annual subsidized PCE payment per eligible customer was $1,166 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Tanana. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Tanana:

- Residential Sector
  - Residual Fuel Oil No. 5 = 211.19 MT CO_2e
  - Wood and Residuals = 18.18 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 220.85 MT CO_2e

- o Propane = 16.86 MT CO_2e
- o Wood and Wood Residuals = 0.61 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Tanana was modeled. The analysis indicated that approximately 1,145.17 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (329.81 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + Battery Energy Storage System (BESS) scenario to meet this fraction. For Tanana, the maximum fraction of existing energy production that could be replaced by renewables is 30%, represented by a 631 kW solar PV and a 755 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Tanana are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

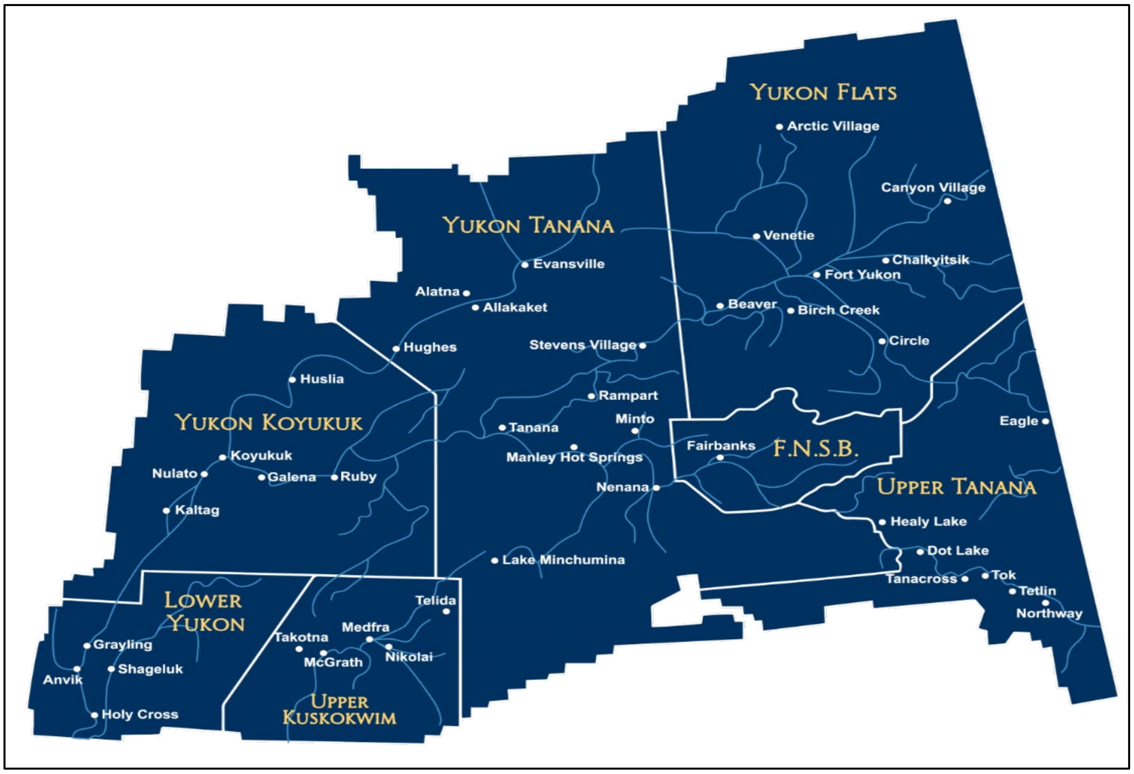
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

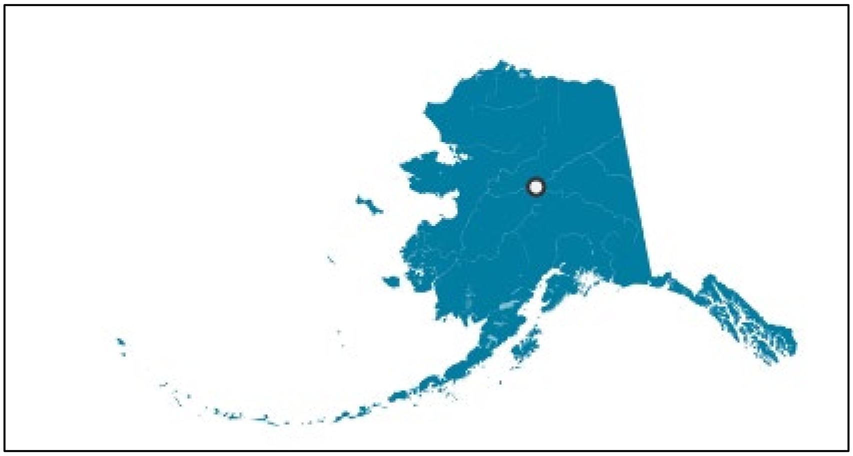
1.4 Scope of this PCAP: The Community of Tanana

Tanana is a traditional Yukon Tanana Athabascan village that is home to approximately 190 residents. Tanana is located about 2 miles west of the junction of the Tanana River and Yukon River and about 130 air miles west of Fairbanks (Figure 2). Tanana's power is supplied by The Tanana Power Company (TPC).

Tanana is located in the continental climatic zone, where winters are cold, and summers are warm. The average low temperature during January range from -14 °F to -48 °F. The average high temperature in July ranges between 64 °F to 70 °F. Extreme temperatures ranging from a low of -71 °F to a high of 94 °F have been recorded. Average annual precipitation is 13 inches, and annual snowfall averages 50 inches.

Most of Tanana's tribal population is below poverty level. Tanana is a Historically Disadvantaged Community existing in an Area of Persistent Poverty. Approximately 64% of Tanana's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Location of Tanana, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar

[2] https://www.huduser.gov/portal/publications/xls/icdbg_aian_options-11-15.xlsx

panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Tanana. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and

utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Tanana and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Tanana's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Tanana's airport is right on the edge of the village, so a solar array located there would not require long tie-in lines to the village power supply. Upgrades to the power grid would need to be made in order to incorporate solar power in Tanana.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Tanana is estimated to be 6 mph[3], which is a Class 1 (light breeze) wind resource. Class 3 wind resources are considered to be excellent wind resources. Still, for a community of only about 190 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Tanana and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Tanana because of the number of moving parts that must continue operating at very cold temperatures. Should Tanana decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

[3] Tanana Wind Forecast, AK 99777 - WillyWeather

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

In 2008, Tanana received $400k from the AEA Renewable Energy Fund and installed their first two GARN wood-fired heating devices in the water plant/laundry facility (Schmidt et al. 2021). As of 2021, the community has installed another 11 units with funding from various grants. Overall, $2.4M in state and federal grants have been used to help build their biomass program (Schmidt et al. 2021). The wood is gathered from designated areas, including wildfire burn areas, by local residents who are paid for their efforts. Wood heat has saved the community upwards of 34,000 gallons of diesel fuel annually to heat the laundromat, water treatment plant, and domestic water lines. This has resulted in significant GHG reduction for the community.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Tanana, the transmission lines and power grid are likely due for upgrade and maintenance. Should Tanana explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Tanana's airport could be powered from a solar array should one be installed for village use. Currently, there are no plans for electrification of Tanana's airport or waterfront.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.

- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

In 2016, the ADOT&PF constructed or upgraded 24 miles of road near Tanana to complete a 50-mile-long travel corridor between Manley Hot Springs and the south bank of the Yukon River, across from the Village of Tanana. This was done to reduce costs of freight, cargo, and travel and to increase access to areas for mineral development. There is no bridge across the Yukon River at the terminus of the road, so access to the community via road is in winter only, or by a short boat trip across the river in summer. Since Tanana is now connected to the Alaska road system, including the Parks Highway, in winter, it stands to reason that in time, an EV charging station could be constructed in Tanana or at the parking area on the south bank of the Yukon River.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers. Tanana is located on the north bank of the Yukon River; however, there are no plans to pursue a hydrokinetic project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Tanana, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of housing and building components in Tanana would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Tanana in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Tanana (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel is the primary energy source of power and GHG emissions in Tanana in 2022 (AEA 2023). Tanana's 105 residential customers, 7 community facility customers, and 46 other customers required 1,325,712 kWh of diesel-generated power. A total of 92,283 gallons of diesel fuel were consumed by Tanana customers in 2022 at a cost of $259,857 ($2.82 per gallon). Assuming 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that 2,065,294 lbs CO_2 were produced in Tanana in FY2022.

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Table 1. Tanana Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
190	105	7	46

Source: AEA 2023

Table 2. Tanana Fuel Consumption and CO_2 Emissions

Diesel kWh Generated	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[5] (lbs)
1,325,712	0	87.7%	14.37	1,188,798	92,283	2,065,294

Sources: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Tanana (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Tanana. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Tanana:

- Residential Sector
  - Residual Fuel Oil No. 5 = 211.19 MT CO_2e
  - Wood and Residuals = 18.18 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 220.85 MT CO_2e
  - Propane = 16.86 MT CO_2e
  - Wood and Wood Residuals = 0.61 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Tanana was modeled. The analysis indicated that approximately 1,145.17 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (329.81 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector

3.4 GHG Reduction Targets

Tanana may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce GHG emissions;
- A woodchip boiler that could heat community buildings and reduce GHG emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for funding for a solar / battery array to reduce diesel fuel consumption, generator run time, and GHG emissions.

2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for additional funding for weatherization of residences and tribal / city buildings to reduce fuel oil consumption, wood burning and GHG emissions.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 40% of the TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software (UL Solutions 2024), TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 631 kW PV + 755 kWh BESS Scenario

Solar + BESS Sizing	CapEx (Mill. $)	Utility Improvements (Mill. $)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
631 kW PV; 755 kWh BESS	3.38	1.00	30%	69,212	23,071	87,332	234,050	234

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

The rural and remote communities the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as indicated above.

TCC & Tanana's chief concerns around Yukon Tanana region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy.

3.7 Review of Authority to Implement

The Tanana Tribal Council (TTC) is the governing body for the Native Village of Tanana, a federally-recognized tribe. The TTC has the authority to implement GHG reduction measures through resolutions passed in TTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, TTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Tanana to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should consider applying for funding for a solar PV + BESS system to reduce diesel consumption and GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community apply for funding for weatherization of residences and tribal / city buildings. It is likely that the several homes, and tribal / city buildings have not had energy efficiency improvements beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Tanana is considered a light breeze resource, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on

a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.

4. **Other Steps:** It is recommended that the community examine the condition of their current power grid to determine what upgrades are required. It is recommended that the community consider applying for funding to upgrade, maintain, and modernize the electrical grid.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Tanana (FY2022)

Tanana PCE

Utility: TANANA POWER COMPANY INC.
Reporting Period: 07/01/21 to 06/30/22

Community Population	190
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	105
Community Facility Customers	7
Other Customers (Non-PCE)	46
Fiscal Year PCE Payments	**$130,573**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	288,550	Average Annual PCE Payment per Eligible Customer	$1,166
PCE Eligible kWh - Community Facility Customers	141,086	Average PCE Payment per Eligible kWh	$0.30
Total PCE Eligible kWh	429,636	Last Reported Residential Rate Charged (based on 500 kWh)	$0.65
Average Monthly PCE Eligible kWh per Residential Customer	229	Last Reported PCE Level (per kWh)	$0.30
Average Monthly PCE Eligible kWh per Community Facility Customer	1,680	Effective Residential Rate (per kWh)	$0.35
Average Monthly PCE Eligible Community Facility kWh per Person	62	PCE Eligible kWh vs Total kWh Sold	37.0%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	1,325,712	Fuel Used (Gallons)	92,283
Non-Diesel kWh Generated	0	Fuel Cost	$259,857
Purchased kWh	0	Average Price of Fuel	$2.82
Total Purchased & Generated	1,325,712	Fuel Cost per kWh sold	$0.22
		Annual Non-Fuel Expenses	$443,333
		Non-Fuel Expense per kWh Sold	$0.38
		Total Expense per kWh Sold	$0.60

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	310,794	Consumed vs Generated (kWh Sold vs Generated-Purchased)	87.7%
Community Facility kWh Sold	151,617	Line Loss (%)	10.3%
Other kWh Sold (Non-PCE)	700,210	Fuel Efficiency (kWh per Gallon of Diesel)	14.37
Total kWh Sold	1,162,621	PH Consumption as % of Generation	2.0%
Powerhouse (PH) Consumption kWh	26,177		
Total kWh Sold & PH Consumption	1,188,798		

Comments

Provides Power To Klukwan Facility For Sales To Its Customers

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Village of Venetie

Venetie, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
OCED	US Department of Energy Office of Clean Energy Demonstrations
O&M	Operational Expenditures
OPEX	Operational Expenditures
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States
VTC	Venetie Traditional Council

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Venetie, a rural and predominantly Alaska Native community of approximately 189 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Venetie. GHG production levels and energy costs for Venetie was first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy, 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Venetie in 2022 (AEA 2023). Venetie's 96 residential customers, 9 community facility customers, and 14 other customers required 602,000 kWh in diesel-generated power. A total of 69,205 gallons of fuel were consumed by Venetie customers in 2022 at a cost of $329,619 ($4.76 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Venetie accounted for approximately 1,548,808 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Venetie in 2022 was $0.60. The annual non-fuel expenses associated with power generation totaled $43,125 in FY22, resulting in an additional cost of $0.08 per kWh sold. Thus, the combined fuel and non-fuel expenses in Venetie were approximately $0.68 per kWh sold in FY22. The last reported electric rate paid by customers was $0.90 per kWh. Thus, Venetie's electric rate is over 5.5 times the national average of $0.16 per kWh. Venetie was PCE eligible for 57.8% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Venetie in the amount of $154,876 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,475 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Venetie. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Venetie:

- Residential Sector
  - Residual Fuel Oil No. 5 = 26.40 MT CO_2e
  - Wood and Residuals = 12.12 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 101.15 MT CO_2e

- Propane = 7.72 MT CO_2e
- Wood and Wood Residuals = 0.28 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Venetie was modeled. The analysis indicated that approximately 562.52 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (16.01 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Venetie, the maximum fraction of existing energy production that could be replaced by renewables is 40%, represented by a 392 kW solar PV and a 555 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Venetie are:

- Solar PV + BESS array to reduce diesel fuel consumption and CO_2 emission;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

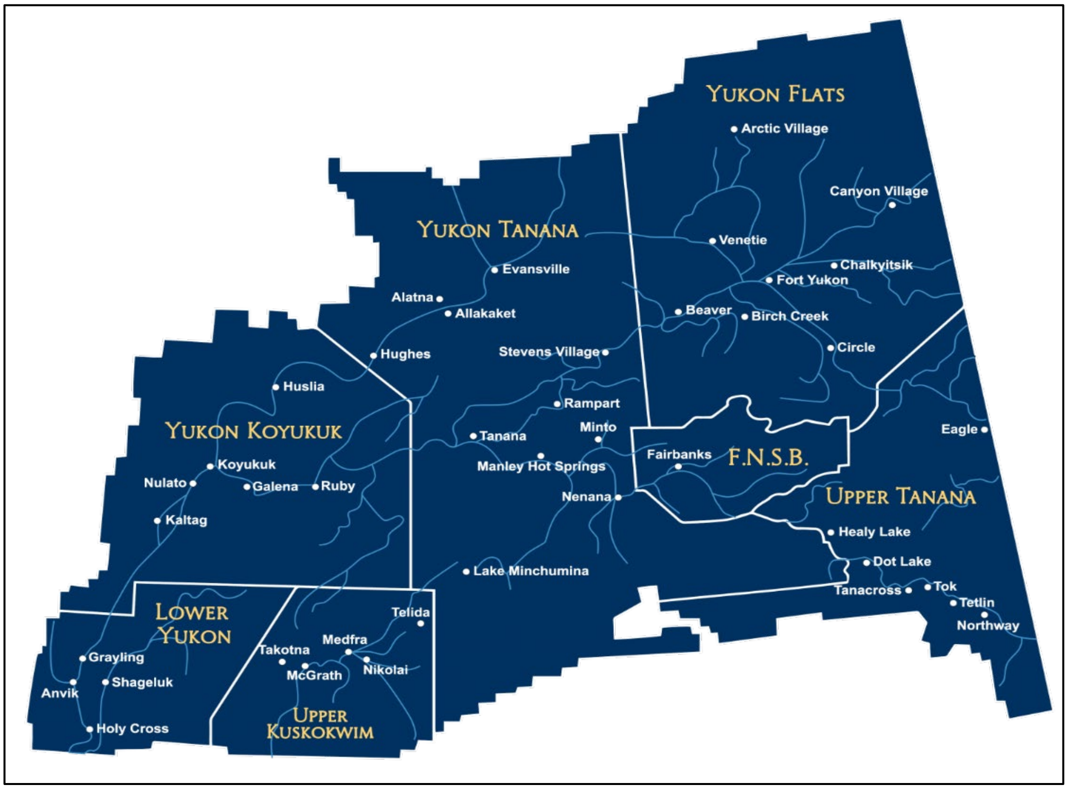
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 225 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

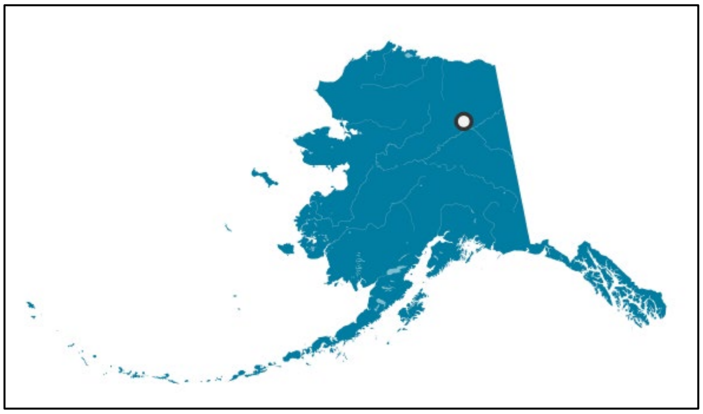
1.4 Scope of this PCAP: The Community of Venetie

Venetie is a traditional Yukon Flats Tanana Athabascan village that is home to approximately 160 residents. Venetie is located on the north side of the Chandalar River, 45 miles northwest of Fort Yukon.

In Venetie The winters are long and harsh, and the summers are short but warm. Daily minimum temperatures between November and March are usually below 0 °F. Extended periods of -50 to -60 °F are common. Summer high temperatures run 65 to 72 °F; a high of 97 °F has been recorded. Total annual precipitation averages 6.6 inches, with 43 inches of snowfall.

The Chandalar River is ice-free from the end of May through mid-September. The U.S. EPA indicates that Venetie's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Venetie as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 78.7% of Venetie's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2]

Figure 2. Location of Venetie, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Venetie. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies west of Venetie and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Venetie's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been

effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Venetie's public airport is located one mile southeast of the central business district of Venetie. There is one runway with a gravel surface and features a small terminal building. Additionally, there are several other areas around the village that may be suitable.

Venetie received funding from a USDA High Energy Cost Grant for implementing renewable energy systems (solar/battery). This will allow the community to improve energy generation efficiency, reduce diesel consumption, and lower GHG emissions.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more

difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Venetie is estimated to be 6.2 mph[3] which is a Class 1 (Light Breeze) wind resource. Class 3 wind resources are considered to be excellent wind resources. Still, for a community of only about 189 people, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions

[3] Venetie Wind Forecast, AK 99781 - WillyWeather

that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.[4]

In July of 2008, a Level 2 Feasibility study was conducted to determine maximum displacement of fuel oil for heat in commercial buildings (Wall and Koontz 2008). Venetie is surrounded by forest composed of aspen, black and white spruce, balsam poplar, white spruce, and many species of willow that may be used as a local fuel source. Multiple wildfires have burned in the region over the past 50 years. Fire is a threat to most of the villages and thinning is needed as a fuel mitigation strategy in and around the village. Harvest strategies are being developed to work in both summer and winter conditions. During summer, harvest equipment must be sized so it can be moved across the open water of rivers and harvests must be planned to stay on dry ground. During winter, harvest equipment must work in sub-zero weather, snow up to 3 feet, and must move across frozen wetlands and rivers. Most of the biomass would be hauled in winter. Concern exists by some whether chips systems are too complicated to be successful in rural Alaska off road conditions.

Three buildings in Venetie were evaluated: the school, school housing, and the washeteria. The evaluation compared a stick-fired boiler to chip-fired boilers at individual buildings and as a 3-building system. Economies of scale demonstrated that in both scenarios the 3-building system made the most sense. The stick-fired boiler would pay back capital costs in 5.9 years, and the chip-fired boiler would do so in 5.8 years, so there was nearly no difference in the economics. The stick-fired system would use about 290 cords annually to displace 33,390 gallons of fuel, and the chip system would use 403 green tons to displace approximately 27,000 gallons. The tradeoff between the two systems is that the stick-fired boilers would have to be fired more than 4 times per day on the coldest days, which if staggered would require almost constant firing; the chip-fired system would require less attention. The chip-fired system would require a small chipper to produce and handle 403 tons of chips annually. If a small systematic approach to producing chips can be developed then this may be the best scenario. However, more complexity at a small scale is an issue and must be decided with significant local input.

[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

A preliminary assessment of Venetie's electrical system was conducted in 2012 (Sandia National Laboratories 2012). It was reported that diesel generators supply, almost exclusively, the entire electrical energy for the village. There are three generators located in the village powerhouse, a 125 kW, a 180 kW, and a 190 kW units. The 180 kW and the 190 kW generators are currently in service, and the 125 kW unit failed with no plan to put it back into service (Sandia National Laboratories 2013). The generators are housed in building at the center of town next to a washeteria where combined heat and power are utilized by sending the generator waste heat to the washeteria to supplement the heating requirements of the boilers (Sandia National Laboratories 2013). At that time, the generator building was scheduled to be replaced in the near future, but it is unknown how this plan progressed.

The average summer load (May-August) in Venetie fluctuated around 60 kW, with spring load running higher at 80 kW; winter load fluctuated at highest rates from 140 - 150 kW, while load during the fall was around 110 kW (Sandia National Laboratories 2013).

The generators at that time fed a 12,470/7200 kV overhead distribution system, and a three-phase distribution system was used to split out and distribute power throughout the village. Unequal balance detected was thought to be the cause of some undue frequency fluctuations and power quality issues (Sandia National Laboratories 2013). The loads in the village comprised a couple of relatively large loads, including the school and residential housing. Each home uses from one to two kW load, on average. It was recommended at that time that the powerhouse and generators be replaced in order to increase the safety, reliability, and efficiency of operation (Sandia National Laboratories 2013).

In Venetie, transmission lines, transformers, and switch gear may be due for upgrade, along with other hardware required to maintain the power grid. Should Venetie explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Venetie has a public use airport and is privately owned by the Venetie Tribal Government. The airport has one gravel runway. Currently, there are no plans for electrification of the airport or waterfront.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.

- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Venetie does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine’s location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Venetie is located on the north side of the Chandalar River, 45 miles northwest of Fort Yukon. However, there are no known plans to develop a hydrokinetic project at this time.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In 2015, Venetie opened a new 2,269 square-foot health clinic equipped with a heat recovery system through partnerships with ANTHC, Denali Commission, the Department of Health and Social Services, Indian Health Service, and the Alaska Mental Health Trust Authority. The energy-efficient heating system is expected to provide more than 90 percent of the heat needed for the new clinic at considerable cost savings for operation (ANTHC 2015).

Venetie's generators are housed in a sub-standard, tight building at the center of town next to a washeteria. Combined heat and power is utilized by sending the generator waste heat to the washeteria to supplement the heating requirements of the boilers (Sandia National Laboratories 2013).

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include

insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

In 2018, an energy audit report was prepared for the Venetie Village Council focusing on the Venetie Head Start Building (Whelan et al., 2018). It included an analysis of building occupancy schedules, building shell, heating systems, lighting, and other electrical loads. The 1,020 square-foot building was renovated in the 2000s, and was selected to participate in a flush/haul pilot project through ANTHC in 2001. It has a main room for Head Start events, an office, a kitchen, and a storage area. Data was gathered on a site survey and an interview with the Head Start coordinator. Some of the recommendations of this audit for improving energy efficiency included upgrading the wood stove to better meet the community's needs, using active remote monitoring systems, minimizing use of multiple refrigerators and freezers with empty space, unplugging these appliances when not in use, applying shrink-wrap film to windows to reduce air / heat loss through the windows, and installing thermally insulating or heavy curtains to reduce air / heat loss through the windows (Whelan et al., 2018).

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Venetie in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Venetie (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Venetie in 2022 (AEA 2023). Venetie's 96 residential customers, 9 community facility customers, and 14 other customers required 602,000 kWh in diesel-generated power. A total of 69,205 gallons of fuel were consumed by Venetie customers in 2022 at a cost of $329,619 ($4.76 per gallon). Assuming 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Venetie accounted for approximately 1,548,808 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Venetie in 2022 was $0.60. The annual non-fuel expenses associated with power generation totaled $43,125 in FY22, resulting in an additional cost of $0.08 per kWh sold. Thus, the combined fuel and non-fuel expenses in Venetie were approximately $0.68 per kWh sold in FY22. The last reported electric rate paid by customers was $0.90 per kWh. Thus, Venetie's electric rate is over 5.5 times the national average of $0.16 per kWh. Venetie was PCE eligible for 57.8% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Venetie in the amount of $154,876 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,475 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Venetie Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
160	96	9	14

Source: AEA 2023

Table 2. Venetie Fuel Consumption and CO_2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ gal. Diesel) *	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[5] (lbs)
602,000	-	91.3%	8.7	568,55	69,205	3,092.27

Sources: AEA 2023, *AP&T for Venetie

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Venetie (Constellation Energy 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Venetie. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Venetie:

- Residential Sector
  - Residual Fuel Oil No. 5 = 26.40 MT CO_2e
  - Wood and Residuals = 12.12 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 101.15 MT CO_2e
  - Propane = 7.72 MT CO_2e
  - Wood and Wood Residuals = 0.28 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Venetie was modeled. The analysis indicated that approximately 562.52 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (16.01 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

3.4 GHG Reduction Targets

Venetie may pursue reduced GHG emissions through opportunities that would result in:

- Additional community solar + BESS to help meet maximum demands and further reduce CO_2 emissions;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Waterfront safety and navigational lighting powered by solar + BSSE;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs;
- An assessment of whether wind would be practical or lucrative

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for additional funding to reach maximum energy cost savings and CO_2 emissions reduction.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for funding for weatherization of residences and tribal / city buildings.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 40% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 392 kW PV Renewable Solar + 555 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar + BESS*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
392 kW PV; 555 kWh BESS	2.17	1.00	40%	44,983	24,222	91,689	245,727	246

Source: HOMER Pro Software; * = Fuel Used x (1-Renewable Frac+.05)

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

3.8 Review of Authority to Implement

The Venetie Traditional Council (VTC) is the governing body for Venetie Village, a federally-recognized tribe. The VTC has the authority to implement GHG reduction measures through resolutions passed in VTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, VTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Venetie to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should consider applying for additional funding for solar PV + BESS to reduce diesel fuel consumption and GHG emissions.

2. **Residential Weatherization.** It is likely that many community homes and residences in Venetie have not had significant weatherization beyond their initial construction. Updated weatherization could create significant energy savings, reduce GHGs, and make residents more comfortable.

3. **Biomass Project(s):** Biomass heating systems provide a sustainable fuel source for heating community buildings. One system is operating, and it is recommended that the community apply for additional funding to expand the use of these systems to further reduce GHGs and dependency on heating oil.

4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Venetie is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community should examine the condition of the current power grid and consider applying for grid resiliency funding, as it likely has not been significantly upgraded since initial construction.

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Appendix A

Alaska Energy Authority’s Power Cost Equalization Program

Statistical Report for Tetlin (FY2022)

Venetie PCE

Utility: VENETIE VILLAGE ELECTRIC
Reporting Period: 07/01/21 to 06/30/22

Community Population	160
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	96
Community Facility Customers	9
Other Customers (Non-PCE)	14
Fiscal Year PCE Payments	**$154,876**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	199,928	Average Annual PCE Payment per Eligible Customer	$1,475
PCE Eligible kWh - Community Facility Customers	117,763	Average PCE Payment per Eligible kWh	$0.49
Total PCE Eligible kWh	317,691	Last Reported Residential Rate Charged (based on 500 kWh)	$0.90
Average Monthly PCE Eligible kWh per Residential Customer	174	Last Reported PCE Level (per kWh)	$0.70
Average Monthly PCE Eligible kWh per Community Facility Customer	1,090	Effective Residential Rate (per kWh)	$0.20
Average Monthly PCE Eligible Community Facility kWh per Person	61	PCE Eligible kWh vs Total kWh Sold	57.8%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	602,000	Fuel Used (Gallons)	69,205
Non-Diesel kWh Generated	0	Fuel Cost	$329,619
Purchased kWh	0	Average Price of Fuel	$4.76
Total Purchased & Generated	602,000	Fuel Cost per kWh sold	$0.60
		Annual Non-Fuel Expenses	$43,125
		Non-Fuel Expense per kWh Sold	$0.08
		Total Expense per kWh Sold	$0.68

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	245,240	Consumed vs Generated (kWh Sold vs Generated-Purchased)	91.3%
Community Facility kWh Sold	170,834	Line Loss (%)	5.5%
Other kWh Sold (Non-PCE)	133,313	Fuel Efficiency (kWh per Gallon of Diesel)	8.70
Total kWh Sold	549,387	PH Consumption as % of Generation	3.2%
Powerhouse (PH) Consumption kWh	19,368		
Total kWh Sold & PH Consumption	568,755		

Comments

Reported diesel kWh gen, fuel, pwrhse cons=11 months; Non-fuel expense=7 months

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Anvik Village

Anvik, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
ATC	Anvik Tribal Council
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MT	Metric Ton
MPH	Miles Per Hour
OCED	US Department of Energy Office of Clean Energy Demonstrations
O&M	Operational Expenditures
OPEX	Operational Expenditures
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Anvik, a rural and predominantly Alaska Native community of approximately 79 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Anvik. GHG production levels and energy costs for Anvik was first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Anvik in 2022 (AEA 2023). Anvik's 34 residential customers, 11 community facility customers, and 20 other customers required 393,815 kWh in diesel-generated power. A total of 36,214 gallons of fuel were consumed by Anvik customers in 2022 at a cost of $101,456 ($5.27 per gallon). Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Anvik accounted for approximately 810,469 lbs. of CO_2 produced in FY2022.

The average fuel cost per kWh in Anvik in 2022 was $0.30. The annual non-fuel expenses associated with power generation totaled $68,160 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Anvik were $0.49 per kWh sold in FY22. The last reported electric rate paid by customers was $0.61 per kWh. Anvik's electric rate is slightly more than 3.5 times the national average of $0.16 per kWh. Anvik was PCE eligible for 49.5% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Anvik in the amount of $55,836 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,241 (AEA 2023).

Constellation Energy (2024) modeled GHG emission sources and outputs for Anvik. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Anvik:

- Residential Sector
    - Residual Fuel Oil No. 5 = 224.39 MT CO_2e
    - Wood and Residuals = 5.70 MT CO_2e
- Commercial Sector
    - Distillate Fuel Oil No. 1 = 66.81 MT CO_2e

- Propane = 5.10 MT CO_2e
- Wood and Wood Residuals = 0.19 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Anvik was modeled. The analysis indicated that approximately 339.76 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (97.85 MT CO_2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Homer Pro modeling software (UL Solutions 2024) was used to simulate Interior Alaska communities' maximum fraction of existing energy production (%) that could be replaced by a renewable energy system (solar array), and then apply an appropriately scaled solar photovoltaic (PV) + battery energy storage system (BESS) scenario to meet this fraction. For Anvik, the maximum fraction of existing energy production that could be replaced by renewables is 50%, represented by a 333 kW PV solar PV and a 375 kWh BESS.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Anvik are:

- Solar PV + BESS array to reduce fuel consumption and CO_2 production;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

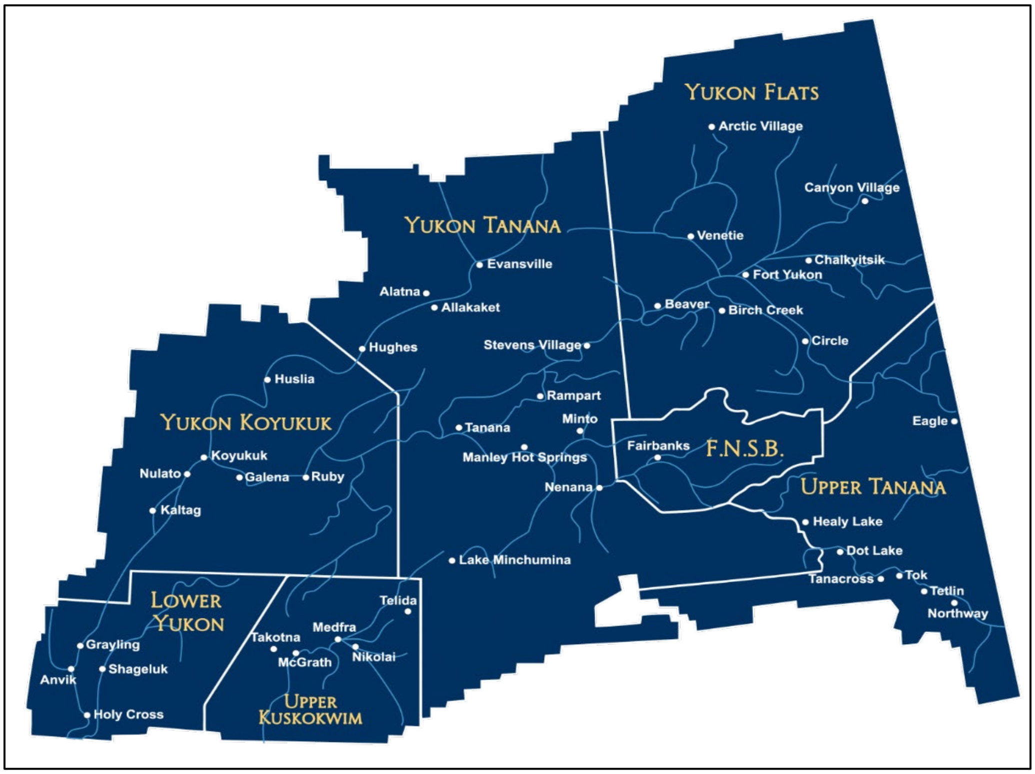
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing GHG emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- TCC – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Anvik

Anvik is a traditional Lower Yukon Tanana Athabascan village that is home to approximately 79 residents. Anvik is located in Interior Alaska on the Anvik River just inside the old mouth of the Anvik River along the hillside. It is west of the Yukon River, 34 miles north of Holy Cross.

Anvik is located in the continental climatic zone, where winters are cold, and summers are warm. In winter, cool air settles in the valley, and ice fog and smoke conditions are common. The area also experiences frequent wind gusts due to its location near the Yukon River. The climate of Anvik is continental. Temperatures range from -60 to 87 °F. Total precipitation averages 21 inches per year, and snowfall averages 110 inches per year. The Yukon River is ice-free from June through October.

The U.S. EPA indicates that Anvik's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Anvik as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 72% of Anvik's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2]

Figure 2. Location of Anvik, Alaska

Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar

[2] https://www.huduser.gov/portal/icdbg2022/home.html

panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Anvik. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and

utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies just west of Anvik and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Anvik's case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska's winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community's dependence on fossil fuels and mitigates carbon emissions.

Solar PV technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Anvik's public airport is located one mile southeast of the central business district of Anvik. There is one runway with a gravel surface and features a small terminal building. Additionally, there are several other areas around the village that may be suitable.

Alaska Village Electric Cooperative (AVEC) operates the electric utility in Anvik, Alaska. The power plant building was constructed in the mid 1970's and was relocated to its present site in the late 1990's.

Anvik received a portion of a grant from The US Department of Energy Office of Clean Energy Demonstrations (OCED) to reduce emissions and establish largely Solar/Batter arrays. This will provide more than 35% of the annual electric power through renewable energy for Anvik and the other seven remote tribal communities included in this grant.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Anvik is estimated to be 8.7 mph[3] which is a Class 1 wind resource, approaching Class 2. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 79 people, turbines turned by even a Class 1 or Class 2 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Anvik experiences frequent wind gusts due to its location near the Yukon River but due to the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Anvik because of the number of moving parts that must continue operating at very cold temperatures. Should Anvik decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed

[3] Anvik Wind Forecast, AK 99558 - WillyWeather

by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce GHG emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [4]

The State of Alaska Renewable Energy Fund provided the majority of the funding for an upgrade to a biomass boiler in the water treatment plant building in Anvik. This funding allowed Anvik to switch to the local, renewable resource of biomass in selected buildings to decrease the amount of fuel oil purchased each year. The Alaska Department of Commerce and Economic Development and the Environmental Protection Agency Safe Drinking Water Act also contributed funds to the biomass project.

Anvik also received a biomass district heating system. TCC commissioned the system in late 2017. It is currently providing heat to four buildings, the community hall, the city office, the clinic, and the water treatment plant and washeteria building.

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[4] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

The district system has two GARN 2000 boilers, each with a maximum heating output of 350,000 BTU/hour. They are housed in a centrally-located building, built as part of the SPARC project. The City and Tribe share operation of the boilers.

Biomass optimization included several improvements to increase the efficiency, reliability, and safety of the system, such as relocating the air intake ducts to above the snowline, rewiring the combustion air intake damper on one of the GRAN units, reconfiguring various controllers to improve functionality and efficiency, treating boilers with biological growth inhibitors, and replacing a circulation fan.

In 2017, the Anvik health clinic joined the district biomass heating loop, was air-sealed, and received programmable thermostats. In addition, the Anvik community hall joined the heating loop. The electric usage in 2018, after the retrofit, was 16% lower than in 2016, when the offices were already relocated, a savings of roughly 2,000 kWh per year.[5]

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Anvik, the transmission lines are likely due for maintenance along with any transformers and other hardware required to maintain the power grid. Should Anvik explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and

[5] SPARC_report_Anvik_final.pdf (cchrc.org)

collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Anvik has a public airport located one mile southeast of the central business district. The airport is owned by the state of Alaska and operated by the Alaska Department of Transportation and Public Facilities.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.

- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Anvik does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Anvik is located on the Anvik River, just inside the old mouth of the Anvik River along the hillside. They currently do not have plans to pursue a hydropower project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

A heat recovery system was installed in Anvik in 1999 to provide heat to the school and saved the school approximately 5,000 gallons of heating fuel per year. In circa 2004, the plant cooling system was modified to provide heat to two uninsulated 8'X20' storage containers and one insulated 8'x20' crew living quarters. Due to the high heat demand of the uninsulated storage containers there is no longer any recovered heat available to the school. It was suggested that the storage containers be insulated equivalent to a minimum R13 envelope, it is estimated there would be enough recovered heat available to save the school approximately 3,200 gallons of diesel fuel per year. [6]

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of housing and building components in Anvik would reduce heat loss and improve energy efficiency.

In October 2016, RurAL CAP completed a scope of work assessment, reviewing the energy audits and noting changes to the buildings that had occurred post-audit. This allowed them to slightly modify the scope of work from the original audits to reflect the current conditions of the buildings. The weatherization crew was able to retrofit all of the audited buildings in Anvik

[6] Microsoft Word - ANVIK-CHP REPORT.doc (northwestchptap.org)

with the exception of the wireless network building. The majority of the retrofits involved installing programmable thermostats, upgrading lighting to LED bulbs, and a blower door-guided air-sealing effort. The weatherization crew replaced thermostats in the Anvik health clinic with a programmable version to facilitate temperature setbacks to reduce energy use when the building is empty. Additionally, at the Anvik health clinic the weatherization crew was able to seal air leaks on a door after a blower door test was completed. [7]

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Anvik in late 2023 to inform to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Anvik (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel,

[7] SPARC_report_Anvik_final.pdf (cchrc.org)

including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Anvik indicated that diesel was the primary energy source of power and GHG emissions in Anvik in 2022 (AEA 2023). Anvik's 34 residential customers, 11 community facility customers, and 20 other customers required 393,815 kWh in diesel-generated power. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Anvik accounted for approximately 8,813,580 lbs. of CO_2 produced in FY2022.

A total of 36,214 gallons of fuel were consumed by Anvik customers in 2022 at a cost of $101,456 ($2.80 per gallon). The average fuel cost per kWh in Anvik in 2022 was $0.30. The annual non-fuel expenses associated with power generation totaled $68,160 in FY22, resulting in an additional cost of $0.20 per kWh sold. Thus, the combined fuel and non-fuel expenses in Anvik were $0.49 per kWh sold in FY22. Anvik's electric rate is 3.5 times the national average of $0.16 per kWh. Anvik was PCE eligible for 49.5% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Anvik in the amount of $55,836 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,241 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Anvik Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
79	34	11	20

Source: AEA 2023

Table 2. Anvik Fuel Consumption and CO_2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)	Fuel Efficiency (kWh/ gal. Diesel)	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO_2 produced[8] (lbs)
393,815.00	0	87.0%	10.87	360,207.00	36,214	1,618

Sources: AEA 2023

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a

[8] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 AVEC Power Generation Data

AVEC is the electric utility for eight of the communities in TCC's region, including Anvik. AVEC provides the following data[9] for Anvik:

- Diesel Generators:
    - Station 1: CAT 3304 1800, 128 kW
    - Station 2: Detroit Diesel S60K4 1200, 236 kW
    - Station 3: Detroit Diesel S60 DDEC 4, 236 kW
- Peak Load: 107 kW
- Average Load: 45 kW
- Gross Diesel: 396,636 kWh
- Fuel Oil Used: 34,771 gallons / year
- Net kWh: 379,728 kWh
- Average Gross Fuel Efficiency: 11.4 kWh / gallon

3.4 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Anvik (Constellation Energy, 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated

[9] Data are averaged over four years from 2019 - 2023

with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the GHGs gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

Constellation Energy (2024) modeled GHG emission sources and outputs for Anvik. The contribution of GHGs by fuel type to each sector's overall GHG emissions was reported. The modeling indicated the following stationary combustion sources and quantities of GHG emissions in Anvik:

- Residential Sector
  - Residual Fuel Oil No. 5 = 224.39 MT CO_2e
  - Wood and Residuals = 5.70 MT CO_2e
- Commercial Sector
  - Distillate Fuel Oil No. 1 = 66.81 MT CO_2e
  - Propane = 5.10 MT CO_2e
  - Wood and Wood Residuals = 0.19 MT CO_2e

The level of on-site combustion emissions that result in electricity generation for Anvik was modeled. The analysis indicated that approximately 339.76 MWh electricity is used in this capacity and that the resulting emissions all come from diesel (97.85 MT CO2e). Additional emissions were attributed to non-stationary sources in the transportation sector.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

3.5 GHG Reduction Targets

Anvik may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.6 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** The community should consider applying for funding for a solar array and BESS project to reduce diesel fuel consumption and GHG emissions.
2. **Weatherization of Residential and Public Structures.** The community should consider applying for funding for weatherization of residences and tribal / city buildings to reduce the use of heating oil and wood and lower GHG emissions.

3.7 Benefits Analysis

An analysis was performed under a scenario in which 20% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 333 kW PV Renewable Solar + 375 kWh BESS Scenario

Solar + BESS Sizing	CapEx ($ Mill.)	Utility Improvements ($ Mill.)	Renewable Frac.	Adj Fuel Used After Solar+BESS (Fuel Used*	Delta Fuel (gal)	Delta Fuel (liters)	Delta CO_2 (kg)	Delta CO_2 (MT)
333 kW PV; 375 kWh BESS	2.01	1.00	50%	32,018	19,918	16,296	165,324	165

Source: HOMER Pro Software

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.
Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced GHG emissions.

Anvik is 100% diesel powered due to legacy infrastructure and the high cost of diversifying from diesel generation in the region. The rural and remote communities of the Yukon Tanana region experience exceptionally high diesel fuel costs for electricity generation, which are exacerbated by the costs to transport the fuel great distances in remote Alaska. Diesel prices are also subject to high levels of variability due to unpredictable changes in the global market. This translates to high residential retail power rates, as noted above.

TCC and AVT's chief concern around Upper Tanana region's electrical infrastructure is finding methods to create affordable and reliable electricity. The high cost and price variability of diesel in these rural and remote communities discourages beneficial electrification and depresses the load base, preventing the region from finding economies of scale in electricity production or further developing the local economy. The existing older equipment is also more prone to disruptive outages.

3.8 Review of Authority to Implement

The Anvik Tribal Council (ATC) is the governing body for Anvik Village, a federally recognized tribe. The ATC has the authority to implement GHG reduction measures through resolutions passed in ATC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, DLTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Anvik to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should consider applying for funding for a solar array and BESS project to reduce diesel fuel consumption and GHG emissions.
2. **Residential Weatherization.** It is likely that the homes in Anvik have not had further weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** The wood-fired boiler that is used to heat a number of homes in Anvik has helped to offset high heating costs. Anvik should consider applying for funds for maintenance of the system and to potentially expand it to heat additional buildings.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Anvik is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed.

5 References

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Appendix A

Alaska Energy Authority’s Power Cost Equalization Program
Statistical Report for Anvik (FY2022)

Anvik PCE

Utility: ALASKA VILLAGE ELECTRIC COOP
Reporting Period: 07/01/21 to 06/30/22

Community Population	79
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	34
Community Facility Customers	11
Other Customers (Non-PCE)	20
Fiscal Year PCE Payments	**$55,836**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	120,369	Average Annual PCE Payment per Eligible Customer	$1,241
PCE Eligible kWh - Community Facility Customers	49,389	Average PCE Payment per Eligible kWh	$0.33
Total PCE Eligible kWh	169,758	Last Reported Residential Rate Charged (based on 500 kWh)	$0.61
Average Monthly PCE Eligible kWh per Residential Customer	295	Last Reported PCE Level (per kWh)	$0.36
Average Monthly PCE Eligible kWh per Community Facility Customer	374	Effective Residential Rate (per kWh)	$0.26
Average Monthly PCE Eligible Community Facility kWh per Person	52	PCE Eligible kWh vs Total kWh Sold	49.5%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	393,815	Fuel Used (Gallons)	36,214
Non-Diesel kWh Generated	0	Fuel Cost	$101,456
Purchased kWh	0	Average Price of Fuel	$2.80
Total Purchased & Generated	393,815	Fuel Cost per kWh sold	$0.30
		Annual Non-Fuel Expenses	$68,160
		Non-Fuel Expense per kWh Sold	$0.20
		Total Expense per kWh Sold	$0.49

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	134,607	Consumed vs Generated (kWh Sold vs Generated-Purchased)	87.0%
Community Facility kWh Sold	138,237	Line Loss (%)	8.5%
Other kWh Sold (Non-PCE)	69,928	Fuel Efficiency (kWh per Gallon of Diesel)	10.87
Total kWh Sold	342,772	PH Consumption as % of Generation	4.4%
Powerhouse (PH) Consumption kWh	17,435		
Total kWh Sold & PH Consumption	360,207		

Comments

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Tanana Chiefs Conference

Priority Climate Action Plan

Dot Lake Village

Dot Lake, AK

Table of Contents

List of Figures

List of Tables

List of Appendicies

Acronyms and Abbreviations

AEA	Alaska Energy Authority
ADOT&PF	Alaska Department of Transportation & Public Facilities
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power & Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
DLTC	Dot Lake Tribal Council
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt

kWh	Kilowatt Hour
LED	Light-Emitting Diode
Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
O&M	Operational Expenditures
OPEX	Operational Expenditures
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
REC	Renewable Energy Certificates
REGO	Renewable Energy Guarantees of Origin
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States
VPSO	Village Public Safety Officer
WTP	Water Treatment Plant

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Dot Lake, a rural and predominantly Alaska Native community of approximately 61 residents in Interior Alaska. It identifies sources of greenhouse gas (GHG) emissions in the community and proposes diverse strategies for reducing them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Dot Lake. GHG production levels and energy costs for Dot Lake were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy, 2024).

Based on the available data, diesel was the primary energy source of power and GHG emissions in Dot Lake in 2022 (AEA 2023). Dot Lake's 24 residential customers, 6 community facility customers, and 15 other customers required a portion of the 10,513,000 kWh of diesel-generated power and 0 kWh of non-diesel-generated power produced by the Alaska Power & Telephone Company (AP&T) facility in Tok, which also provides power to the communities of Tok, Tanacross, and Tetlin. A total of 411,333 total kWh was sold to Dot Lake customers, requiring approximately 4% of the powerhouse consumption of the 724,329 gallons of diesel fuel (28,973 gallons) at the AP&T facility. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Dot Lake accounted for approximately 648,416 lbs of CO_2 produced by the AP&T facility in FY2022.

A total of 724,329 gallons of fuel were consumed at the AP&T facility (about 28,973 gallons by Dot Lake customers) in 2022 at a cost of $2,166,028 ($2.99 per gallon; $86,630 for Dot Lake customers). The average fuel cost per kWh in Dot Lake in 2022 was $0.25. The annual non-fuel expenses associated with power generation at the AP&T facility totaled $1,890,212 in FY22, resulting in an additional cost of $0.22 per kWh sold. Thus, the combined fuel and non-fuel expenses at the AP&T facility that were required to produce power for Dot Lake were $0.47 per kWh sold in FY22. The last reported electric rate paid by customers was $0.57 per kWh. Dot Lake's electric rate is over 3.5 times the national average of $0.16 per kWh. Dot Lake was PCE eligible for 28.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Dot Lake in the amount of $34,361 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,145 (AEA 2023).

Constellation Energy (2024) emission inventory reporting for Dot Lake indicated that approximately 83.02% of GHG emissions (53.87MT) in Dot Lake come from the residential sector, with the highest amount of GHGs coming from burning fuel oil (52.80 MT) and wood (1.07 MT) in stationary locations. Alternatively, 16.98% of stationary emissions come from the commercial and industrial sectors. A negligible amount of emissions resulted from the transportation sector. Total annual electricity usage in Dot Lake was reported as approximately 411 MWh (Constellation 2024).

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information preferred options for cleaner, lower cost energy in Dot Lake are:

- Solar PV + BESS array (may reduce fuel consumption and CO_2 production by up to 20%);
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

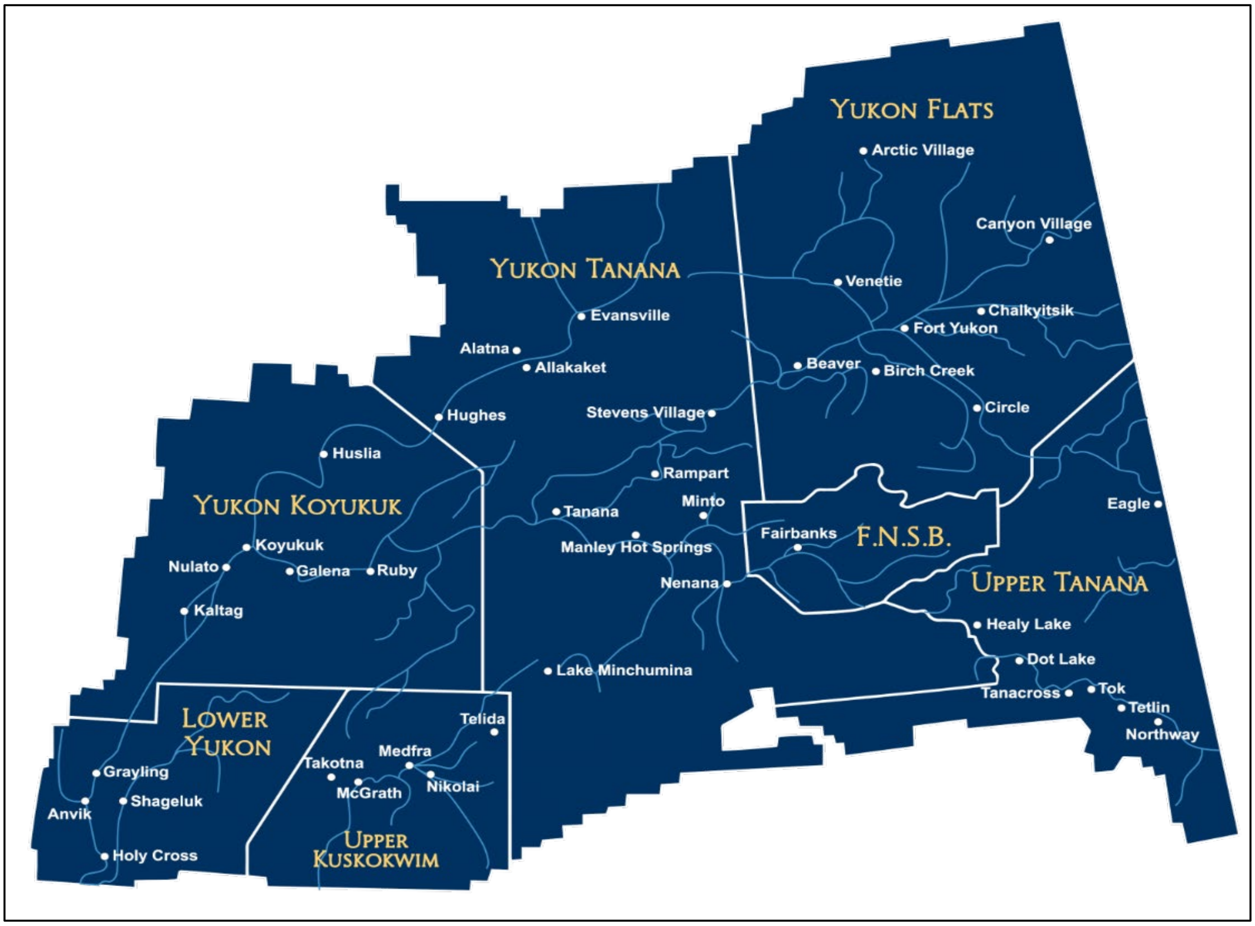
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation Energy – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Community of Dot Lake

Dot Lake is a traditional Upper Tanana Athabascan village that is home to approximately 61 residents. Dot Lake is located on the Alaska Highway, 50 miles northwest of Tok and 155 road miles southeast of Fairbanks (Figure 2). It lies south of the Tanana River. Dot Lake's power is supplied by The Alaska Power & Telephone Company (AP&T).

Dot Lake is located in the continental climatic zone, where winters are cold, and summers are warm. In winter, cool air settles in the valley, and ice fog and smoke conditions are common. The average low temperature during December, January, and February is -22 °F. The average high temperature during June, July, and August is 65 °F. Extreme temperatures ranging from a low of -75 to a high of 90 °F have been measured. Average annual precipitation is 9 inches, and annual snowfall averages 27 inches.

The U.S. EPA indicates that Dot Lake's Tribal population is below poverty level, and the U.S. Department of Transportation (DOT) classifies Dot Lake as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty. Approximately 72% of Dot Lake's Tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD).

Figure 2. Location of Dot Lake, Alaska

Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
    - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
    - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;

- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities;
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or rewiring may balance loads to conserve fuel;
- Utilizing battery energy storage systems (BESS) allows existing generators to run optimally and avoid excess / waste power generation;
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Dot Lake. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Dot Lake and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In Dot Lake’s case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community’s dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community’s airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Dot Lake’s airstrip was closed, but the area north of the Lodge where the airstrip was located may still be a suitable location for a solar array. Additionally, there are a number of other areas around the village that may be suitable.

Dot Lake's power is generated at the AP&T facility in Tok and transferred to Dot Lake via underground cables. Upgrades to the power grid would need to be made in order to incorporate solar power in Dot Lake.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in Dot Lake is estimated to be 4.3 m/s (9.6 mph) which is a Class 3 (moderate) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of only about 106 people, turbines turned by even a Class 2 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in Dot Lake and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Dot Lak because of the number of moving parts that must continue operating at very cold temperatures. Should Dot Lake decide to pursue wind energy, their next step would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power grid upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

Notably, in 2016, AP&T won a grant to build a 1.8 MW wind farm located in a Class 4 wind area that would help the communities of Tok, Tetlin, Tanacross and Dot Lake by providing a locally available source of cleaner, more affordable renewable energy. The project was estimated to offset over a quarter million gallons of diesel fuel per year, with annual carbon savings of more than 66,650 metric tons.[2]

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

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[2] https://www.power-grid.com/renewable-energy/alaska-power-telephone-wins-grant-to-build-wind-farm/#gref

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future. [3]

A 2008 case study by the Cooperative Extension Service at the University of Alaska Fairbanks (UAF 2008) focused on Dot Lake's use of a Garn wood-fired boiler with a heat exchanger that is used in conjunction with an oil-fired boiler to heat 8 homes in the community. The initial cost was less than $70,000, and operating costs are fairly low since the fuel is harvested locally. The USDA recognized this wood fired project as an example of the successful use of woody biomass energy.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittencies (e.g., periods of low light for solar energy systems, periods of low wind for wind energy systems).

In Dot Lake, the transmission lines from Tok are likely due for maintenance along with any transformers and other hardware required to maintain the power grid. Should Dot Lake explore alternative sources of electrical generation, upgrades would be needed to accommodate new projects.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating

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[3] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5299781.pdf

renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Dot Lake does not have an operating airport at this time.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.
- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Dot Lake does not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head.

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Dot Lake is two miles away from the Tanana River; however, they currently do not have plans to pursue a hydropower project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In Dot Lake, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include

insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of housing and building components in Dot Lake would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Community Survey

A community survey offered to Dot Lake in late 2023 to inform to help inform the PCAP development process was not returned.

3.2 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Dot Lake (Constellation Energy, 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and

methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

3.2.1 Stationary Combustion

The Alaska Emissions Inventory Tool estimates Direct GHG emissions from records of stationary (non-transport) combustion of fossil fuels at facilities and includes combustion within boilers, turbines, and process heating, but also incorporates end-uses like space or water heating, and appliances. The data for Dot Lake stemming from the Alaska Emissions Inventory Tool pertain to residential, commercial, community and industrial buildings and facilities:

- **83.02%** of the community's emissions come from the **residential sector.**
    - Residential Fuel Oil No. 5: 52.80 MT GHG Emissions (81.37%).
    - Wood and Wood Residuals: 1.07 MT GHG Emissions (1.65%).
- **16.98%** of the community's emissions come from the **commercial sector**.
- **A negligible amount** of the community's emissions come from the **industrial sector**.

3.2.2 Transportation

Direct GHG emissions associated with fuel combustion in owned or operated mobile sources, such as on-road vehicles (passenger vehicles, trucks,) and off-road vehicles (planes, boats) or equipment (air support, construction, etc.) were also estimated:

- **A negligible amount** of the community's emissions come from the **transportation sector**.

3.2.3 Purchased Electricity

- **A negligible amount** of the community's emissions come from **purchased electricity**.
- **The total electricity** used is **410.96 MWh.**

3.3 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Dot Lake (AEA 2023; Appendix A). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Dot Lake indicated that diesel was the primary energy source of power and GHG emissions in Dot Lake in 2022 (AEA 2023). Dot Lake's 24 residential customers, 6 community facility customers, and 15 other customers required a portion of the 10,513,000 kWh of diesel-generated power and 0 kWh of non-diesel-generated power produced by the Alaska Power & Telephone Company (AP&T) facility in Tok, which also provides power to the communities of Tok, Tanacross, and Tetlin. A total of 411,333 total kWh was sold to Dot Lake customers, requiring approximately 4% of the powerhouse consumption of the 724,329 gallons of diesel fuel (28,973 gallons) at the AP&T facility. Assuming that 22.38 lbs CO_2 were produced per gallon of diesel consumed, it can be determined that Dot Lake accounted for approximately 648,416 lbs of CO_2 produced by the AP&T facility in FY2022.

A total of 724,329 gallons of fuel were consumed at the AP&T facility (about 28,973 gallons by Dot Lake customers) in 2022 at a cost of $2,166,028 ($2.99 per gallon; $86,630 for Dot Lake customers). The average fuel cost per kWh in Dot Lake in 2022 was $0.25. The annual non-fuel expenses associated with power generation at the AP&T facility totaled $1,890,212 in FY22, resulting in an additional cost of $0.22 per kWh sold. Thus, the combined fuel and non-fuel expenses at the AP&T facility that were required to produce power for Dot Lake were $0.47 per kWh sold in FY22. The last reported electric rate paid by customers was $0.57 per kWh. Dot Lake's electric rate is over 3.5 times the national average of $0.16 per kWh. Dot Lake was PCE eligible for 28.9% of its total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Dot Lake in the amount of $34,361 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,145 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Dot Lake Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
61	24	6	15

Source: AEA 2023

Table 2. Dot Lake Fuel Consumption and CO2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ Gal. Diesel) *	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO2 produced[4] (lbs)
10,513,000	0	82.5%	14.5	411,333	28,973	648,419

Sources: AEA 2023, *AP&T for Tetlin, Tok, Tanacross and Dot Lake combined

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

[4] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

3.4 GHG Reduction Targets

Dot Lake may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 20% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Capital expenditures (CAPEX) and operational expenditures (OPEX) of the system were also modeled, along with annual generator fuel costs and operation and maintenance (O&M) costs under this scenario. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 20% Renewable Solar + BESS Scenario

PV (kW)	PV Energy Production (kW / yr)	1 kWh Li BESS (#)	Fuel Consum. (gal./yr.)	Generator Prod. (kWh)	CAPEX ($)	OPEX ($)	Annual Generator Fuel Cost ($/yr)	Annual Generator O&M Cost ($/yr)
410.3	399,701.2	464	56,494.1	809,031.7	2,520,727	337,437	171,083	39,858

Source: HOMER Pro Software

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

3.7 Review of Authority to Implement

The Dot Lake Tribal Council (DLTC) is the governing body for Dot Lake Village, a federally-recognized tribe. The DLTC has the authority to implement GHG reduction measures through resolutions passed in DLTC meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, DLTC meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Dot Lake to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should apply for funding for a 2MWe solar array project along with 3MWe BESS (top priority).
2. **Residential Weatherization.** It is likely that the homes in Dot Lake have not had further weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** The Gam wood-fired boiler that is used to heat a number of homes in Dot Lake had some initial design flaws, including buried pipes that were easily damaged. Dot Lake should consider applying for funds for maintenance and to potentially expand the number of homes this project serves.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Dot Lake is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed.

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Tetlin (FY2022)

Tetlin PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	106
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	50
Community Facility Customers	5
Other Customers (Non-PCE)	10
Fiscal Year PCE Payments	**$62,161**

PCE Statistical Data

PCE Eligible kWh - Residential Customers	147,152	Average Annual PCE Payment per Eligible Customer	$1,130
PCE Eligible kWh - Community Facility Customers	67,875	Average PCE Payment per Eligible kWh	$0.29
Total PCE Eligible kWh	215,027	Last Reported Residential Rate Charged (based on 500 kWh)	$0.57
Average Monthly PCE Eligible kWh per Residential Customer	245	Last Reported PCE Level (per kWh)	$0.37
Average Monthly PCE Eligible kWh per Community Facility Customer	1,131	Effective Residential Rate (per kWh)	$0.20
Average Monthly PCE Eligible Community Facility kWh per Person	53	PCE Eligible kWh vs Total kWh Sold	51.5%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	0	Fuel Used (Gallons)	0
Non-Diesel kWh Generated	0	Fuel Cost	$0
Purchased kWh	0	Average Price of Fuel	$0.00
Total Purchased & Generated	0	Fuel Cost per kWh sold	See Comments
		Annual Non-Fuel Expenses	$0
		Non-Fuel Expense per kWh Sold	See Comments
		Total Expense per kWh Sold	$0.00

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	195,221	Consumed vs Generated (kWh Sold vs Generated-Purchased)	See Comments
Community Facility kWh Sold	68,026	Line Loss (%)	See Comments
Other kWh Sold (Non-PCE)	154,536	Fuel Efficiency (kWh per Gallon of Diesel)	N/A
Total kWh Sold	417,783	PH Consumption as % of Generation	N/A
Powerhouse (PH) Consumption kWh	0		
Total kWh Sold & PH Consumption	417,783		

Comments

See Tok for power generation

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Priority Climate Action Plan

Telida Village

Telida, AK

Table of Contents

List of Figures

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode

Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
MT	Metric Tons
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the community of Telida, a rural and predominantly Alaska Native community in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emission in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

The PCAP identifies several Energy Focus Areas for Interior Alaska communities, and specifically for Telida. Telida's population has been recorded in the single digits multiple times since 2000; most of Telida's residents moved to Takotna and only return to Telida during the summer months. This makes evaluating GHG production levels and energy costs challenging, as there is limited information. There was no PCE report generated for Telida in FY2022, and a GHG Emission Inventory Report could not be produced for the community (Constellation Energy 2024). Still, this PCAP models reductions in generator-produced power and fuel costs in a scenario in which some of Telida's energy infrastructure would be converted to the most likely renewable system: solar photovoltaic (PV) with battery energy storage system (BESS). This may produce enough power to meet some of Telida's limited needs, primarily in summer. Finally, the PCAP recommends specific strategies for Telida to become more energy efficient with the aim of lowering both GHG emissions and operational costs in the community.

Following a review of this information, preferred options for cleaner and lower cost energy in Telida are expected to be:

- Solar PV + BESS array;
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study

It is projected that a solar PV + BESS array under an optimized design would result in reduced diesel fuel consumption, CO_2 emission, and operational costs for Telida.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to help Tribes and Territories identify sources of greenhouse gas (GHG) emissions in their communities and develop diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the main goals of:

1. Improving their understanding of current and future GHG emissions;
2. Identifying priority strategies to reducing emissions and the resulting benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

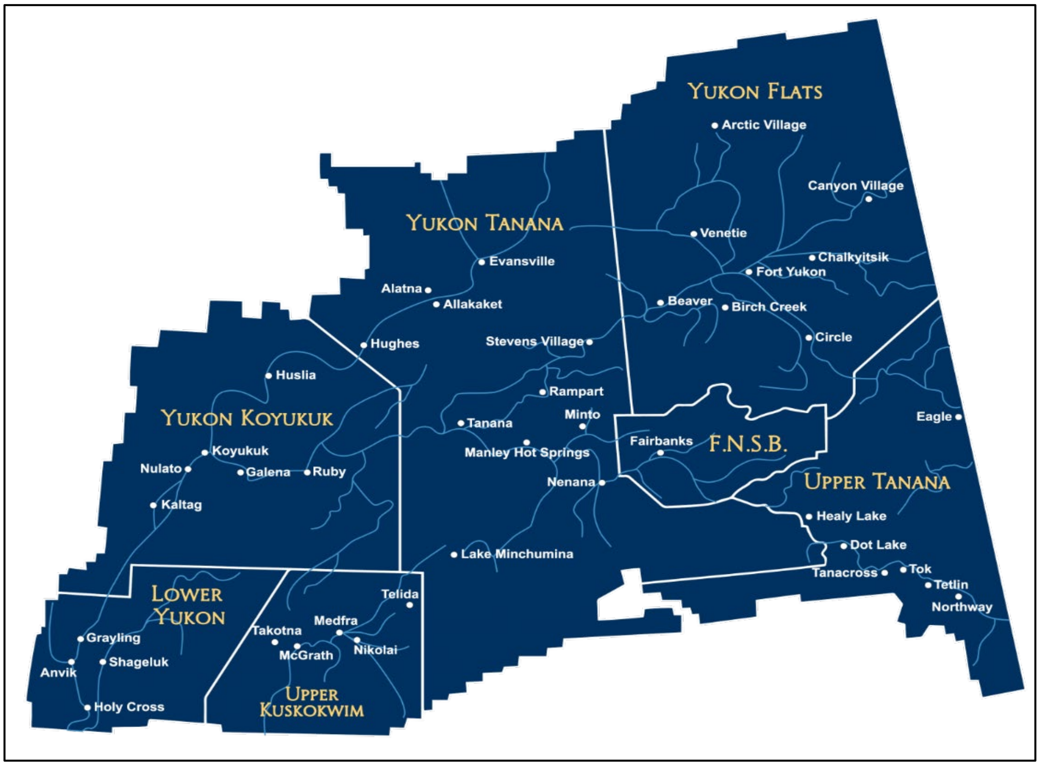
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. Its region covers an area of 235,000 square miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services healthcare, tribal development, natural resource management, public safety, community planning and transportation, and infrastructure division including energy projects.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
    - Alaska Native Tribal Health Consortium (ANTHC) – data analysis and GHG emission estimates
    - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating Power Cost Equalization (PCE), Alaska Retrofit Information System (ARIS), and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
    - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.1 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.2 Scope of this PCAP: The Community of Telida

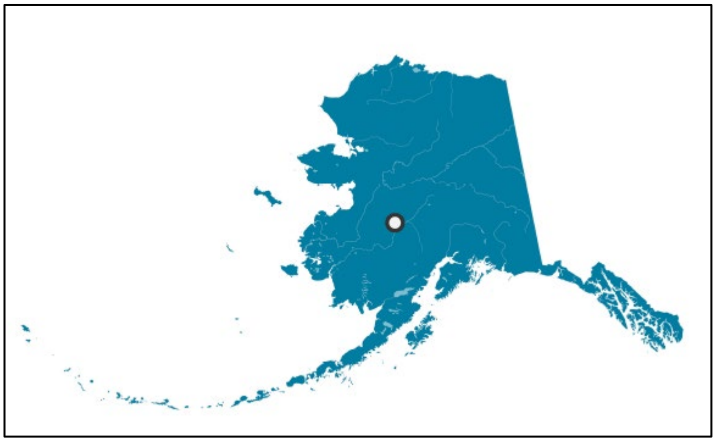
Telida, Alaska is a rural, primarily Upper Kuskokwim Athabascan village with a reported population in the single digits (3 residents in 2000 and 2010 census). Telida is located on the south side of the Swift Fork (McKinley Fork) of the Kuskokwim River, about 50 miles northeast of Medfra (Figure 2).

The area experiences a cold, continental climate with extreme temperature differences. Temperatures generally range from -60 to 0°F in winter and from 42 to 80 °F in summer. The Kuskokwim River is generally ice-free from June through October

Telida is not connected to a road system or major power grid. In 2012, Telida was awarded a grant to install three Energer brand biomass stoves to produce energy (State of Alaska DCCED 2012). This may be the only source of electricity in Telida.

Telida's tribal population is below poverty level, and Telida is classified as a Historically Disadvantaged Community, existing in an Area of Persistent Poverty[2]. Approximately 75% or more of Telida's tribal residents are classified as either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[3].

Figure 2. Telida, Alaska



Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the Tribe and the broader community, continuing communication with the Tribe as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar

[2] https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5
[3] https://www.huduser.gov/portal/icdbg2022/home.html

panels to experience differential movement, risking the success of a project (ANTHC 2024)

- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;
- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery systems allows existing generators to run optimally and avoid excess / waste power generation
- Limited or inconsistent data and non-standardized data limit decision making.

2.1 Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Telida. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term battery storage systems or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar’s appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak, which lies north of Telida and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar power. This may not be a practical goal in winter, however, because of the low light of winter and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing the heat. In Telida’s case, this could be either an electric boiler, or a small diesel boiler to inject heat into the generator coolant loop (ANTHC 2024).

Alaska presents a unique advantage for solar systems. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting, coupled with the technology's simplicity and low maintenance, positions solar power as a viable and sustainable energy source in Alaska (UAF 2022). (UAF Solar Design Manual for Alaska, Sixth Edition). Due to the potential for the presence of discontinuous permafrost in Interior Alaska, the mounting strategy for any solar installation should be carefully considered during the design process (ANTHC 2024). Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community’s dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community's airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Telida's airstrip is very close to the village so it could be a good location for a solar array.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are usually the highest. Similar to solar, capital costs can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Average wind speed in Telida is estimated to be 3 m/s (6.6 mph) which is a Class 1 (moderate) wind resource. Class 3 wind resources are considered to be excellent wind resources. Still, for a community with so few year round residents, turbines turned by even a Class 1 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

Because of the marginal wind resource in Telida, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Telida because of the number of moving parts that must continue operating at very cold temperatures. Telida's next steps in pursuing a wind project would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power plant upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.

Telida won a $25,000 grant in 2012 for the installation of three stoves that would provide direct heat, could be used for cooking, and would create electric power (State of Alaska DCCED 2012). Data gathered from the testing of these stoves was to be used to determine whether they helped reduce field consumption.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

Telida's electric grid would need to be upgraded to accommodate any new infrastructure. Since most residents do not live in Telida year-round it is likely that few upgrades and very little maintenance has occurred.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

Telida's airstrip is very near the village, but is not well maintained, and there are no structures that would require electrification.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.

- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

There are no plans to incorporate EV charging stations in Telida.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Telida is located on the bank of the Swift Fork of the Kuskokwim River, however there are no plans for a hydrokinetic project.

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive. In Telida, it is unlikely that fuel savings would result from heat recovery to justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Telida would benefit from upgrades to the weatherization of the buildings in the village. Since so few residents live in Telida year-round, it is unlikely that any significant weatherization of buildings or residences has occurred.

3 PCAP Elements

This PCAP includes the following elements:

- A GHG inventory
- GHG emissions projections and reduction targets

- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Telida Community Survey

A community survey offered to Telida in late 2023 to help inform the PCAP development process was not returned.

3.2 AEA PCE Reports

Telida's population was recorded in the single digits multiple times since 2000. Most of Telida's residents moved to Takotna and only return to Telida during the summer months. Therefore, there was no AEA PCE report generated for Telida in FY2022.

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if the community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

3.3 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool[4] was created to assess GHGs emitted from 245 communities around Alaska; however, Telida was not included (Constellation Energy 2024). The inventory tool is based off modeling informed by federal and state datasets, in addition to local data contributions where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

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[4] Alaska Emissions Inventory Map Tool - Alaska Federal Funding (akfederalfunding.org)

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed “market-based” accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings’ heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations’ buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

3.4 GHG Reduction Targets

Telida could reduce GHG emissions by pursuing funding opportunities that will pay for:

- A community solar + BESS project that would reduce CO_2 emissions.

- Maintaining the installed wood heating, cooking and electrical stoves and pursuing more of them as the need arises.
- An assessment of whether wind would be practical or lucrative;
- Funds for weatherization to retain more heat in buildings, thus producing fewer GHGs.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the Tribe or the broader community. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

1. **Community Scale Solar PV and BESS.** It is recommended that the community consider applying for funding for a solar / battery array to reduce diesel fuel consumption, generator run time, and GHG emissions.
2. **Weatherization of Residential and Public Structures.** It is recommended that the community consider applying for additional funding for weatherization of residences and tribal / city buildings to reduce fuel oil consumption, wood burning and GHG emissions.

3.6 Benefits Analysis

An analysis was performed for most TCC villages under a scenario in which a portion of a community's current energy usage would be displaced by energy from solar PVs + BESS. Unfortunately, this could not be achieved for Telida due to limited information.

3.7 Review of Authority to Implement

The Telida Council is the governing body for Telida Village, a federally recognized tribe. The Council has the authority to implement GHG reduction measures through resolutions passed in Council meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, Council meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Telida to reduce GHGs:

1. **Community Scale Solar PV and BESS.** It is recommended that Telida pursue a small-scale solar PV + BESS to provide power to the community without the need for much diesel fuel.
2. **Residential Weatherization.** It is likely that the homes in Telida have not been weatherized beyond their initial construction. Funding for updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** It is recommended that Telida assess whether a biomass project, such as wood chip boiler system, may lower heating costs using locally available fuel.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Telida is considered a moderate resource, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community should examine the condition of the current power grid as it likely has not been updated since initial installation. Future funding may be able to modernize or repair this infrastructure.

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Tanana Chiefs Conference

Priority Climate Action Plan

Villages of

Tok and Tanacross, AK

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

AEA	Alaska Energy Authority
AML	Alaska Municipal League
ANTHC	Alaska Native Tribal Health Consortium
AP&T	Alaska Power and Telephone Company
ARIS	Alaska Retrofit Information System
BESS	Battery Energy Storage System
CAPEX	Capital Expenditures
CCAP	Comprehensive Climate Action Plan
CO_2	Carbon Dioxide
CPRG	Climate Pollution Reduction Grant
CSEAP	Comprehensive Sustainable Energy Action Plan
DC	Direct Current
DOE	Department of Energy
DOT	Department of Transportation
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas Inventory
HUD	Housing and Urban Development
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode

Li	Lithium
LIDAR	Light Detection and Ranging
MET	Meteorological Tower
MPH	Miles Per Hour
O&M	Operational Expenditures
OPEX	Operational Expenditures
PCAP	Priority Climate Action Plan
PCE	Power Cost Equalization
PV	Photovoltaic
RCA	Regulatory Commission of Alaska
TCC	Tanana Chiefs Conference
UAF	University of Alaska Fairbanks
U.S.	United States
VPSO	Village Public Safety Officer
WTP	Water Treatment Plant

Executive Summary

This Priority Climate Action Plan (PCAP) is designed for the communities of Tok and Tanacross, rural and predominantly Alaska Native communities of approximately 1,304 residents (approximately 1,200 in Tok) in Interior Alaska. This PCAP identifies sources of greenhouse gas (GHG) emission in the community and proposes a diverse set of strategies for lowering them through an iterative stakeholder engagement process.

Several Energy Focus Areas were identified for Interior Alaska, and specifically, for Tok and Tanacross. GHG production levels and energy costs for Tok and Tanacross were first evaluated by reviewing data from the Alaska Energy Authority's (AEA's) Power Cost Equalization (PCE) Program Statistical Report (AEA 2023) and a GHG Emission Inventory Tool (Constellation Energy, 2024). Next, the impact of future renewable energy systems in the community was evaluated using modeled reductions in generator-produced power and fuel costs with HOMER Pro software (UL Solutions) under a scenario in which 20% of a representative community's energy infrastructure would be converted to the most likely renewable energy system: solar photovoltaic (PV) with battery energy storage system (BESS). Finally, recommendations were provided for specific strategies for Tok / Tanacross to become more energy efficient with the aim of lowering GHG emissions and operational costs for the community.

Based on the available data, diesel was the primary energy source of power and GHG emissions in Tok / Tanacross in 2022 (AEA 2023). Tok and Tanacross's 787 residential customers, 33 community facility customers, and 191 other customers required a portion of the 10,513,000 kWh of diesel-generated power and 0 kWh of non-diesel-generated power from the Alaska Power & Telephone Company (AP&T) facility in Tok which provides power to the communities of Dot Lake and Tetlin. A total of 8,671,409 total kWh sold to Tok and Tanacross customers requiring approximately 84% of the powerhouse consumption of the 724,329 gallons of diesel fuel (approximately 623,556 gallons) at the AP&T facility. Assuming that 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that Tok and Tanacross accounted for approximately 13,955,183 lbs CO_2 produced by the AP&T facility in FY2022.

A total of 724,329 gallons of fuel were consumed at the AP&T facility (about 623,556 by Tok and Tanacross customers) at a cost of $2,166,028 ($2.99 per gallon; $1,864,432.44 for Tok and Tanacross customers). The average fuel cost per kWh in Tok and Tanacross in 2022 was $0.25. The annual non-fuel expenses associated with power generation totaled $197,470 in FY22, resulting in an additional cost of $0.20 per kWh sold. The annual non-fuel expenses associated with power generation at the AP&T facility totaled $1,890,212 in FY22, resulting in an additional cost of $0.22 per kWh sold. Thus, the combined fuel and non-fuel expenses at the AP&T facility required to produce power for Tok and Tanacross was $0.47 per kWh sold in FY22. The last reported electric rate paid by customers was $0.57 per kWh. Tok's and Tanacross' electric rate is over 3.5 times the national average of $0.16 per kWh. Tok and Tanacross were PCE eligible for 36.6% of their total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Tok and

Tanacross in the amount of $918,793 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,120 (AEA 2023).

Constellation Energy (2024) emission inventory reporting for Tanacross indicated that approximately 46.61% of GHG emissions (201.12MT) in Tanacross come from the residential sector, with the highest amount of GHGs coming from burning fuel oil (105.59 MT) and wood (7.84 MT) in stationary locations. Alternatively, 50.73% of stationary emissions (218.9MT) come from the commercial and industrial sectors. Approximately 2.66**%** of the community's GHG emissions (11.49 MT) come from the transportation sector, with aviation gasoline being the only listed GHG contributor. Total annual electricity used in Tanacross equates to approximately 693 MWh. Tok estimates were not provided.

Using the Constellation Emission Inventory Tool and HOMER Pro modeling software for a representative Interior Alaska community, it was projected that a solar PV + BESS array under an optimized design would result in substantial reductions in diesel fuel consumption, CO_2 emission, and operational costs.

Following a review of this information, preferred options for cleaner and lower cost energy in Tok / Tanacross may be:

- Solar PV + BESS array (may reduce fuel consumption and CO_2 production by up to 20%);
- Weatherization of residences, tribal buildings, and commercial buildings;
- Biomass energy systems (e.g., wood chip boilers); and
- Wind energy study.

1 Introduction

1.1 Purpose of a Priority Climate Action Plan (PCAP)

The purpose of a Priority Climate Action Plan (PCAP) is to assist Tribes and Territories in identifying sources of greenhouse gas (GHG) emissions in their communities and developing diverse and appropriate strategies for reducing them through an iterative stakeholder engagement process. PCAPs are designed as narrative reports that include a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions. A targeted result of PCAP development is to inform the more detailed Comprehensive Climate Action Plan (CCAP). CCAPs are narrative reports that provide an overview of a Tribe or Territory's significant GHG sources / sinks and sectors, establish near-term and long-term GHG emission reduction goals, and identify strategies or measures that will address the highest priority sectors to achieve those goals.

PCAPs may include a GHG inventory, or list of emission sources and sinks, and the associated emissions quantified using standard methods. The PCAP's GHG inventory is a simplified version of a forthcoming comprehensive or detailed GHG inventory that will be developed in the CCAP where multiple sectors will be evaluated, including industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

The United States (U.S.) Environmental Protection Agency (EPA) has funded this PCAP development effort through a Climate Pollution Reduction Grant (CPRG)[1] with the goals of:

1. Improving the understanding of current and future GHG emissions;
2. Identifying priority strategies for reducing emissions and documenting the benefits; and
3. Engaging a variety of stakeholders in an emissions reduction planning process.

The EPA encourages Tribes to collaborate with each other and with other entities (states, municipalities, etc.), to explore opportunities to leverage other federal funds, and to prioritize durable and replicable GHG reduction measures.

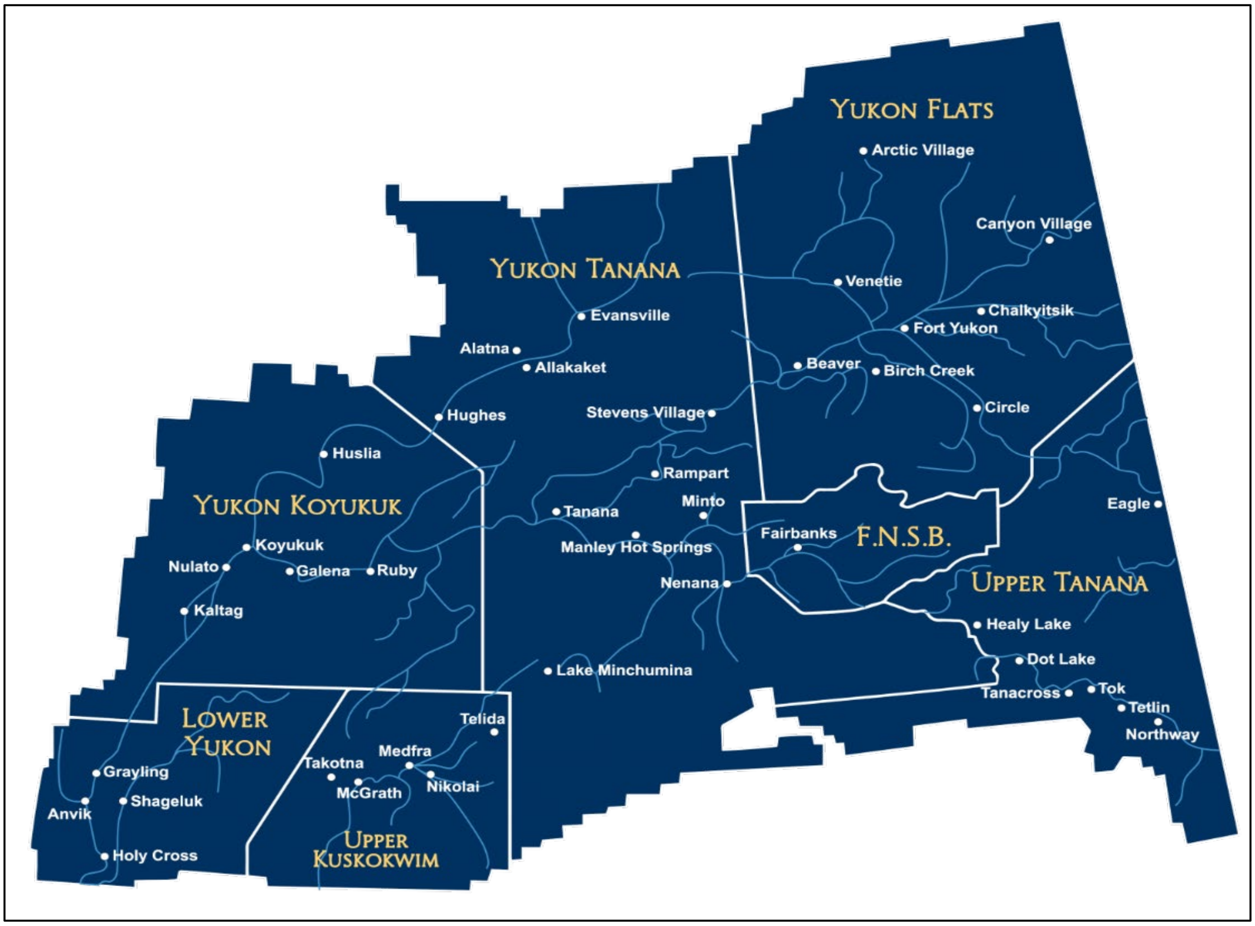
1.2 Tanana Chiefs Conference's Climate Pollution Reduction Grant

Tanana Chiefs Conference (TCC) is a tribal consortium made up of 42 members, including 37 federally recognized tribes. TCC was awarded a CPRG from the U.S. EPA to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. TCC provides a unified voice in advancing sovereign tribal governments through the promotion of physical and mental wellness, education, socioeconomic development, and culture of the Interior Alaska Native people. TCC's region covers an area of 235,000 square

[1] Climate Pollution Reduction Grants | US EPA were authorized under Sec. 60114 of the Inflation Reduction Act.

miles, which is equal to about 37% of the entire state, and just slightly smaller than the state of Texas. TCC exists as an Alaska Native non-profit corporation charged with advancing Tribal self-determination and enhancing regional Native unity. TCC works toward meeting the needs of Tribal members and beneficiaries throughout its region in areas of health and social service. TCC also administers programs and services in healthcare, tribal development, natural resource management, public safety, community planning, transportation, infrastructure and energy.

Figure 1. Tanana Chiefs Conference Communities



The awardee has devised a **CPRG Leadership Team** to administer this award and execute its initial phases. This team includes:

- Tanana Chiefs Conference (TCC) – Awardee and Grant Administrator
  - Dave Messier – Infrastructure Director
  - Jason Paskvan – Project Manager and Community Liaison
  - Eddie Dellamary – Administrative and Project Support

- TCC Cooperators
  - ANTHC – data analysis and GHG emission estimates
  - Alaska Municipal League (AML) / Constellation – Emissions modeling, incorporating PCE, ARIS, and other state data to provide reliable inventory estimates for communities, emission inventory data, other inventories, data projections.
- TCC Subcontractors
  - Axiom Environmental – PCAP Report Development, data review, and community recommendations for reducing GHGs and alternative energies.

TCC will work with EPA Region 10 Staff throughout this process, including:

- Rebecca Derr (EPA Region 10 MPH, Tribal Project Officer and CPRG Planning Officer)
- Kat Compton (EPA Region 10 Climate Coordinator)

1.3 Approach to Developing the PCAP

The CPRG Leadership Team's approach to developing this PCAP includes:

- Identifying and engaging key stakeholders;
- Understanding the GHG emissions inventory;
- Establishing GHG reduction goals;
- Identifying measures to reduce GHG emissions;
- Prioritizing and selecting GHG reduction measures; and
- Estimating potential GHG reduction measure impacts.

1.4 Scope of this PCAP: The Communities of Tok and Tanacross

Tok, Alaska is a rural, traditionally Athabascan village whose current population is primarily non-Native and is home to approximately 1,200 people. Tok is located at the junction of the Alaska Highway and Tok cut-off to the Glenn Highway 200 miles southeast of Fairbanks (Figure 2). It is called the "Gateway to Alaska" as it is the first major community upon entering Alaska 93 miles from the Canadian border.

Tanacross, Alaska is a traditional Athabascan village with a subsistence lifestyle. Tanacross is located on the south bank of the Tanana River, 12 miles northwest of Tok, at milepost 1324 of the Alaska Highway.

Tok and Tanacross experience a cold, continental climate with extreme temperature differences. Temperatures generally range from well below 0°F in winter to the lower 70s °F in summer. The lowest recorded temperature in Tok is -71°F, and the highest recorded temperature is 99°F. In Tanacross the lowest recorded temperature is -75°F with a record high of 90°F. Average annual precipitation is 11 inches, with 33 inches of snowfall.

Tok / Tanacross populations are below poverty level and exist in an Area of Persistent Poverty. Approximately 80% of Nulato's Tribal residents are classified either low or middle income by the U.S. Department of Housing and Urban Development (HUD)[2].

Figure 2. Tok / Tanacross, Alaska

Following release of this PCAP at the end of 1Q 2024, the CPRG Leadership team will next develop a CCAP in partnership with the communities, continuing communication as it moves towards decision-making around clean energy projects. The more detailed CCAP is expected to be completed around 4Q 2026.

2 Tribal Considerations for PCAPs

The evaluation of clean energy alternatives in remote, Tribal communities requires specific considerations for PCAPs, including:

- Geographic constraints
  - A high-latitude environment and the low light of winter can limit year-round efficiency of solar arrays;
  - Areas of degrading permafrost can be challenging from a geotechnical standpoint. If not addressed carefully, permafrost settlement or frost jacking could cause solar panels, wind turbines, or other infrastructure to experience differential movement, affecting maintenance costs and efficiencies;
- Placement of solar panels is important with proximity to hills or mountains, which can block sunlight in shoulder seasons;

[2] https://www.huduser.gov/portal/icdbg2022/home.html

- Interior communities may not have sufficient wind for dual alternative energy systems;
- Wood chip boilers / biofuels may be efficient systems given availability of local timber;
- For river energy, periods of low flow are common for long winters, and river debris, ice dams, and other issues makes use of mainstem rivers challenging;
- Hydrogen may not be practicable at this time;
- The remote nature of communities can make some projects cost-prohibitive and can limit timely maintenance of solar or wind systems;
- Cost-Benefit Analyses (CBAs) for alternative energy investments may rarely work favorably for small, rural communities
- Weatherization is likely to improve the efficiency of existing systems;
- Generators, switch gear, and grid components may be old or outdated, and retrofitting, refurbishing, or re-wiring may balance loads to conserve fuel;
- Utilizing battery systems allows existing generators to run optimally and avoid excess / waste power generation
- Limited or inconsistent data and non-standardized data limit decision making.

2.1Energy Focus Areas

This PCAP identifies several Energy Focus Areas for consideration with respect to Interior Alaska, and specifically, for Tok and Tanacross. These are described in detail, below.

2.1.1 Solar

Solar projects harness energy from sunlight, channeling the generated electricity into long-term BESS or directly into a utility grid. The incorporation of solar into microgrids extends the accessibility of renewable energy's financial and environmental advantages to a broader population. Solar's appeal lies in the prospect of achieving energy independence, as well as the opportunity to become an independent power producer (IPP). Communities or individuals that integrate solar panels with battery backup systems facilitate the production, storage, and utilization of their own electricity. This significantly diminishes dependence on externally generated power, contributing to a more sustainable and resilient energy system.

The University of Alaska Fairbanks (UAF) explores the integration of solar into microgrids, emphasizing its environmental and economic benefits. A microgrid controller's "diesels off" function facilitates automatic coordination between solar power, energy storage, and diesel plants, optimizing the use of solar panels or other clean energy sources. A real-world example of this is the community of Shungnak in Alaska, which lies north of Tok / Tanacross and demonstrates a reduced reliance on diesel power through the implementation of a 225-kW solar array with a 384-kWh battery system (DOE 2024). For several months in summer, the community can switch off diesel-generated power and run solely on solar. This is not an achievable goal in winter, however, because of the low light and because generators are kept warm by their own rejected heat; if they are shut off for a significant amount of time, it may create challenges for re-starting or replacing that heat. In the case of Tok / Tanacross, this could be either an electric boiler, or a diesel boiler to inject heat into the generator coolant loop.

Alaska presents a unique advantage for solar systems despite the misconception that limited sunlight diminishes their viability. While Alaska’s winter months experience reduced sunlight, northern latitudes benefit from extended daylight with prolonged sunrises and sunsets. Although the nature of solar energy in a strongly seasonal environment poses some challenges, Alaska's solar potential avoids the use of mobile or moving parts. Solar energy offers reliability, minimal environmental impact, and a steady, evenly distributed presence. The declining cost of solar energy harvesting coupled with the technology's simplicity and low maintenance positions solar power as a viable and sustainable energy source in Alaska (UAF 2022).

Due to the potential for the presence of discontinuous permafrost in Interior Alaska, mounting strategies for any solar installation should be carefully considered during the design process. Common approaches to installation involve either using an insulated, ballasted racking system that minimally disturbs the soil, or using helical piles driven into the ground past the active permafrost layer.

Solar power is considered to be one of the most viable options for rural Alaska. Solar power systems are modular and can be easily scaled to meet the specific energy demands of remote Alaska communities. Solar installations can be adapted to various scales for residential, commercial, or community applications. Solar photovoltaic (PV) systems have minimal moving parts, resulting in lower operational and maintenance costs compared to traditional power generation. Once installed, solar panels can operate with relatively little maintenance. Many remote areas in Alaska currently rely on diesel generators for power, which emit GHGs and can be expensive (AEA 2023). Solar power provides an alternative that helps to reduce a community’s dependence on fossil fuels and mitigates carbon emissions.

Solar photovoltaic (PV) technology is a proven means of electrical power production that is rapidly now being pursued in rural Alaska through federal funding to offset initial capital costs. Solar PV has been effective in charging battery storage systems in spring due to the longer days combined with increased surface albedo from snow cover on the ground.

Some northern communities have identified airports and airstrips as ideal locations for placement of solar panels because the PVs could take advantage of long, cleared upland areas that are generally south facing. However, a deterrent to this approach is that the Alaska Department of Transportation & Public Facilities (ADOT&PF) must allow construction and maintenance over the lands that it manages for aviation purposes, and the cost of authorized land use could be prohibitive without statutory changes. Additionally, if a community’s airport or airstrip is a long distance from town, the cost of connecting solar systems to existing utility lines could be prohibitive. Tok’s and Tanacross’s airstrips are both a mile from each town, so they could be decent locations for solar arrays.

Tok's and Tanacross's power is generated at the AP&T facility in Tok and transferred via underground cables. Upgrades to the power grid would need to be made in order to incorporate solar power. TCC developed a concept paper for an application for a solar array and battery storage project to be operated by AT&P. The proposed 1.5MWh Lithium Ferrous Phosphate battery energy storage portion would use a Blue Planet LX containerized system. A 1MW Solar PV generation facility would be constructed in Tanacross.

2.1.2 Wind

Wind power is a renewable energy source harnessed from the kinetic energy of air currents. Wind energy is converted to electrical power through wind turbines, which consist of small to large blades attached to a hub that spins as the wind blows. The kinetic energy from the rotating blades is converted to electrical energy by a generator, although the amount of energy generated depends on several factors, such as wind speed and direction, turbine efficiency, and the density of air. Thus, location of wind facilities is a crucial consideration for installations.

As the technology behind wind power advances, innovative turbine designs and greater efficiency are enhancing its feasibility and competitiveness. In remote Alaska communities, where access to conventional power infrastructure is limited, wind power may be a viable and sustainable solution to meet the energy needs of isolated communities. Small-scale wind turbines can sometimes be installed at strategic locations to generate electricity locally, thus reducing reliance on diesel generators and lowering overall power production costs. The intermittent nature of wind energy is typically complemented by energy storage solutions such as batteries, ensuring a consistent power supply even during periods of low wind.

Many coastal areas of Alaska are gravitating towards wind power options, but for Interior Alaska, greater certainty around wind speed, direction, and magnitude are necessary to determine whether an investment is worthwhile. While there are installations around Alaska, wind turbines come with some operational and maintenance challenges that may be more difficult to address than solar, which has no moving parts. One advantage of wind power over solar, however, is the generally greater availability of wind as a resource during winter when community loads are highest. Like solar, capital costs of wind can be high, and include design, permitting, transportation, and installation. Permitting wind projects may be a more lengthy process than solar projects due to the potential impacts to avian wildlife and impacts to visual aesthetics.

Average wind speed in the area of Tok and Tanacross is estimated to be 2.3 m/s (5.2 mph) which is a Class 2 (light) wind resource. Class 5 wind resources are considered to be excellent wind resources. Still, for a community of over 1,300 people, turbines turned by even a Class 2 wind resource may noticeably reduce the cost of electricity and lower utility bills in winter.

The high initial capital cost can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

The high initial capital can typically only be recovered in a moderate amount of time if there is a strong and reliable wind resource; however, if capital costs are offset by grants, they can be part of a community's portfolio as an IPP.

Because of the marginal wind resource in the area of Tok and Tanacross, and the higher capital cost associated with wind, further study is required before pursuing a wind project. There is also hesitancy around wind for Interior Alaska communities like Tok and Tanacross because of the number of moving parts that must continue operating at very cold temperatures. The next step for Tok and Tanacross in pursuing (a) wind project(s) would be to install a LIDAR unit at the potential wind site to measure and collect data for at least one year. A future wind project could benefit from power plant upgrades if they were previously performed to allow the integration of solar by reducing the capital cost of the wind project.

Notably, in 2016, AP&T won a grant to build a 1.8 MW wind farm located in a Class 4 wind area that would help the communities of Tok, Tetlin, Tanacross and Dot Lake by providing a locally available source of cleaner, more affordable renewable energy. The project was estimated to offset over a quarter million gallons of diesel fuel per year, with annual carbon savings of more than 66,650 metric tons.[3]

2.1.3 Biofuels and Biomass Systems

Biofuels and Biomass Systems are a category of renewable energy derived from organic materials. These fuels are produced through various processes that convert biomass, such as crops, crop residues, wood, and algae, into liquid or gaseous forms that can be used for transportation and energy generation. Biofuels are considered a sustainable energy source because the CO_2 emitted during their combustion is roughly equivalent to the amount absorbed by the plants or algae used in these systems during their growth. This creates a closed carbon cycle that doesn't contribute to a net increase in GHGs.

In Alaska, biofuels and biomass systems are gaining attention as a potential solution to address the unique energy challenges faced by this remote and expansive state. Their use in Alaska primarily focuses on energy derived from woody biomass, such as timber and forest residues, as well as organic waste materials from agricultural and forestry activities. One notable example is the potential use of wood pellets or chips for heating in residential and commercial buildings, reducing the reliance on traditional heating fuels like diesel or heating oil.

Alaska's vast forests and abundant biomass resources make it well-suited for exploring biofuel applications. Alaska has been involved in initiatives to promote sustainable bioenergy production, with a focus on utilizing local resources to enhance energy security and reduce greenhouse gas emissions.

While biofuels and biomass systems are not yet as widely adopted in Alaska as in some other regions, ongoing research and pilot projects aim to explore and develop bioenergy solutions

[3] https://www.power-grid.com/renewable-energy/alaska-power-telephone-wins-grant-to-build-wind-farm/#gref

that align with the state's commitment to sustainable and renewable energy sources. As technology advances and the economic feasibility of biofuel production improves, Alaska may increasingly incorporate biofuels into its diverse energy portfolio to address the unique challenges of its remote communities. Ethanol and biodiesel are two common types of biofuels globally, but these are unlikely to gain wide popularity in remote Alaska.

Concerns about land-use change, competition with food production, and the overall environmental impacts of biofuel production methods highlights the importance of sustainable practices and continual research to ensure that biofuels contribute positively to the country's transition to a more sustainable and low-carbon energy future.

In 2008 the Alaska Department of Natural Resources outlined a series of projects that showed how hazard mitigation a bio-energy easily coexist. The area around Tok and Tanacross is susceptible to wildfires as the vegetation consists largely of closely spaced white and black spruce. The Department of Forestry Tok area staff, US Fish and Wildlife Service Tetlin National Wildlife Refuge staff, and a local contractor worked to thin dense stands of trees that were not commercially suitable. The fire breaks created would allow for the growth of hardwoods and other vegetation that is less fire prone. Other fire break areas around homes and the school were also identified.

The wood harvested from the thinning and fire break projects were to be stored for later chipping. The biomass would be used for a proposed wood-fired (biomass) boiler system to heat the school. The biomass boiler was planned to replace the previous oil-fired boiler. AT&P ultimately shelved this project.

2.1.4 Electric Grid Capabilities and Upgrades

Electric grids can help to interface with and incorporate cleaner, renewable energy sources. Advanced grid technologies, such as smart grids, enable better management and integration of fluctuating renewable energy generation.

Upgrading and optimizing a community's transmission and distribution infrastructure enhances the efficiency of the electric grid. This reduces energy losses during electricity transport and ensures that power generated from renewable sources can be efficiently delivered to end-users, minimizing the need for additional generation capacity and associated GHG emissions. Energy storage solutions, such as batteries, may also help address renewable system intermittency (e.g. periods of low light for solar systems, periods of low wind for wind energy systems).

In Tok, upgrades to the switchgear, controllers, and transformers would be necessary to accommodate solar and wind generated energy. The current diesel system is believed to be nearing its useful life necessitating upgrades regardless of wind or solar integration.

2.1.5 Port and Airport Electrification

Port and airport electrification is a strategy aimed at reducing carbon emissions associated with major transportation centers that include airports, seaports, and terminals. The transition from traditional fossil fuel-powered systems to electric power at these centers offers several potential environmental and economic benefits. Success depends on factors such as the availability of reliable electric infrastructure, the integration of renewable energy sources, and collaboration between stakeholders including port authorities, shipping companies, and energy providers.

In remote Alaska communities, however, ports may exist only as a rudimentary dock; airports may exist only as a lighted airstrip with weather station and storage shed. Incorporating renewable energy, developing microgrids, installing charging infrastructure, and fostering community collaboration are integral components of successful electrification initiatives in such challenging environments. If power and lighting needs at airstrips and ports are minimal, solar and battery arrays may be able to provide some or all the required power supply for short term use when planes and vessels are approaching, loading / unloading, or departing.

2.1.6 EV's & Charging

Electric vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike traditional internal combustion engine vehicles that rely on gasoline or diesel, electric vehicles use electricity as their primary source of energy. Charging an electric vehicle involves replenishing the energy stored in its battery. Electric vehicle charging can occur at various locations:

- Home Charging: Most EV owners charge their vehicles at home using a residential charging station. These stations are typically Level 1 (120 volts) or Level 2 (240 volts).
- Public Charging: Public charging stations are available at various locations in the community. These stations can be Level 2 chargers or Level 3 (DC fast chargers), which provide a quicker charge.
- Fast Charging: Fast charging, often available at public charging stations, utilizes Level 3 chargers to provide a rapid charge to the EV battery.

EVs face unique challenges in remote areas of Alaska due to the state's vast geography, harsh climate, and limited infrastructure. Some of the key challenges include:

- Limited Charging Infrastructure: Remote areas in Alaska often lack an extensive charging infrastructure for electric vehicles.
- Cold Weather Impact: Alaska's extreme cold temperatures can significantly impact the performance of electric vehicle batteries. Cold weather reduces the efficiency of batteries, leading to a decrease in driving range.

- Limited Support Services: Access to specialized support services for electric vehicles, such as trained technicians and repair facilities, may be limited in remote areas.
- High Initial Cost: The upfront cost of purchasing an electric vehicle and installing home charging infrastructure can be relatively high.
- Islanding Issues: Many remote communities in Alaska operate as microgrids, generating power locally. The integration of EVs may pose challenges in managing the power flow, especially if the microgrid wasn't initially designed to accommodate the unique characteristics of electric vehicle charging. Many remote areas in Alaska have power grids designed to meet the basic needs of the local population. The introduction of multiple EVs charging simultaneously can strain the grid's capacity, potentially leading to voltage fluctuations, outages, or the need for costly grid upgrades.

Tok and Tanacross do not have plans to incorporate EV charging stations at this time.

2.1.7 Hydrokinetic

Power can be extracted from rivers by harnessing current using an in-river turbine or by harnessing elevation head with an impulse-style turbine. Impulse-style turbines have a better track record in Alaska, with several successful installations throughout the state even though this type of power generation requires significant elevation head (ANTHC 2024).

Hydrokinetic systems have moving or rotating parts, similar to wind energy systems, that require more frequent and potentially more labor-intensive maintenance than systems that do not have moving parts (e.g., solar + battery arrays, wood chip boilers). Alaskan rivers also can have a high silt content, which is extremely abrasive and can obstruct the moving components of turbines. If consistent maintenance is required, it may be challenging due to the turbine's location in the flowing waterbody.

Rivers in Interior Alaska freeze in the winter, making power generation limited to the summer and shoulder seasons, with turbines removed in winter. Even turbines mounted on the river bottom under ice would need to contend with significantly reduced winter flow rates, which limits power generation. Design, research (e.g., stream gauging), and preparatory work are required prior to construction. For these reasons, in-river hydrokinetic systems have not yet demonstrated that they can provide cost-competitive power to rate payers.

Tok is located near the Tok River and Tancross is located on the south side of the Tanana River. A large number of tributaries in the area provide potential for hydropower projects. In 2014 Tanacross Inc and the Village of Tanacross partnered with AT&P to develop a small Yerrick Creek Hydroelectric Project that was planned to supplant about 40% of the diesel fuel used in the AT&P Tok service area (Tok, Tanancross, Tetlin and Dot Lake). A federal assessment showed the project would bring electricity costs down by about 20%. [4]

2.1.8 Heat Recovery

Approximately one-third of the energy produced by diesel-fueled engines is harnessed to generate electricity, while the remaining two-thirds are dissipated as heat, either expelled through an exhaust system or rejected through the cooling radiators. A heat recovery system can reclaim a portion of the heat expelled via radiators and use it to warm nearby buildings, thereby improving generator efficiency. However, the equipment and piping required to transfer heat through these systems can be expensive.

In Tok and Tanacross, it is unlikely that fuel savings resulting from heat recovery would justify the high cost of implementing such a project.

2.1.9 Weatherization

Weatherization refers to the process of designing, preparing, or modifying buildings and their components to effectively retain heat and slow its dissipation to the outside elements by conduction or convection. Through weatherization, buildings are made more energy-efficient and weather-resistant, typically with the goal of improving comfort, reducing energy consumption, and lowering utility costs. Through weatherization programs, communities may implement a series of measures to enhance the insulation, sealing, and overall efficiency of a structure to ensure that it can better withstand external weather conditions. Weatherization measures can be applied to both residential and commercial buildings and may include insulation, air sealing, upgrading windows and doors, and optimizing heating or cooling systems.

Weatherization helps reduce GHG emissions by improving the overall energy efficiency of buildings, which, in turn, decreases energy demand from traditional fossil fuel-based power sources. By addressing energy inefficiencies in buildings through weatherization, a significant portion of GHG emissions related to energy consumption can be mitigated. This makes weatherization an essential component of broader strategies aimed at achieving energy sustainability and combating climate change.

Additional weatherization of housing and building components in Dot Lake would reduce heat loss and improve energy efficiency.

3 PCAP Elements

This PCAP includes the following elements:

[4] https://fm.kuac.org/energy-environment/2014-09-15/tanacross-native-group-village-partner-with-utility-on-tok-area-hydro-proposal

- A GHG inventory
- GHG emissions projections and reduction targets
- Quantified GHG reduction measures (priority measures)
- A benefits analysis
- A review of Authority to Implement
- Identification of other funding mechanisms

3.1 Tok and Tanacross Community Surveys

A community survey offered to Tok and Tanacross in late 2023 to inform to help inform the PCAP development process was not returned.

3.2 Greenhouse Gas (GHG) Emissions Inventory

An Alaska Emissions Inventory Tool was created to assess GHGs emitted from 245 communities around Alaska, including Tok and Tanacross (Constellation Energy, 2024). The inventory tool was developed using modeling informed by federal and state datasets in addition to local data contributions, where relevant. Many community-level inventories accessible through this tool were updated in collaboration with their relevant tribal CPRG grantees. The tool will be continually updated with additional emissions sectors and more community-level data as part of planning for the state's Comprehensive Sustainable Energy Action Plan (CSEAP).

Briefly, the methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

There are two major approaches to scope 2 emissions accounting. One uses the location of the purchased electricity consumption to approximate the greenhouse gases emitted to the atmosphere. This location factor is based on the electricity physically delivered to the organization or reporting entity. It relies on average regional grid emission factors and reflects the average emissions intensity of grids on which energy consumption occurs. The other method, termed "market-based" accounting, calculates the emissions from the electricity the reporting entity purchases through direct contracts with suppliers. This method supports and uses any relevant reporting of green energy tariffs, such as via Renewable Energy Certificates (REC) and Guarantees of Origin (REGO), etc.

Purchased heating, steam, and cooling are classified and usually purchased from a supplier in weight or BTUs, often with power generation. Steam capacity is often transferred for use in buildings, such as for cooking, but also industrial applications in turbines. If the combustion leading to the steam is conducted in equipment owned by the organization, the fuel source being used would be counted as their scope 1 emissions, similar to accounting for electricity emissions. Similarly, steam is usually purchased from a supplier in weight or BTUs, often with power (co)generation. The heat generated in such centralized locations is distributed through a system of insulated pipes for a buildings' heating requirements, such as space heating and water heating. If the biomass, fossil-fuel or renewable energy-based co-generation plant is owned by the organization, the fuel usage will be reported as their scope 1 stationary emissions.

Lastly, district cooling systems, if available, use water chilled by cooling plants (chillers or residual heat for cooling) which travels from the upstream plant to the organizations' buildings to cool the space. Fossil or renewable feedstock used in these systems, if owned by the organization, would be reported as their scope 1 emissions.

3.2.1 Stationary Combustion

The Alaska Emissions Inventory Tool estimates Direct GHG emissions from records of stationary (non-transport) combustion of fossil fuels at facilities and includes combustion within boilers, turbines, and process heating, but also incorporates end-uses like space or water heating, and appliances. The data for Tok and Tanacross stemming from the Alaska Emissions Inventory Tool pertain to residential, commercial, community and industrial buildings and facilities:

- **46.61%** of Tanacross's emissions come from the **residential sector.**
    - Residential Fuel Oil No. 5: 105.59 MT GHG Emissions (24.47%).
    - Wood and Wood Residuals: 7.84 MT GHG Emissions (1.82%).
- **50.73%** of Tanacross's emissions come from the **commercial sector.**
- **A negligible amount** of the Tanacross' emissions come from the **industrial sector.**

3.2.2 Transportation

Direct GHG emissions associated with fuel combustion in owned or operated mobile sources, such as on-road vehicles (passenger vehicles, trucks,) and off-road vehicles (planes, boats) or equipment (air support, construction, etc.).

- **2.66%** of the community's emissions come from the **transportation sector**
    - Aviation Gasoline: 11.49 MT GHG Emissions (2.66%)
    - No other transportation related emissions reported
- **On-road**
    - None reported
- **Non-Road**
    - Aircraft: 11.49 MT GHG Emissions (100%)

3.2.3 Purchased Electricity

- **20.32%** of the community's emissions come from **purchased electricity**.
  - Petroleum (diesel) Residential : 87.70 MT GHG Emissions (20.32%)
  - Petroleum (diesel) Commercial : 111.75 MT GHG Emissions (25.9%)
  - No other electricity source currently reported
- **The total electricity** used by Tok and Tanacross is **8,671,409 MWh** (AEA 2023).

3.2 AEA PCE Reports

Data from the AEA's PCE Program Statistical Report for FY2022 was reviewed to best understand the State of Alaska's assessment of financial and emissions estimates in Tok and Tanacross (AEA 2023). To assist AEA in developing this report, eligible utilities submit monthly reports to AEA that document the eligible power sold and PCE credits applied to eligible customers' bills. AEA then calculates the amount of PCE on a monthly basis, and after verifying the eligibility of customers and of community facilities, issues a subsidy payment to the utility. AEA calculates required pro-rated PCE levels based on available funds.

The Regulatory Commission of Alaska (RCA) determines the PCE level per kWh for each utility. Two categories of costs are used in determining the PCE level: a) fuel expenses: the cost of fuel, including transportation of fuel; and b) non-fuel expenses: salaries, insurance, taxes, power plant parts and supplies, interest and other reasonable costs.

The AEA PCE data for Tok and Tanacross indicated that diesel was the primary energy source of power and GHG emissions in Tok / Tanacross in 2022 (AEA 2023). Tok and Tanacross's 787 residential customers, 33 community facility customers, and 191 other customers required a portion of the 10,513,000 kWh of diesel-generated power and 0 kWh of non-diesel-generated power from the Alaska Power & Telephone Company (AP&T) facility in Tok which provides power to the communities of Dot Lake and Tetlin. A total of 8,671,409 total kWh sold to Tok and Tanacross customers requiring approximately 84% of the powerhouse consumption of the 724,329 gallons of diesel fuel (approximately 623,556 gallons) at the AP&T facility. Assuming that 22.38 lbs CO_2 are produced per gallon of diesel consumed, it can be determined that Tok and Tanacross accounted for approximately 13,955,183 lbs CO_2 produced by the AP&T facility in FY2022.

A total of 724,329 gallons of fuel were consumed at the AP&T facility (about 623,556 by Tok and Tanacross customers) at a cost of $2,166,028 ($2.99 per gallon; $1,864,432.44 for Tok and Tanacross customers). The average fuel cost per kWh in Tok and Tanacross in 2022 was $0.25. The annual non-fuel expenses associated with power generation totaled $197,470 in FY22, resulting in an additional cost of $0.20 per kWh sold. The annual non-fuel expenses associated with power generation at the AP&T facility totaled $1,890,212 in FY22, resulting in an additional cost of $0.22 per kWh sold. Thus, the combined fuel and non-fuel expenses at the AP&T facility required to produce power for Tok and Tanacross was $0.47 per kWh sold in FY22. The last reported electric rate paid by customers was $0.57 per kWh. Tok's and Tanacross's electric rate is over 3.5 times the national average of $0.16 per kWh. Tok and Tanacross were PCE eligible for 36.6% of their total kWh sold in Fiscal Year (FY) 2022 resulting in PCE payments to Tok and Tanacross in the amount of $918,793 to offset its high energy costs. The average annual subsidized PCE payment per eligible customer was $1,120 (AEA 2023). PCE data are summarized in Tables 1 and 2, below.

Table 1. Tok and Tanacross Population and Customer Base

Community Population	Residential Customers	Community Facility Customers	Other Customers (Non-PCE)
1,304	787	33	191

Source: AEA 2023

Table 2. Tok and Tanacross Fuel Consumption and CO2 Emissions

Diesel kWh Generated*	Non-Diesel kWh Generated	Efficiency (kWh Sold / Generated)*	Fuel Efficiency (kWh/ Gal. Diesel)*	Total kWh Sold + Powerhouse Consumption	Fuel Used (gal)	CO2 produced[5] (lbs)
10,513,000	0	82.5%	14.5	8,860,717	623,556	13,955,183

Source: AEA 2023 , *AP&T for Tetlin, Tok, Tanacross and Dot Lake combined

While AEA's PCE Program is critical for rural residents, one unintended consequence of it is that there is little incentive for utility-owned renewables. This is because any savings of generation costs stays with the PCE endowment fund, which pays out communities in accordance with a prescribed formula, rather than being passed on to the community itself. However, if a community owns the renewable asset and sells power to the local electric utility at a price close to the avoided cost of fuel (in essence acting as an IPP), the PCE payment is preserved and the revenue from power sales stays in the community (as noted in ANTHC 2024). This maintains the utility's costs at its current level and thus its PCE payment, thereby ensuring that economic benefits of the renewable energy system benefit the community. While revenue from power sales cannot be used to reduce electric costs directly, it can be used to reduce costs of other utilities, such as water, sewer, heating, or it can be saved for future community investment.

[5] Assumes 22.38 lbs CO_2 are produced per gallon of diesel consumed.

3.4 GHG Reduction Targets

Tok and Tanacross may pursue reduced GHG emissions through opportunities that would result in:

- A community solar + BESS project that could reduce CO_2 emissions by about 20%;
- A woodchip boiler that could heat community buildings and thereby reduce emissions;
- Weatherization to retain more heat in buildings, thus producing fewer GHGs.
- An assessment of whether wind would be practical or lucrative.

3.5 GHG Reduction Measures

Existing tribal goals and policies work towards overall GHG emissions reductions, and these can be expanded further as long as they do not have a significant financial impact to the communities. The above targets may be pursued by the community in the future, working with TCC or others. Additionally, educational programs and public outreach efforts may be developed to assist in efforts for GHG reduction.

3.6 Benefits Analysis

An analysis was performed under a scenario in which 20% of a typical TCC community's current energy usage would be displaced by energy from solar PVs + BESS. Using HOMER Pro software, TCC determined the PV power output, optimized number of BESS Lithium (Li) batteries, fuel consumption, and reduction in generator-produced power. Capital expenditures (CAPEX) and operational expenditures (OPEX) of the system were also modeled, along with annual generator fuel costs and operation and maintenance (O&M) costs under this scenario. Results are provided in Table 3, below.

Table 3. TCC Community Modeling: 20% Renewable Solar + BESS Scenario

PV (kW)	PV Energy Production (kW / yr)	1 kWh Li BESS (#)	Fuel Consum. (gal./yr.)	Generator Prod. (kWh)	CAPEX ($)	OPEX ($)	Annual Generator Fuel Cost ($/yr)	Annual Generator O&M Cost ($/yr)
410.3	399,701.2	464	56,494.1	809,031.7	2,520,727	337,437	171,083	39,858

Source: HOMER Pro Software

Results of this modeling demonstrated a benefit of reduced fuel consumption and costs in the community, coupled with reduced greenhouse gas emissions.

3.7 Review of Authority to Implement

The Tok Native Association, Tanana Inc and the Villages of Tok and Tanancross work together to govern Tok and Tanacross. The organizations have the authority to implement GHG reduction measures through resolutions passed in meetings in which a quorum is present.

Milestones achieved for reducing GHGs include community outreach, community meetings, and letters of support. A schedule of milestones may be developed to implement each reduction measure included in this report.

4 Next Steps

4.1 Identification of Other Funding Mechanisms

TCC has recommended the following projects should be pursued by Tetlin to reduce GHGs:

1. **Community Scale Solar PV and BESS.** The community should apply for funding for a 2MWe solar array project along with 3MWe BESS (top priority).
2. **Residential Weatherization.** It is likely that the homes in Dot Lake have not had further weatherization beyond their initial construction. Updated weatherization could create significant energy savings and make residents more comfortable.
3. **Biomass Project(s):** The Gam wood-fired boiler that is used to heat a number of homes in Dot Lake had some initial design flaws, including buried pipes that were easily damaged. Dot Lake should consider applying for funds for maintenance and to potentially expand the number of homes this project serves.
4. **Wind Energy Study:** A full wind energy study should be performed prior to pursuing design or capital funding for the project. Wind-powered turbines may be able to provide additional fuel savings, including during winter. However, the wind source around Dot Lake is considered marginal, and maintenance costs should be considered. A wind study is likely to require deployment of one or more meteorological monitoring stations to characterize the resource in the desired area(s). Alternatively, a LiDAR wind profile could be installed in lieu of a meteorological station to save costs on a wind study. The economics of wind projects in Interior Alaska should be included in this study to better understand operating and maintenance costs versus benefits.
5. **Other Steps:** The community should examine the condition of the current power grid as it likely has not been updated since the lines were initially installed.

5 References

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Appendix A

Alaska Energy Authority's Power Cost Equalization Program

Statistical Report for Tanacross / Tok (FY2022)

Tok; Tanacross PCE

Utility: ALASKA POWER COMPANY
Reporting Period: 07/01/21 to 06/30/22

Community Population	1,304
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	787
Community Facility Customers	33
Other Customers (Non-PCE)	191
Fiscal Year PCE Payments	**$918,793**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	2,900,574	Average Annual PCE Payment per Eligible Customer	$1,120
PCE Eligible kWh - Community Facility Customers	276,571	Average PCE Payment per Eligible kWh	$0.29
Total PCE Eligible kWh	3,177,145	Last Reported Residential Rate Charged (based on 500 kWh)	$0.57
Average Monthly PCE Eligible kWh per Residential Customer	307	Last Reported PCE Level (per kWh)	$0.37
Average Monthly PCE Eligible kWh per Community Facility Customer	698	Effective Residential Rate (per kWh)	$0.20
Average Monthly PCE Eligible Community Facility kWh per Person	18	PCE Eligible kWh vs Total kWh Sold	36.6%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	10,513,000	Fuel Used (Gallons)	724,329
Non-Diesel kWh Generated	0	Fuel Cost	$2,166,028
Purchased kWh	0	Average Price of Fuel	$2.99
Total Purchased & Generated	10,513,000	Fuel Cost per kWh sold	$0.25
		Annual Non-Fuel Expenses	$1,890,212
		Non-Fuel Expense per kWh Sold	$0.22
		Total Expense per kWh Sold	$0.47

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	4,098,899	Consumed vs Generated (kWh Sold vs Generated-Purchased)	82.5%
Community Facility kWh Sold	276,571	Line Loss (%)	15.7%
Other kWh Sold (Non-PCE)	4,295,939	Fuel Efficiency (kWh per Gallon of Diesel)	14.51
Total kWh Sold	8,671,409	PH Consumption as % of Generation	1.8%
Powerhouse (PH) Consumption kWh	189,308		
Total kWh Sold & PH Consumption	8,860,717		

Comments

Provides power to Dot Lake/Dot Lake Village & Tetlin

*The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.

Priority Climate Action Plan

Northwest Arctic Borough, Alaska

March 1, 2024

TABLE OF CONTENTS

APPENDICES

Appendix A - GHG Emissions Inventory (by community)

TABLES

FIGURES

ACRONYMS

AHFC	Alaska Housing Finance Corporation
AVEC	Alaska Village Electric Cooperative
BESS	Battery Energy Storage System
BOD	Biologic Oxygen Demand
CCAP	Comprehensive Climate Action Plan
CO2	Carbon Dioxide
CO2e	CO2 Emissions
CPRG	Climate Pollution Reduction Grant
DOE	Department of Energy
ESC	Energy Steering Committee
FO	Fuel Oil
GHG	Greenhouse Gas
GWP	Global warming potential
HO	Heating Oil
IRA	2022 Inflation Reduction Act
KEA	Kotzebue Electric Association
LIDAC	Low Income and Disadvantaged Community
NAB	Northwest Arctic Borough
NEPA	National Environmental Policy Act
NIHA	Northwest Inupiat Housing Authority
OCED	DOE Office of Clean Energy Demonstrations
PCAP	Priority Climate Action Plan
RDM	Red Dog Mine
RPSU	Rural Power System Upgrade
RurAL CAP	Rural Alaska Community Action Program, Inc.
sq mi	square miles
tpy	tons per year
USEPA	U.S. Environmental Protection Agency
VIF	Village Improvement Fund

EXECUTIVE SUMMARY

The Inflation Reduction Act of 2022 provides funding to the USEPA for the Climate Pollution Reduction Grant (CPRG) program. The Northwest Arctic Borough (NAB) received funding as a subawardee under the Tanana Chiefs Conference (TCC) for the 11 tribal communities in the borough. The NAB's funding covers the development of this Priority Climate Action Plan (PCAP) and a subsequent Comprehensive Climate Action Plan (CCAP). This PCAP includes the following elements:

- Development of a greenhouse gas (GHG) emissions inventory for the NAB.
- Development of potential reduction measures that may be implemented to reduce GHG emissions.
- Analysis of the benefits that may be realized from the adoption of the measures described above.
- Identification of funding mechanisms for the proposed measures.
- Analysis of Low Income and Disadvantaged Community (LIDAC) applicability for the borough's communities.

For the NAB, the largest source of GHG emissions is the combustion of fuels, with fuel combustion for transportation, household/building heating, and electricity generation being the three largest sources of emissions respectively. Figures ES-1 and ES-2 depict the calculated emissions from each community and from each source/categories for the borough as a whole.

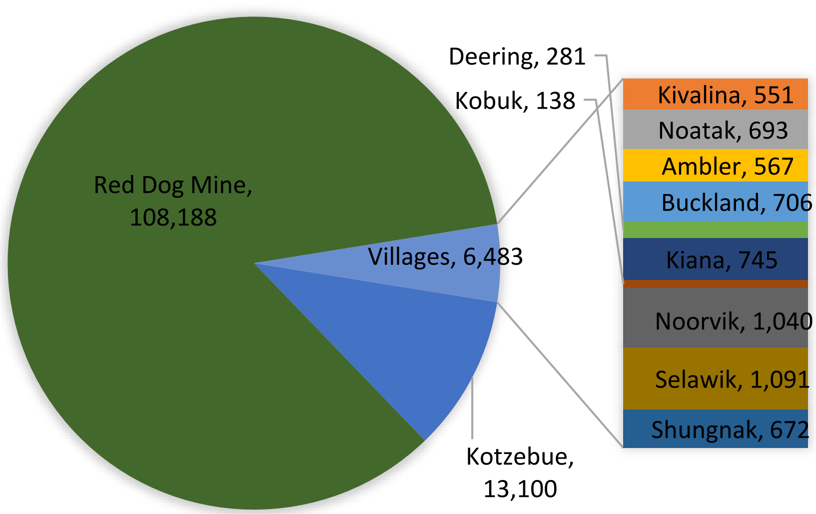


Figure ES-1. NAB GHG emissions by community

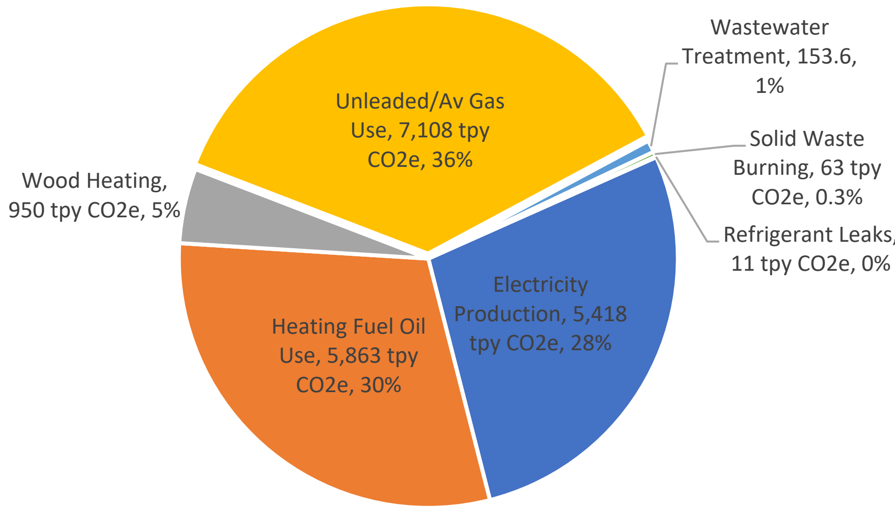


Figure ES-2. NAB GHG emissions by category (not counting Red Dog Mine)

Numerous potential GHG emission reduction measures are underway for the borough and are described in this PCAP. These measures are summarized in Table ES-1. These reduction measures are identified to help the borough meet its diesel/imported fuel reduction goals:

- Decrease imported fuel use by 10% by 2020, as compared to 2008 metrics. The NAB's Regional Energy Plan identifies this goal as "accomplished." (Deerstone Consulting 2022)
- Decrease imported fuel use by 25% by 2030.
- Decrease imported fuel use by 50% by 2050.

Achieving these goals will reduce GHG emissions while also reducing

Table ES-1. *Summary of potential GHG emission reduction measures*

GHG Reduction Measure	*Description*	*Estimated Costs*	*GHG Reduction Potential*
Solar-Battery Systems	Solar arrays coupled with battery energy storage systems in each community to minimize diesel for electrical generation	$2-3 million for each new community	Up to 1,600 tpy CO2e (full buildout of solar across borough with heat pumps)
Intertie Transmission Lines	Electrical transmission lines between communities to enable power systems to take advantage of operational efficiencies, improve reliability, and use alternative energy sources	$15-25 million for 10-15 mile lines	Up to 1,600 tpy CO2e (fully connections between all 11 communities)
Building Weatherization	Improve buildings to maximize energy efficiency	Costs depend upon specific action	Up to 1,200 tpy CO2e (if all buildings were fully weatherized)
Increased Biomass/Wood Heating	Use wood for building or household heating and for heating of community buildings or systems	$10,000-20,000 per house	Up to 900 tpy CO2e (if all potential households used wood heat)

GHG Reduction Measure	Description	Estimated Costs	GHG Reduction Potential
Increased Wind Energy	Add new wind turbines to certain communities to reduce diesel use for electrical generation	>$1 million for each new turbine	Up to 500 tpy CO2e (if additional turbines added to subject communities)
Increased Heat Pump Adoption/Use	Implement heat pumps for building heating to use excess solar power and improve building heating efficiency, replacing diesel power	$10,000-20,000 per house	See above for Solar-Battery potential
Hydroelectric Power Implementation	Implement hydropower (Cosmos Hills) to reduce diesel use in electrical generation	>$50 million for Upper Kobuk Region	Up to 500 tpy CO2e (for Upper Kobuk communities)
Energy Efficiency Projects	Implement lighting upgrades for communities and households	$50 per household $10,000 per streetlight	Less than 50 tpy CO2e
Electric Vehicles (ATVs)	Purchase electric ATVs for in-community transportation	$25,000-$50,000 per ATV	Less than 10 tpy CO2e
Water/Sanitation System Improvements	Increase energy efficiency for the water systems	>$100,000 per system	Less than 20 tpy CO2e
Tree Planting	Plant trees near communities to sequester carbon and provide source of wood for biomass heating	Uncertain price estimate	Less than 10 tpy CO2e
Local Farming/Gardening	Foster the development of community gardens to support local food production	$10,000-20,000 per community	Less than 10 tpy CO2e

Funding for the implementation of these measures will need to be developed from a variety of sources, including the grants available through the CPRG program. For example, the recent announcement of the grant from the Department of Energy (DOE) Office of Clean Energy Demonstration (OCED) for the solar-battery and heat pumps project provides a significant input of funds for sizeable GHG reductions.

Further development of the GHG inventory and the specific reduction measures/opportunities will be contained in the CCAP for the NAB, to be released in 2025.

1 INTRODUCTION AND BACKGROUND

This Priority Climate Action Plan (PCAP) is developed to comply with the requirements of the U.S. Environmental Protection Agency's (USEPA) Climate Pollution Reduction Grant (CPRG) program. The PCAP provides a plan to achieve the following objectives:

- Calculate the greenhouse gas (GHG) emissions for the Northwest Arctic Borough (NAB) and its communities (i.e., a GHG inventory).
- Provide an overview of measures that may be implemented to reduce GHG emissions.
- Provide an analysis of the benefits that may be achieved through the adoption of the measures described above.
- Outline and identify the implementation strategy for the proposed measures.
- Identification of funding mechanisms for the proposed measures.
- Analysis of Low Income and Disadvantaged Community (LIDAC) applicability for the borough.


Noatak (Photo: Beeps Luther)

Subsequent sections of this plan describe each of the above elements.

1.1 Background

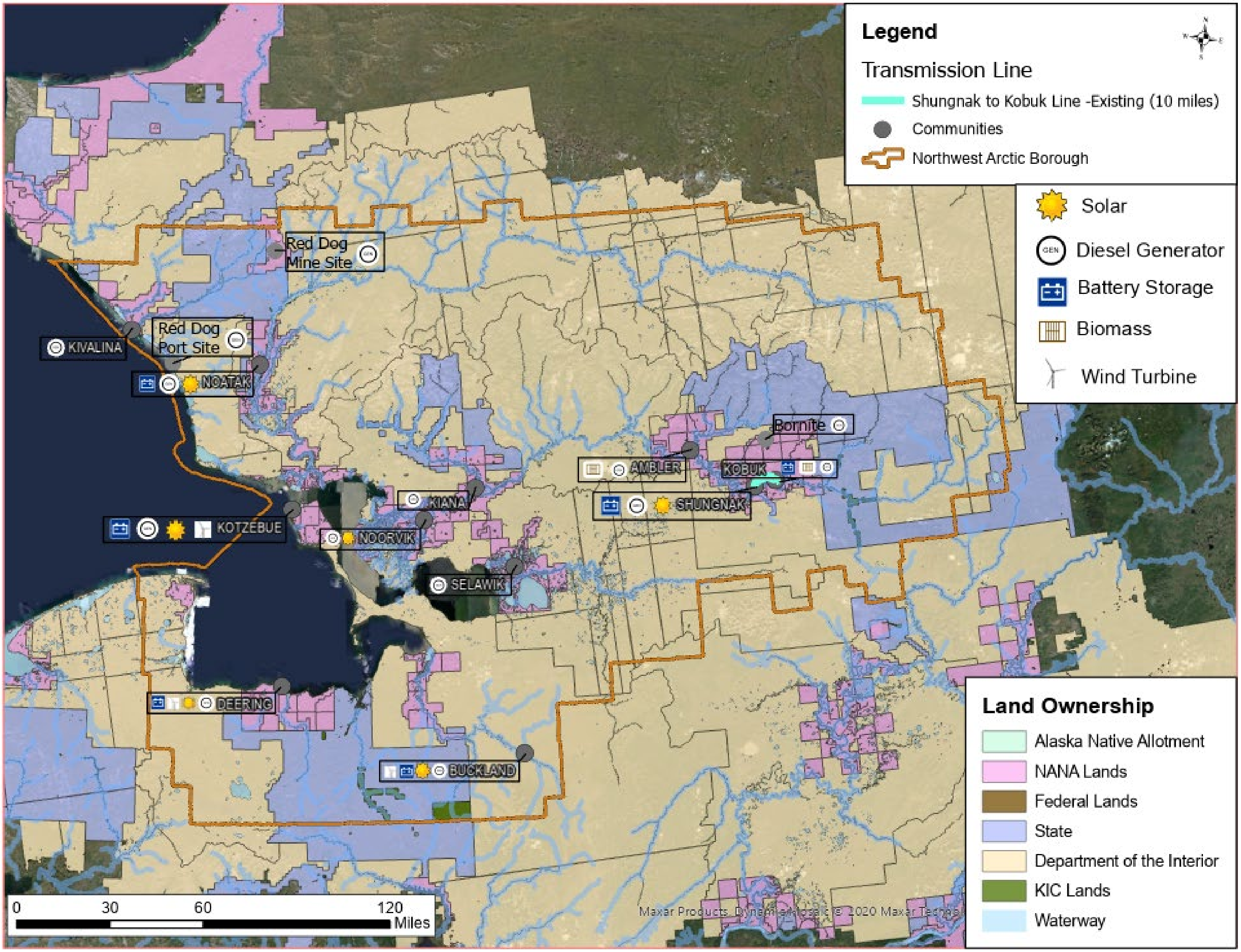
The CPRG program is an element of the 2022 Inflation Reduction Act (IRA), Section 60114 (U.S. Congress 2022). This program provides grants for the development of planning tools and subsequent implementation measures for the reduction of GHG emissions for states, municipalities, tribes, and territories.

The NAB is a subawardee for the planning grants available to tribes; the NAB's grant falls under the grant award provided to the Tanana Chiefs Conference (TCC). Under this grant, the NAB represents the 11 tribal communities within the borough: Kivalina, Kotzebue, Buckland, Deering, Selawik, Noorvik, Kiana, Noatak, Ambler, Shungnak, and Kobuk.

The NAB is the governmental jurisdiction covering northwest Alaska, spanning an area of 40,749 square miles (sq mi), or over 26,000,000 acres.

None of the communities in the borough is road-connected to the remainder of Alaska. Travel into and out of the borough is via water or air. Goods and supplies for each community are transported via seasonal barges/ships and/or air transport. Personal transportation between and within communities in the borough primarily occurs via boat, atvs, snowmachine, and airplanes. .

Figure 1. Northwest Arctic Borough Map with Land Ownership and Energy Sources



A map of the borough, depicting the locations of the 11 communities and the on-going "industrial" activities is provided as Figure 1. Industrial activities for the borough are largely those from mining operations and mineral exploration. The only industrial activity included in this PCAP and the GHG inventory are the operations from Red Dog Mine. More information on these activities is provided in Section 2.3.

1.2 Low Income and Disadvantaged Community (LIDAC) Analysis

The 11 communities in the NAB have a total population of 7,423 individuals as of 2022, with just over 40% of the borough's population residing in Kotzebue. Over 80% of the population is Alaska Native or of another minority ethnicity. Nearly all this minority population are NANA shareholders and enrolled tribal members. The median household income for the borough is $77,647, though this varies significantly between communities largely due to the significant impacts of employment opportunities available through Red Dog Mine.

Table 1 provides socioeconomic metrics for the borough. The NAB comprises a single census district, covering the full borough.

Table 1. Key socioeconomic metrics for the NAB.

Community	*Tribal Community?*	*Population (1)*	*Number of Households (1)*	*Median Household Income (1)*	*Unemployment Rate (1)*
Kivalina	Y	769	144	$68,750	22.5%
Kotzebue	Y	3,088	852	$101,071	5.7%
Deering	Y	189	45	$49,375	23.2%
Buckland	Y	644	133	$53,819	27.1%
Selawik	Y	557	120	$52,917	33.1%
Noatak	Y	536	102	$67,500	35.5%
Kiana	Y	422	90	$62,727	28.9%
Noorvik	Y	654	120	$56,563	33.7%
Ambler	Y	277	86	$37,857	21.6%
Shungnak	Y	244	73	$68,750	21.8%
Kobuk	Y	133	52	$36,250	6.1%
TOTAL		7,513	1,817		

Notes: (1) Source is U.S. Census Bureau (http://data.census.gov)

According to the definitions provided for the CPRG program, the entirety of the borough is considered as a LIDAC, given that each community also includes tribal governments. Additionally, as noted above, tribal membership in most communities exceeds 80% of the local population.

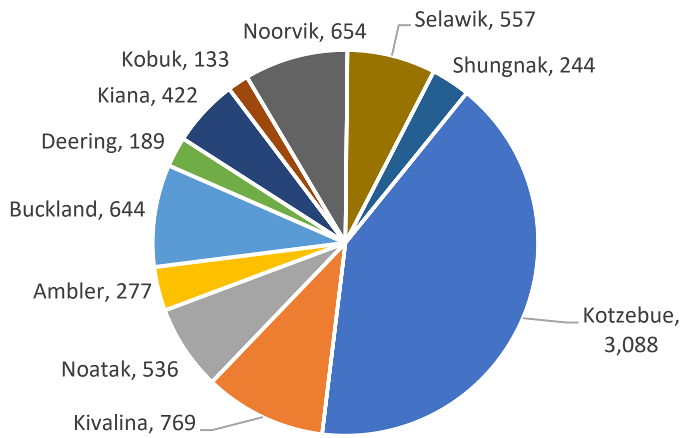


Figure 2. NAB community populations.

2 GHG INVENTORY

Greenhouse gas emissions from the tribal communities in the NAB are largely those originating from the combustion of fuel for electrical production, heating, and transportation. The remote nature of the borough limits the inbound sources of these fuels: each community contains one or more bulk tank farms that store and dispense fuel for these purposes. Other sources of GHG emissions are identified in Table 2.

Table 2. Sources of GHG Emissions

GHG Contribution Rank	*Emission Source*	*Sub-Category*	*Notes*
1	Transportation	Diesel, gasoline, aviation fuel combustion	• *Intra-Community:* Cars, trucks, ATVs, boats, snowmachines • *Inter-Community:* Boats, ATVs, snowmachines, planes
2	Heating	– Heating oil combustion – Wood combustion	Fuel combustion is captured in bulk farm throughputs
3	Electrical Generation	Diesel combustion	Fuel is stored in bulk tank farms in each community
4	Wastewater Treatment	Carbon dioxide emissions	Aerobic biologic activity for sewage treatment (lagoons)
5	Refrigerant Use	Small Appliance Leakage	Appliance disposal is not tracked
6	Solid Waste Disposal	Waste burning	Landfills are not capped; significant volume of waste is burned

The largest source of GHG emissions for the borough is from Red Dog Mine, roughly 85 miles northeast of Kotzebue. The mine is one of the largest zinc and lead producers in the world, annually producing over 500,000 and 100,000 tons of each metal (in concentrates) respectively. As a remote operation, Red Dog Mine has more than 18 million gallons of diesel storage and uses more than 19 million gallons annually for both electrical generation and transportation purposes. Red Dog's GHG emissions from the mine operations are reported under the USEPA's Greenhouse Gas Reporting Program (GHGRP), as required through 40 CFR 98.

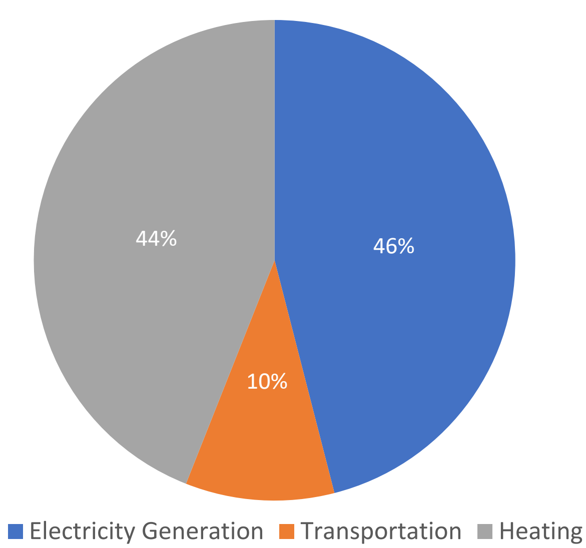


Figure 3. Diesel fuel use in the NAB, 2021.

2.1 GHG Emission Categories/Sources

As noted in Table 2, transportation is the largest GHG source. This is largely due to the use of jet fuel/aviation fuel for transportation throughout the borough. The use of unleaded fuel is also a large contributor to GHG emissions.

The second largest source of GHG emissions across the borough are the emissions from the use of diesel or heating oil (arctic grade/heating oil #1) for residential and commercial building heat. The production of electricity through the diesel electric generators in each community's power plants is the third largest source of GHG emissions. Four electrical utilities serve the Borough's 11 communities:

- Alaska Village Electric Cooperative (AVEC)
- Kotzebue Electric Association (KEA)
- City of Buckland
- Ipnatchiaq Electric Company (Deering)

Fuel for each of these utilities is generally provided through bulk tanks owned/operated by the utilities. The NAB's Regional Energy Plan from 2022 identifies that over 46% of the diesel fuel used in the borough is for electrical generation; Figure 3 summarizes the NAB's diesel and unleaded usage.

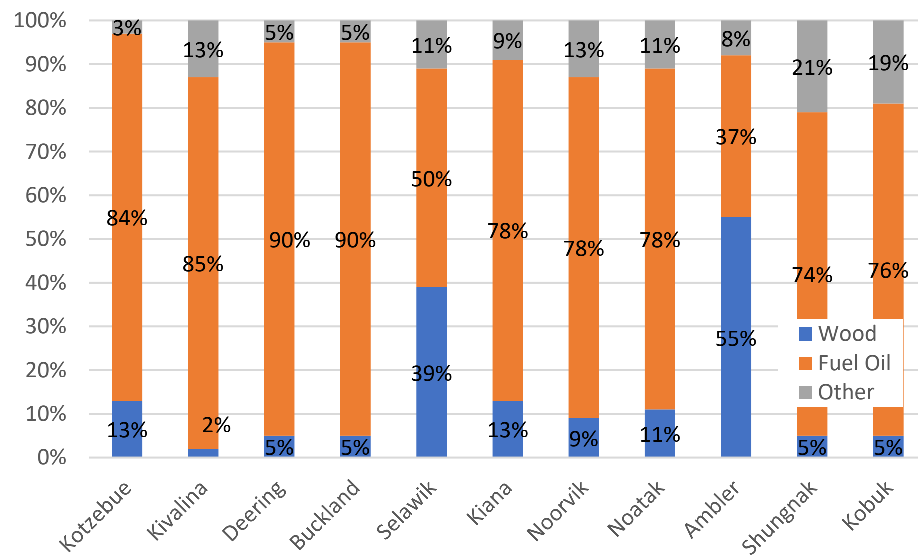


Figure 4. Summary of home heating fuels by community, 2022

NANA performed a home heating survey in 2022 that identified the primary sources of heating for borough residents (McKinley Research Group, 2022). This survey identified the breakdown of heating sources by community in the borough, which varies widely due to the availability and pricing of fuel. Figure 4 provides a summary of these sources by community.

Emissions from wood burning and fuel oil are calculated using common conversion factors. For wood, it is conservatively assumed that 6 cords of wood are used per house per year, with the wood consisting of a mix of spruce and birch. Other fuels are a mix of electric and other fuels (such as propane). This GHG inventory currently does not include the emissions from these other fuels, as consumption information is not readily available for the borough.

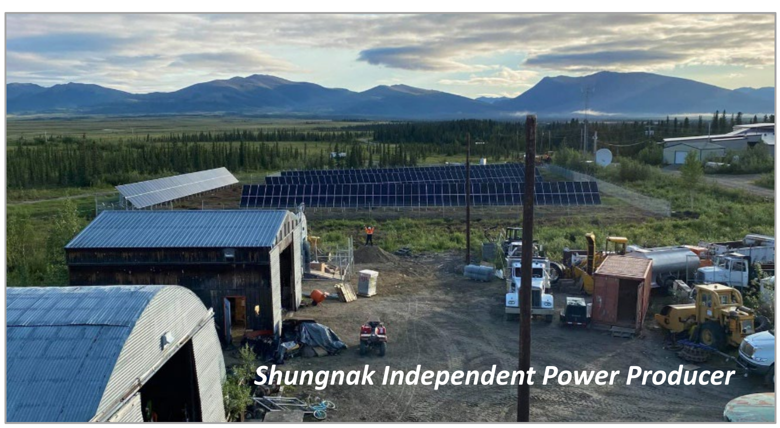
Transportation fuel use across the borough is largely for transportation within each community, including cars, ATVs, and snowmachines. Additional fuel is used by aircraft within the borough and by boats. Much of this fuel use is captured through the fuel throughput in the Crowley bulk tanks in Kotzebue. Some additional fuel is used in the borough through both boats and aircraft that transit into and out of the borough. This includes regular flights to/from Kotzebue and Red Dog Mine from Anchorage and Fairbanks. Emissions from travel into/out of the borough are not included in this PCAP (most of these aircraft would likely not be fueled in the borough).

Shipping vessels also visit Kotzebue and Red Dog Mine throughout the summer shipping season. The emissions from these vessels are not currently included in the inventory as information is limited on their fuel use and actual time spent within the vicinity of the borough. These vessels also generally do not take on fuel in the borough.

Outside of fuel burned in the above categories, other sources of GHG emissions in the borough include the following:

- *Wastewater treatment emissions.* Many of the communities use lagoons for managing and treating sewage flows. The aerobic microbiologic activity in typical lagoons is a source of CO2 emissions. Estimates for these emissions are from typical residential sewage strengths (biologic oxygen demand, BOD) and average flow rates for each community.
- *Solid waste burning*. A portion of the solid waste generated across the borough is burned either in home burn barrels or in larger burns performed at the community landfill. A conservative estimate is that roughly 10% of the solid waste generated (estimated at 2 – 2.5 lb/person/day) is burned. As a result, solid waste burning is therefore 0.2 lb/person/day. Emissions are calculated using the 40 CFR 98 emission factors.
- *Refrigerant leaks.* The leaking of fluorocarbon refrigerants is a source of GHG emissions, especially when the high global warming potential (GWP) of the refrigerant is accounted for. The two most common appliance refrigerants in use across the U.S. are R-134a and R-410a. Most appliances contain up to 0.5 lbs of refrigerant. As a conservative assumption it can be estimated that each household in a community contains 0.1 lbs of refrigerant and that 5% of that amount is released to the atmosphere via leaks each year. An average global warming potential (GWP) is applied to these emissions (1,759): the GWP for R-410a is 2,088 and for R-134a is 1,430 (National Refrigerants 2018).

Full details on the specific calculation methods and data sources used for this GHG emission inventory are provided in the NAB CPRG Program Quality Assurance Project Plan (QAPP) (Kuna 2024).



Shungnak Independent Power Producer

2.2 GHG Emissions Summary

The estimated total GHG emissions, commonly expressed as tons of carbon dioxide equivalents (CO2e) for the NAB is 19,583 tons per year (tpy). Table 3 provides the summary of these emissions by community and by source. Figure 5 depicts the total GHG emissions (as tpy CO2e) for each source category in the borough. In general, the level of GHG emissions roughly follows the populations in each community, though some communities, such as Buckland and Deering, have lower levels of GHG emissions than their corresponding population levels. This is likely attributed to their reduced fuel uses as a result of implemented alternative energy measures (these are described in subsequent sections of this plan). Kotzebue's emissions also include those from aviation/jet fuel use, which are technically distributed across the borough geographically, but attributed to Kotzebue due to the bulk tanks for these fuels in the community.

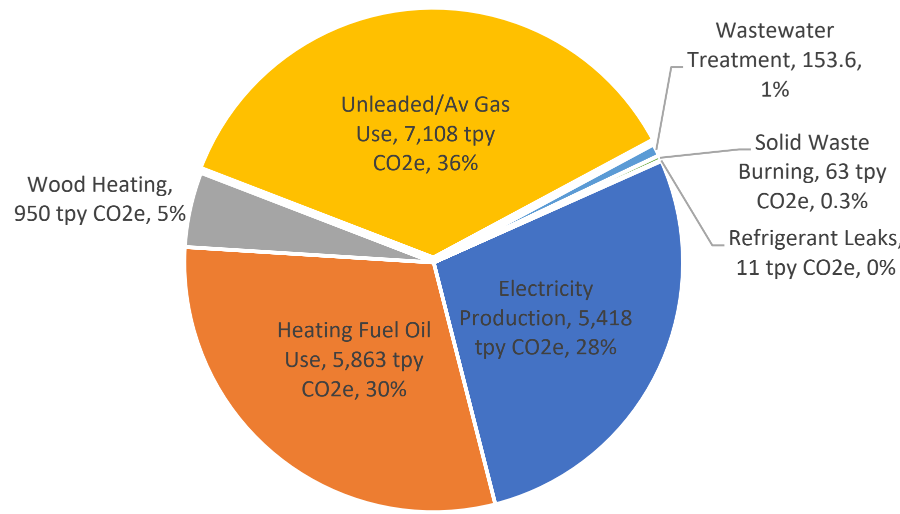


Figure 5. NAB GHG emissions by category.

Table 3. NAB GHG emissions summary.

		Total CO2e Emissions (tons/year)				
Community	***Total CO2e Emissions (tons/year)***	**Fuel Use**	**Wood Heating**	**Solid Waste Burning**	**Wastewater Treatment**	**Refrigerant Leaks**
Kotzebue	13,100	12,623	404	26	42.5	4.8
Kivalina	569	532.1	7.8	6.5	3.8	0.6
Noatak	722	659.9	5.5	4.5	21.9	1.0
Ambler	597	399.8	153	2.3	11.0	1.0
Buckland	725	658.8	17.2	5.4	21.9	0.6
Deering	289	266.0	6.3	1.6	6.6	0.3
Kiana	762	677.2	41.6	3.6	21.9	0.6
Kobuk	145	130.0	6.2	1.1	0.7	0.2
Noorvik	1,060	1,000.2	33.1	5.5	0.3	0.7
Selawik	1,112	925.9	148	4.7	12	0.7
Shungnak	681	530.3	128	2.1	11.0	0.3
Borough Total	**19,900**	**18,403**		**63.3**	**153.6**	**11.0**
Red Dog Mine	108,188	107,898		290.1		

Note: Totals may not match sums of the communities due to rounding.

Figure 7. NAB GHG Emissions (tpy CO2e), by community and industry.

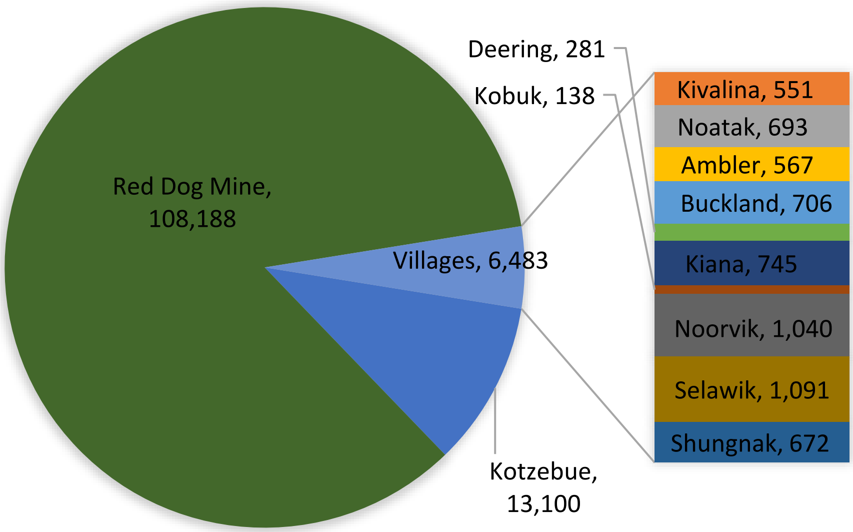
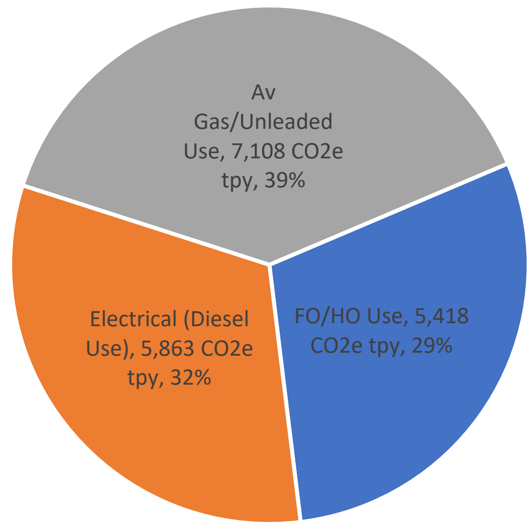


Figure 7. NAB GHG emissions (tpy CO2e) summary for liauid fuels



2.3 Industrial Sources of GHG Emissions

Table 3 identifies the estimated GHG emissions from each community in the NAB, alongside the emissions reported by the largest industrial source in the borough, Red Dog Mine (RDM). As shown, the emissions from RDM are more than five times those of the rest of the borough combined. It is important to note that the RDM emissions only represent those emissions reported according to 40 CFR 98, and do not include emissions from mobile sources or emissions from the port operations. If those additional sources were included, the RDM GHG emissions would be significantly higher. RDM is currently pursuing several opportunities for GHG reduction; these may be further described in the NAB's Comprehensive Climate Action Plan (CCAP).

3 IMPLEMENTATION AND GHG REDUCTION MEASURES

The use of fuel in the 3 primary categories (transportation, heating, and electrical production) are the largest sources of GHG emissions for the borough. While opportunities for reducing fuel use for transportation may be difficult to implement, especially given the prevalence of aviation requirements in the borough, the use of fuel for heating (via fuel oil (FO) or heating oil (HO)) and the use of diesel for electricity production do present opportunities for reducing GHG emissions from these categories.

The Northwest Arctic Regional Energy Plan, updated in 2022, provided goals for the reduction of fuel use across the borough and its communities. These goals are as follows:

- Decrease imported fuel use by 10% by 2020, as compared to 2008 metrics. The plan notes this goal as "accomplished."
- Decrease imported fuel use by 25% by 2030.
- Decrease imported fuel use by 50% by 2050.

Achieving these latter two goals will result in significant GHG reductions, while also achieving benefits such as reduced economic outflows (fuel expenditures), improved local air quality, reduced fuel spill potentials, increased reliance upon local energy sources that improve economic development opportunities, and increased opportunities for local workforce development. Fuel cost fluctuations generally reduce the opportunity for economic development given these high costs.

The borough has an established Energy Steering Committee (ESC) that meets twice per year to review and discuss the on-going energy related goals and projects. The ESC is supporting the continued development of measures to meet the goals identified above. Some of these measures are identified in the table below; these measures are also largely taken from the Regional Energy Plan. Each of the measures is further described in the following subsections. A more detailed accounting of the benefits that may be recognized through each of the measures below is described in the subsequent section of this plan.

Table 4. Potential GHG Reduction Measures

Category	*Measure*	*Status*
Fuel Use Reduction	Implement/increase solar for electrical production, coupled with battery energy storage systems (BESS)	• Shungnak system completed in 2022. • Ambler system to be implemented 2024-2025. • Funding necessary for additional systems and expansion of existing systems.
Fuel Use Reduction	Implement intertie transmission lines between communities	• Kobuk-Shungnak intertie completed in 1994; needs replaced. • No current connections between other communities.
Fuel Use Reduction	Increase building energy efficiency (building weatherization)	Some on-going measures and projects across the borough.
Fuel Use Reduction	Support adoption of residential sized heat pumps borough-wide	NAB/NANA applied for DOE OCED grant funding to implement across the borough; successful grant announced late Feb-2024.
Fuel Use Reduction	Increase use of wind turbines	• Some turbines are effective in select locations; these require regular maintenance • Some opportunities exist for adding to existing systems that are functioning effectively
Fuel Use Reduction	Improved community sanitation systems	Upgrades to community wastewater systems are planned; these will reduce energy use and reduce non-compliant discharges
Fuel Use Reduction	New/renovated housing	Build new housing units and renovate existing housing to improve overall energy efficiency
Fuel Use Reduction	Further implement biomass systems for home heating	• Existing community systems in-place in Kobuk (water system) and Ambler (City building and washeteria) • Develop additional local support and opportunities for harvesting wood to use for home heating • Implement biomass boilers for additional community buildings in other appropriate locations
Energy Efficiency	Implement community projects to improve energy efficiency	• Implement LED lighting across each community • Implement upgrades to water treatment and wastewater treatment facilities to improve energy efficiency
Fuel Use Reduction	Hydroelectric implementation	Implement hydroelectric project(s) to replace diesel fuel use
Fuel Use Reduction	Implement electrified ATVs	Implement electric ATVs for travel within the communities
GHG Sequestration (Tree Planting)	Grow trees for carbon neutral heating and carbon sequestration	Develop local forestry opportunities
Waste Disposal	Appliance backhaul/disposal	Remove appliances with potential refrigerant leaks
Local Gardening	Develop community gardens	Reduce food imports and improve sustainability

3.1 Implementation Details

The implementation of the potential GHG reduction measures described in this section will require appropriate planning and support. The following table provides a high-level summary of how each measure may be implemented.

Table 5. Potential GHG Reduction Measures Implementation Details

Measure	*Specific Opportunities [Estimated Costs]*	*Timing/Schedule*	*Responsible Agency/Entity*
Increased Solar-BESS	• Implement in additional communities (Ambler, Selawik, Kiana, Noorvik, Kivalina) [$2-3 million per community] • Increase sizes of existing systems (Deering, Buckland, Kotzebue, Noatak) [$1-3 million per community, pending size]	• DOE OCED grant will support additional communities, 2024 – 2029 • System design (per community) and implementation takes 3-4 years pending funding availability	Northwest Arctic Borough or Tribal Independent Power Producer (IPP)
Electrical Transmission Interties	• Kobuk-Shungnak line needs replaced; funding included in recent OCED grant award [$10 million estimate] • Potential Ambler-Shungnak line provides next best opportunity [$20 million estimate] • Other feasible lines include Noorvik-Kiana and/or Noorvik-Selawik [$15-25 million estimate]	• Implementation timeframe for Kobuk-Shungnak replacement is 2-3 years • Ambler-Shungnak timeframe is 3-4 years (Right-of-Way [ROW] is currently in-place) • Other lines are 4+ years	AVEC or NAB is likely owner of the transmission lines
Building Weatherization	Upgrade/weatherize buildings across the borough [individual projects can be in the thousands; larger/grouped projects can be significantly more]	1 – 5 years pending available funding and grants/financing opportunities	NAB or NANA to administer AHFC or other grant/ financing opportunities
Heat Pump Implementation	Provide heat pumps to individual residences across the borough [$10,000-20,000 per household estimated[	DOE OCED grant provides initial funding to support; roughly 1 year per household	NAB to oversee funding for across borough residences
Increase Wind Use	Add capacity to Kotzebue, Deering, and/or Buckland [widely varying estimated costs]	Timeframe is approximately 5 years pending available funding	Existing utilities to oversee projects
Sanitation System Upgrades	Modify/improve existing water or sewage systems, upgrading heat transfer systems from powerplants and replacing pumps/blowers with more efficient models [widely varying cost estimates]	Typical upgrades take approximately 3 years minimum to implement	ANTHC to oversee most projects
Housing Upgrades or Replacements	Renovate and/or replace housing in many communities [widely varying cost estimates] to improve energy efficiency	Typical new housing or large renovation projects take at least 3 years to implement	Northwest Inupiaq Housing Authority (NIHA) to oversee most housing projects

Measure	*Specific Opportunities [Estimated Costs]*	*Timing/Schedule*	*Responsible Agency/Entity*
Biomass Implementation (Community and/or Residential)	• Add biomass heating capability to Ambler water system [<$1 million] • Add biomass heating for Kobuk city buildings [<$1 million] • Add biomass heating for various facilities in Noatak [$500k - $2 million] • Provide biomass heating to Shungnak (various buildings/systems) [$500k - $2 million] • Provide grant or financing opportunities for more residential wood stoves in Kobuk, Ambler, Shungnak, or Noatak [$10,000 - $20,000 per house]	Most projects will take at least 2 years to implement, pending available funding	NAB in combination with Tribes and/or Cities
Community Energy Efficiency Projects	• LED light bulb distribution [$50 per household estimated] • LED streetlight implementation [$10,000 per light]	• Residential LED distribution: 1 year to implement • Community LED streetlights: 1-2 years to implement	NAB and individual City Councils
Hydropower Implementation	Implement Upper Cosmos Hills hydropower opportunity [$>50 million]	>5 years to implement	NAB or AVEC
Electric ATVs	Replace tribal/city ATVs with electric models [$10,000 – 50,000 per model]	1-2 years to implement	Each tribal council
GHG Sequestration (Tree Farming)	Grow trees to support increased wood use for heating or for general carbon sequestration; only generally applicable in Ambler, Kobuk, Shungnak, and Noatak [varying price estimate]	>10 years to implement	Each tribal council
Appliance Backhaul/ Disposal	Implement program in each community to subsidize the proper backhaul/disposal of refrigeration appliances [$1,000 estimated cost for backhaul of each appliance]	1-3 years to implement; perform on every 3- or 5-year cycle in each community	NAB supported program
Local Gardening Support	Provide support for establishing community gardens and local food production ($10,000-20,000 per community)	On-going annual support would be necessary	NAB or Maniilaq

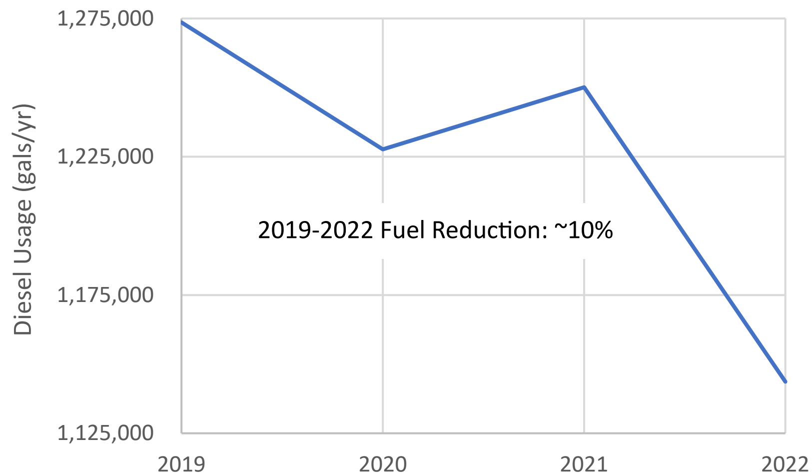
3.2 Solar and Battery Energy Systems

The recent improvements and cost reductions in solar panels and lithium ion batteries present opportunities to implement these technologies in microgrid communities such as those in the NAB. Four communities in the borough (Noatak, Shungnak, Deering, and Buckland) have recently implemented variations of these systems to reduce the community's reliance upon imported diesel. Designs are complete for an additional four communities (Ambler, Noorvik, Selawik, and Kiana). Lessons learned from the implementation for each of these communities are being applied to subsequent communities. Many of these improvements are described in the Regional Energy Plan. Implementation or increasing the sizes of these systems in the NAB communities will help achieve the diesel displacement goals as outlined above, reduce GHG emissions, and decrease power costs for the community. A more detailed description of these measures' benefits is provided in the following section of this plan. Importantly, it is recognized that implementing new or additional solar and battery systems requires modifications to the existing utility grid to fully recognize the technology's potential. A recent grant announcement from the Department of Energy (DOE), Office of Clean Energy Demonstrations (OCED) provides for the full buildout of solar in the borough, including upsizing of some of the existing systems.

Shungnak Solar Array

As the largest utility in the region, Kotzebue Electric Association (KEA) continues to increase its use of solar energy, while also installing larger battery systems. These systems are also augmenting the installed wind turbines. Combined, the utility documents savings of nearly 100,000 gallons of diesel over the past few years (2019 – 2022) from the wind/solar/battery systems.

Figure 8. KEA diesel usage, 2019 – 2022.



3.3 Intertie Transmission Lines

Each of the communities in the NAB currently operates its electrical systems as small microgrids (with the exception of Shungnak-Kobuk, that have an existing intertie). The operations of microgrids with significant load variations and limited operational efficiencies presents opportunities to reduce GHG emissions through interties between communities that improve efficiency, reliability, and other factors. The existing intertie between Shungnak and Kobuk provides a good example of the benefits that can be gained. Although this 10.5-mile transmission line is now 30 years old, it continues to provide the primary


Deering power lines

power for Kobuk. This enables the recently implemented Shungnak solar-battery system to share power to Kobuk and to minimize the operational requirements for the Kobuk power plant. In fact, Kobuk reports minimal diesel use in 2022 for their power plant (AEA 2022). Sharing and increasing the load on the electrical generators in the region will improve the efficiency of these engines; a typical diesel generator operates at maximum efficiency when it is running at levels above 70 – 80% (Powerguard 2023).

Development of inter-community transmission lines will require coordination between the large landholders in the region, including various federal agencies and NANA. Some potential routes will also present engineering challenges due to the local terrain and waterbodies that may need to be crossed. A recent study evaluated potential routing options, permitting requirements, and costs for these potential interties (Kuna 2023).

3.4 Household Weatherization/Energy Improvements

Home heating is the largest user of energy in the borough. The NANA Home Heating Survey also documents that many households struggle to pay heating bills and keep their houses sufficiently warm (McKinley Research 2022). The Regional Energy Plan documents that only 32% of the homes in the region have received funding for weatherization projects and 47% of the houses were constructed before 1980. The older houses are known to not be "tight" from an energy perspective, having greater heating requirements than newer or retrofitted homes. Improving the quality of housing within the borough through either housing replacements, weatherization, or other measures will reduce heating costs while also reducing GHG emissions.

Several organizations, including the Northwest Inupiat Housing Authority (NIHA), Alaska Housing Finance Corporation (AHFC), and The Rural Alaska Community Action Program, Inc. (RurAL CAP) provide support for new housing construction, retrofits/remodels, financing, and energy efficiency/weatherization audits.

3.5 Wind Energy Additions

Several communities in the borough have existing wind turbines to reduce their reliance upon diesel use in their power plants. These include Kotzebue, Deering, and Buckland. Other communities have implemented wind turbines but have found the maintenance and severe conditions experienced in the borough have led to the turbines being non-operational after a few years. However, for the communities where wind is being used, it is believed that additional generation may be possible. Newer turbines may also be evaluated for other communities, given their reduced maintenance requirements and improved construction.

3.6 Hydroelectric Power Generation

Hydroelectricity is a reliable source of carbon-neutral electricity. Some areas (rivers/streams) have been studied for potential hydroelectricity production (WHPacific 2014). Hydropower implementation would likely exceed current local community requirements, providing opportunities for greater electric heating adoption and other economic development. Unfortunately, many communities are in relatively flat areas without significant potential hydropower resources nearby.

Kotzebue wind turbines

3.7 Biomass Heating

The use of wood or other biomass for building heating is a proven method of overall GHG emission reductions. In Northwest Alaska, biomass heating replaces typical fuel oil for building heat; this provides a carbon neutral heating source. Both Ambler and Kobuk are currently encouraging the increased adoption of wood stoves, though improved community resources such as a wood storage facility would assist in the overall adoption of this fuel source. Ambler is also using Opportunity exists for the increased adoption of wood/biomass heating for additional communities where nearby wood sources exist. It is important to note that many communities are not in tree-prevalent areas (Deering, Buckland, Kivalina, Selawik).

Kogoluktuk River in the Upper Kobuk

3.8 Residential Heat Pumps

The NANA Home Heating Survey identified that many households in the borough are using heating systems that have reduced efficiencies compared to modern fuel oil boilers, furnaces, or Toyo stoves. The technology for newer air-source heat pumps continues to improve, enabling their operation at temperatures even as low as -20°F.

Air-source heat pump

Heat pumps, coupled with increased alternative energy (electricity) sources for each community will reduce GHG emissions through reduced fuel (heating oil) consumption. While heat pumps would potentially increase the electrical loads for each community, this can be offset through the implementation of the solar-battery systems as described previously. From late February through April of each winter, solar can provide significant output, offsetting the diesel use in the electrical generators.

3.9 Water/Sanitation System Improvements

The cold climate of the NAB necessitates various measures to ensure that the piping for the water and sewer systems in the borough does not freeze. This typically involves the circulation of heated glycol with the water and sewer lines. While some communities heat the glycol with excess heat from the diesel power plant, additional communities can take advantage of this opportunity. Heating of the community's water storage tank is also an opportunity for use of excess powerplant heat. Other system improvements such as the installation of more efficient pumps and treatment processes may also be considered for some communities to reduce their electrical loads and thereby reduce GHG emissions from diesel sourced electricity. Many communities also have implemented solar arrays on their water storage tanks to supplement the heating requirements for these tanks; many of these arrays are broken and may need to be replaced given their ages.

Selawik water tank with solar panels

3.10 Energy Efficiency Projects

Any measures to increase energy efficiency will have direct reductions in GHG emissions, either through reduced electrical or heating requirements for a facility. A leading opportunity for improving energy efficiency is through the greater adoption of LED lighting. Most communities have implemented LED streetlights, however not all households have adopted LED lights for home lighting purposes. Similarly, the replacement of household appliances with new, more efficient equipment will also reduce energy consumption for appliances such as washers, dryers, refrigerators, and freezers. Replacing typical water heaters with on demand (tankless) water heaters will also reduce energy consumption. Subsidy programs for these opportunities will need to be developed to increase their adoption.

3.11 Electric Vehicles

The replacement of community vehicles with electric versions provides opportunities for GHG reduction. In most villages, primary transportation is through ATVs; electric ATVs are not as readily available as larger vehicles (i.e., cars/trucks). However, the NAB may seek to become a test/beta site for future electric ATVs. Partnerships with manufacturers may be available to support this GHG reduction measure. Further examination of this opportunity is merited for potential GHG reduction opportunities.

Recharging an electric ATV. - Source: polaris.com

3.12 Tree Planting

Planting and cultivating significant carbon sinks, such as trees, is a proven method of overall GHG reduction. Cultivated trees may also be coupled with biomass energy production (i.e., wood heating) to replace heating oil use and provide an overall GHG emissions reduction opportunity. It is important to note that generally only the eastern portion of the borough is favorable for tree planting.

Garden in NAB community supported by Maniilaq Association

3.13 Local Farming/Gardening

Planting and cultivating significant carbon sinks, such as trees, is a proven method of overall GHG reduction. Cultivated trees can then be coupled with biomass energy production (i.e., wood heating) to replace heating oil use and provide an overall

GHG emissions reduction opportunity. Generally, only the eastern portion of the borough is favorable for tree planting.

3.14 Funding Mechanisms

Several funding mechanisms, in addition to the CPRG program, exist for supporting the potential GHG reduction measures. For example, the NAB in cooperation with NANA Regional Corporation, has recently received initial notification on the award of DOE OCED funding to support the heat pump and solar-battery program. The NAB, through the Village Improvement Fund (VIF) also supports numerous projects on an annual basis. Weatherization initiatives are also eligible for funding through the Alaska Housing Finance Corporation (AHFC). AEA has also supported the upgrade of some generators through the Rural Power System Upgrade (RPSU) program; these funds may similarly be used for the implementation of alternative energy options.

Funding for the maintenance of alternative power sources, such as the potential solar-battery systems can be partially supported through the establishment of an Independent Power Producer (IPP) in each community that then sells the produced power to the local utility (such as AVEC). This mechanism still enables the utility to receive appropriate Power Cost Equalization (PCE) funding from the State. PCE funding is a crucial tool to ensure the continued affordability of rural power in Alaska.

The identification of specific cooperative funding sources will be performed in greater detail in the forthcoming CCAP.

4 BENEFITS ANALYSIS

This section provides a listing of the benefits that may be recognized through the implementation of the measures described in Section 3. These benefits are listed in Table 6, alongside an estimation of the potential GHG emissions reductions for each, based on the calculated GHG emissions from Section 2.2.

Table 6. Summary of GHG reduction measures and potential benefits.

GHG Reduction Measure	*Potential Advantages/Benefits*	*Relative GHG Reduction Potential*
Solar-Battery Systems	- Decreased diesel fuel use; handling, storage, and spill potential - Batteries provide short-term system reliability - Improved air quality	***Moderate*** (up to 30-40% diesel reduction for electrical production may be possible); 1,600 tpy CO2e estimated reduction [up to 500,000 gals of diesel may be displaced when coupled with heat pumps]
Intertie Transmission Lines	- Overall decreased diesel use, handling, storage, and spill potential - Increased electrical system reliability, efficiency; - Increased opportunities for alternative energy	***Moderate*** (up to 30-40% overall diesel reduction for electrical production); 1,600 tpy CO2e estimated reduction
Building Weatherization	- Decreased fuel oil use for heating, handling, storage, and spill potential - Improved indoor air quality	***Moderate*** (up to 20-30% of fuel oil use reduction may be possible); 1,200 tpy CO2e estimated reduction
Increased Biomass/Wood Heating	- Decreased fuel oil use for heating - Decreased fuel oil handling, storage, spill potential - Increased local fuel source	***Moderate*** (10-20% of fuel oil use reduction may be possible); 900 tpy CO2e estimated reduction
Increased Wind Energy	- Decreased fuel oil handling, storage, spill potential - Improved air quality	***Moderate*** *(5-10% of diesel fuel use reduction may be possible where additional wind is implemented); 100-500 tpy CO2e estimated reduction*
Increased Heat Pump Adoption/Use	- Decreased fuel oil use for heating - Improved indoor air quality - Decreased fuel oil use, handling, storage, spill potential	***Moderate to Significant*** (>30% of fuel oil use reduction may be possible; will need to be coupled with alternative energy); 1,800 tpy CO2e estimated reduction)
Hydroelectric Power Implementation	- Reliable, green energy source - Reduced energy expenditures - Excess power can be used for economic development - Decreased diesel use for electrical production - Decreased diesel handling/spillage potential	***Moderate (overall NAB)*** (reduces diesel electrical production); 500 tpy CO2e estimated reduction for Ambler, Kobuk, Shungnak)

GHG Reduction Measure	Potential Advantages/Benefits	Relative GHG Reduction Potential
Energy Efficiency Projects	- Decreased diesel use for electrical production - Decreased diesel fuel handling, storage, and spill potential	***Minor*** (small amount of diesel electrical reduction); < 50 tpy CO2e estimated
Electric Vehicles	- Decreased fuel use for vehicles - Decreased fuel handling, storage, and spill potential	***Minor*** (small amount of unleaded use reduction); < 10 tpy CO2e estimated reduction
Water/Sanitation System Improvements	- Improved system energy efficiency - System improvements to reduce non-compliant discharges - Improved system reliability/operations	***Minor*** (small amount of fuel oil and diesel electric reduction); < 20 tpy CO2e estimated reduction
Tree Planting/Cultivation	- Development of local carbon sink - Opportunity to couple with home heating	***Minor*** (small amount of GHG reduction); < 10 tpy CO2e estimated uptake
Local Farming/Gardening	- Reduced imported food and transportation/handling requirements - Overall increased economic development	***Minor*** (small amount of GHG reduction); < 10 tpy CO2e estimated uptake or reduction

Notes: Relative GHG reduction potentials are classified as follows: Significant = >1,500 tpy CO2e reduction potential; Moderate = >250 tpy CO2e reduction potential; Minor = <50 tpy CO2e reduction potential

4.1 Co-Pollutant Analyses

The implementation of the above potential GHG reduction measures will provide additional air quality benefits, especially for the measures that result in fuel use reductions. The combustion of fuel for either heating, electrical generation, or transportation results in the emissions of other pollutants such as fine particulate matter (PM2.5) and nitrogen oxides (NOx). In general, the following factors can be applied for each ton of CO2 reduction (USEPA 1996):

- *Diesel combustion* – 1 tpy CO2 reduction also reduces PM2.5 by 18.7 lbs and NOx emissions by 265 lbs (Note: 1 gal of reduced diesel use saves roughly 4.7 lbs of CO2 emissions).
- *Unleaded combustion (and jet fuel combustion)* – 1 tpy CO2 reduction also reduces PM2.5 by 6.3 lbs and NOx emissions by 102 lbs

4.2 Workforce Development

The implementation of each of the potential GHG reduction measures presents opportunities for supporting workforce development initiatives for the borough. Appropriately trained individuals will be required for the long-term success of each measure, ensuring that implemented measures are maintained and optimized for maximum GHG reduction potential. Electricians, HVAC technicians, and water/wastewater treatment system operators are necessary for both the implementation and operation of some of these measures. Training for these professions can be provided through the Alaska Technical Center in Kotzebue. Funding for the development of these training opportunities and student support should be identified as any measure progresses to implementation.

5 AUTHORITY TO IMPLEMENT

The implementation of any of the potential GHG reduction measures requires coordination amongst appropriate agencies and local governments. In the NAB, infrastructure and development projects are required to receive approval through the NAB Planning Department and Commission, according to Title 9 of the NAB administrative code. Implementation of measures in any local community should also be approved by each local tribal council and/or city council (Noatak is the only community without both). Where a specific measure requires an appropriate site for its development, an agreement with the landowner will also be necessary.

As this project moves forward, the NAB will consult with each tribe to receive appropriate authority for the application and implementation of any potential GHG measure that is furthered through the USEPA's CPRG program. The Quality Assurance Project Plan (QAPP) prepared for the NAB CPRG program activities provides a listing of the stakeholders and their contact information that will be used for consultation with each of the tribes and/or cities (Kuna 2024).

5.1 Environmental Permits

Development projects typically require several permits for their construction and/or operation. For example, construction projects over 1 acre in size must be covered under the State's Construction General Permit for stormwater runoff. Similarly, construction projects that affect wetlands must also receive approval for these impacts through Section 404 of the Clean Water Act, administered by the U.S. Army Corps of Engineers. Modifications to the water or wastewater treatment systems in each community are regulated by the ADEC and must receive approval prior to implementation. The State Fire Marshal also reviews and approves the plans for any enclosed structure.

The receipt of any federal funds for any project will require the project to perform an environmental analysis according to the National Environmental Policy Act (NEPA). This review may also be triggered depending upon the level of permitting required (i.e., if any significant federal permits are required).

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APPENDIX A

GHG INVENTORY

GHG Data and Emissions Summary

Community	Population	Percent of Borough Population	No. Households	CO2e Emissions (tons/yr)	CO2e Emissions Percent of Total	Fuel Use CO2e Emissions (tpy)	Electrical CO2e Emissions (tpy)	FO/HO CO2e Emissions (tpy)	Wood CO2e Emissions (tpy)	Unleaded/ Av Gas CO2e Emissions (tpy)
Kotzebue	3,088	41%	852	13,100	67%	12,623	2,845	3,656	404	6,122
Kivalina	769	10%	144	551	3%	532.1	287	185	8	59.1
Noatak	536	7%	102	693	4%	659.9	300	251	5	106.9
Ambler	277	4%	86	567	3%	399.8	227	131	153	40.0
Buckland	644	9%	133	706	4%	658.8	289	270	17	100.0
Deering	189	3%	45	281	1%	266.0	106	129	6	29.7
Kiana	422	6%	90	745	4%	677.2	272	302	42	101.3
Kobuk	133	2%	52	138	1%	130.0	0	96	6	33.9
Noorvik	654	9%	120	1,040	5%	1,000.2	332	358	33	307.7
Selawik	557	7%	120	1,091	6%	925.9	466	320	148	136.6
Shungnak	244	3%	73	672	3%	530.3	294	165	128	70.3
Total	**7,513**		**1,817**	**19,583**		**18,403**	**5,418**	**5,863**	**950**	**7,108**

Total Borough Fuel Use **5,842,900**

Total Tank Farm Capacities	Percent of Fuel Use (1)	Total Bulk Tank Capacities	2019 Electricity Fuel Use (1)	Non-Elec Use (2) (incl gas)	Typical Gas % (3)	Unleaded Gas Use	Fuel Oil Use	Wood Use (gal equiv)
Kotzebue	58%	7,921,636	1,227,703	2,161,179	27%	583,518	1,577,661	134,687
Kivalina	4%	297,400	124,131	109,585	27%	29,588	79,997	2,596
Noatak	5%	252,800	129,989	162,156	33%	53,511	108,645	1,820
Ambler	3%	176,900	98,354	76,933	26%	20,003	56,930	50,924
Buckland	5%	297,300	125,304	166,841	30%	50,052	116,789	5,737
Deering	2%	315,000	46,022	70,836	21%	14,876	55,960	2,089
Kiana	5%	265,600	117,719	174,426	25%	43,607	130,820	13,888
Kobuk	1%	44,100	-	58,429	29%	16,944	41,485	2,058
Noorvik	6%	202,944	143,743	206,831	25%	51,708	155,123	11,040
Selawik	7%	526,900	201,864	207,139	33%	68,356	138,783	49,381
Shungnak	4%	236,400	127,094	106,622	33%	35,185	71,437	42,750
		Subtotals	**2,341,923**	**3,500,977**		**967,348**	**2,533,629**	**316,971**
		Total FO/Diesel	**4,875,552**					

Notes:
(1) From 2022 NAB Strategic Energy Plan and NAB data
(2) Calculated based on percent of overall fuel use in borough and electricity use by community.
(3) Calculated based on ratio of community storage tank capacities. Kotzebue is assumed based on average of other communities.

Emissions	CO2e	CO2	CH4e	N2Oe	Refrigerant
NAB	19,583	19,494	21	57	11.1
Red Dog Mine	108,188	107,791	138	260	
Bornite Camp Site					
Total	**127,772**	**127,285**	**159**	**317**	**11**

Red Dog Mine GHG Emissions

	Total CO2 Emissions (tons/yr)	Total CH4 Emissions (tons/yr)	Total N2O Emissions (tons/yr)	CH4e (tpy)	N2Oe (tpy)
Generator	106,311	3.61	0.966	132.4	251.7
Incinerators	1,244	0.15	0.009	4.9	7.9
Boilers/heaters	236	0.01	0.001	0.2	0.5
Total	107,791	3.77	0.976	137.5	260.1
Total CO2e	**108,188**				

Note: Data obtained from EPA GHG Reporting website.

Kotzebue GHG Calculations

Metrics		Data Source
Population	3,088	ACS 2022 5-year, censusreporter.org
% of borough pop.	41%	
No. Housing Units	1091	
No. Households	852	

Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord Volume	128	ft3
Wood Use	6	cords/yr/household
	851	cords/yr (total)

Heating Fuel Fraction		Data Source
Wood Stove	13%	NANA Survey, 2022 (Table 7)
Fuel Oil	84%	NANA Survey, 2022 (Table 7)
Other	3%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Fuel Use Information				
Crowley Tank Farm		(from 2023 C-Plan)		
Total Fuel Use	7,000,000	gallons per year		
(less xfer to region)	(2,500,000)	gallons per year		
Tank Capacities (gals)			**% of Total**	
ULSD	752,253	ULSD1/ULSD2	14%	
HF-1	1,687,543		31%	
Jet Fuel	1,691,746		31%	
Av Gas	636,345		12%	
Unleaded Fuel	624,429		12%	

KEA Tank Farm		
Total Fuel Use	1,168,000	gals per year (electrical)
ULSD	2,228,820	gallons (4 tanks)
Unleaded Fuel	500	gallons (mobile tank)

Vitus Tank Farm		
Total Fuel Use	300,000	gallons (assumed)
Unleaded Fuel	300,000	gallons

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	12.6	gal/ppl/day (Washeteria flow)
	14,162,000	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	1,091	same as # households (0.1 lbs/unit)
Refrigerant Pounds	109	lbs R-410a/R-134a assumed (0.1 lb/house)
	5	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Kotzebue GHG Calculations

Emission Factor Information

GHG	*GWP*
CO_2	1
CH_4	25
N_2O	298

		Emission Factors					
		CO_2		CH_4		N_2O	
	Heat Content (mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.23	0.003	0.0014	0.0006	0.00027
Unleaded	0.125	70.22	31.85	0.003	0.0014	0.0006	0.00027
Av Gas	0.12	69.25	31.41	0.003	0.0014	0.0006	0.00027
Jet Fuel	0.135	72.2	32.75	0.003	0.0014	0.0006	0.00027

Wood (mmBTU/ton)	17.48	93.8	42.5	0.0072	0.0033	0.0036	0.0016
Solid Waste (mmBTU/ton)	9.95	90.7	41.1	0.032	0.0145	0.0042	0.0019

		Emissions (tons)				
Fuel	**Total Use**	**CO_2**	**CH_4**	**N_2O**	**Other**	
ULSD+HF-1	2,805,364	6,478	0.265	0.053		
Av Gas	636,345	1,199	0.052	0.010		
Jet Fuel	1,691,746	3,740	0.155	0.031		
Unleaded Fuel	583,518	1,162	0.050	0.010		
	Total Fuel CO2e Emissions	**12,579**	**13.06**	**31.13**		
		CO_2	**CH_4**	**N_2O**	**Other**	**Total by source (CO2e)**
Wood (mmBTU/yr)	18,722	398	0.031	0.015		403.6
Solid Waste	1,236	25	0.009	0.0012		26.0
Wastewater Trmt		42.5				42.5
Refrigerant					0.00	4.8
	TOTALS	**13,045**	**0.562**	**0.121**	**0.00**	
	TOTAL CO2e	**13,045**	**14.0**	**36.0**	**4.8**	
	GRAND TOTAL	**13,100**				

PCE Data	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Power Generated (KWH)	17,725,701	17,348,511	17,022,643	14,047,721	17,990,980	17,807,832	17,250,772
Non-Diesel Power (KWH)	3,551,337	4,455,199	4,711,606	1,705,720	3,560,316	3,250,183	4,533,820
Diesel Used (gals)	1,200,444	1,197,011	1,179,262	1,273,584	1,227,703	1,250,134	1,143,667

Kivalina GHG Calculations

Metrics		Data Source
Population	769	ACS 2022 5-year, censusreporter.org
% of borough pop.	10%	
No. Housing Units	164	censusreport.org
No. Households	144	censusreport.org
Commercial Facilities	N/A	assume all are heated w/ liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	16	cords/yr (total)

Heating Fuel Fraction		**Data Source**
Wood Stove	2%	NANA Survey, 2022 (Table 7)
Fuel Oil	85%	NANA Survey, 2022 (Table 7)
Other	14%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Fuel Use Emissions/Information			
Bulk Tank Farm Info		(from NAB Energy Plan)	
Total Fuel Use	233,716	gallons per year	
Tank Capacities			**% of Total**
ULSD/HF-1	253,400	ULSD1/ULSD2	85%
HF-1		see above	0%
Jet Fuel	0		0%

Total AVEC Fuel Use	124,131	gals per year (electrical)
ULSD/FO	79,997	gallons (4 tanks)
Unleaded Fuel	29,588	gallons (mobile tank)

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	4.6	gal/person/day
	1,277,500	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	144	same as # households (0.1 lbs/unit)
Refrigerant Pounds	14	lbs R-410a/R-134a assumed (0.1 lb/house)
	1	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Kivalina GHG Calculations

Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	**CO2**		**CH4**		**N2O**	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.23	0.003	0.0014	0.0006	0.00027
Unleaded	0.125	70.22	31.85	0.003	0.0014	0.0006	0.00027
Av Gas	0.12	69.25	31.41	0.003	0.0014	0.0006	0.00027
Jet Fuel	0.135	72.2	32.75	0.003	0.0014	0.0006	0.00027
	(lb/ton)						
Wood	17.48	93.8	42.55	0.0072	0.0033	0.0036	0.00163
Solid Waste (mmBTU/ton)	9.95	90.7	41.14	0.032	0.0145	0.0042	0.00191

		Emissions (tons)			
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**
ULSD/HF-1	204,128	471	0.019	0.004	
Av Gas	0	0	0	0	
Jet Fuel	0	0	0	0	
Unleaded Fuel	29,588	59	0.003	0.001	
	Total Fuel CO2e Emissions	**530**	**0.55**	**1.30**	

		CO2	**CH4**	**N2O**	**Other**	**Total by source (CO2e)**
Wood (mmBTU)	361	8	0.001	0.0003		7.8
Solid Waste (mmBTU)	308	6	0.002	0.0003	0.0001	6.5
Wastewater Trmt		3.8				3.8
Refrigerant					0.00	0.6
	Totals	548	0.025	0.005	0.00	

TOTAL CO2e	**548**	**0.6**	**1.5**	**0.8**
GRAND TOTAL	**551**			

Noatak GHG Calculations

Metrics		Data Source
Population	536	ACS 2022 5-year, censusreporter.org
% of borough pop.	#REF!	
No. Housing Units	115	censusreport.org
No. Households	102	censusreport.org
Commercial Facilities	N/A	assume all are heated with liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	12	cords/yr (total)

Heating Fuel Fraction		Data Source
Wood Stove	2%	NANA Survey, 2022 (Table 7)
Fuel Oil	85%	NANA Survey, 2022 (Table 7)
Other	14%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Fuel Use Emissions/Information			
Bulk Tank Farm Info		(from NAB Energy Plan)	
Total Fuel Use	292,145	gallons per year	
(less xfer to region)	0	gallons per year	
Tank Capacities			**% of Total**
ULSD/HF-1	253,400	ULSD1/ULSD2	85%
HF-1			0%
Jet Fuel	0		0%
Av Gas	0		0%
Unleaded Fuel	44,000		15%

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	37.3	gal/person/day, from avg daily permit flow
	7,300,000	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	115	same as # households (0.1 lbs/unit)
Refrigerant Pounds	12	lbs R-410a/R-134a assumed (0.1 lb/house)
	1	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Noatak GHG Calculations

Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	CO2		CH4		N2O	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.23	0.003	0.0014	0.0006	0.00027
Unleaded	0.125	70.22	31.85	0.003	0.0014	0.0006	0.00027
Av Gas	0.12	69.25	31.41	0.003	0.0014	0.0006	0.00027
Jet Fuel	0.135	72.2	32.75	0.003	0.0014	0.0006	0.00027

	(lb/ton)	CO2		CH4		N2O	
Wood	17.48	93.8	42.55	0.0072	0.003	0.0036	0.002
Solid Waste (mmBTU/ton)	9.95	90.7	41.14	0.032	0.015	0.0042	0.002

		Emissions (tons)				
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**	
ULSD/HF-1	238,634	551	0.023	0.005		
Av Gas	0	0	0	0		
Jet Fuel	0	0	0	0		
Unleaded Fuel	53,511	107	0.005	0.001		
Total Fuel CO2e Emissions		**658**	**0.68**	**1.62**		**Total by source (CO2e)**
Wood	253	5	0.000	0.000		5.5
Solid Waste	215	4	0.002	0.0002		4.5
Wastewater Trmt		21.9				21.9
Refrigerant					0.00	1.0
	Total	689	0.03	0.01	0.00	

TOTAL CO2e	**689**	**0.7**	**1.7**	**1.0**
GRAND TOTAL	**693**			

Ambler GHG Calculations

Metrics		Data Source
Population	277	ACS 2022 5-year, censusreporter.org
% of borough pop.	#REF!	
No. Housing Units	117	censusreport.org
No. Households	86	censusreport.org
Commercial Facilities	N/A	assume all are heated w/ liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	322	cords/yr (total)

Heating Fuel Fraction		Data Source
Wood Stove	55%	NANA Survey, 2022 (Table 7)
Fuel Oil	37%	NANA Survey, 2022 (Table 7)
Other	9%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Fuel Use Information				
Bulk Tank Farm Info		(from NAB Energy Plan)		
Total Fuel Use	175,287	gallons per year		
(less xfer to region)	0	gallons per year		
Tank Capacities			**% of Total**	**Throughput**
ULSD/HF-1	14,200	ULSD1/ULSD2	88%	155,284
HF-1			0%	0
Jet Fuel	0		0%	0
Av Gas	0		0%	0
Unleaded Fuel	2,000	+ other and temp tanks	12%	20,003

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	36.1	gal/person/day; 10,000 gal/day assumed flow
	3,650,000	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	117	same as # households (0.1 lbs/unit)
Pounds per Unit	12	lbs R-410a/R-134a assumed (0.1 lb/house)
	1	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Ambler GHG Calculations

Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	**CO2**		**CH4**		**N2O**	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.23	0.003	0.00136	0.0006	0.00027
Unleaded	0.125	70.22	31.85	0.003	0.00136	0.0006	0.00027
Av Gas	0.12	69.25	31.41	0.003	0.00136	0.0006	0.00027
Jet Fuel	0.135	72.2	32.75	0.003	0.00136	0.0006	0.00027
	(lb/ton)						
Wood	17.48	93.8	42.55	0.0072	0.00327	0.0036	0.00163
Solid Waste (mmBTU/ton)	9.95	90.7	41.14	0.032	0.01452	0.0042	0.00191

	Emissions (tons)					
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**	
ULSD/HF-1	155,284	359	0.015	0.003		
Av Gas	0	0	0	0		
Jet Fuel	0	0	0	0		
Unleaded Fuel	20,003	40	0.002	0.0003		
Total Fuel CO2e Emissions		**398**	**0.41**	**0.98**		**Total by source (CO2e)**
Wood (mmbtu)	7,079	151	0.012	0.006		152.6
Solid Waste (mmbtu)	111	2	0.001	0.0001		2.3
Wastewater Trmt		11.0				11.0
Refrigerant					0.00	1.0
	Totals	562	0	0	0	

TOTAL CO2e	**562**	**0.7**	**2.7**	**1.0**
GRAND TOTAL	**567**			

Buckland GHG Calculations

Metrics		Data Source
Population	644	ACS 2022 5-year, censusreporter.org
% of borough pop.	9%	
No. Housing Units	145	censusreport.org
No. Households	133	censusreport.org
Commercial Facilities	N/A	assume all are heated w/ liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	36	cords/yr (total)

Heating Fuel Fraction		Data Source
Wood Stove	5%	NANA Survey, 2022 (Table 7)
Fuel Oil	90%	NANA Survey, 2022 (Table 7)
Other	5%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Bulk Tank Farm Info		(from NAB Energy Plan)		
Total Fuel Use	292,145	gallons per year		
(less xfer to region)	0	gallons per year		
Tank Capacities			**% of Total**	**Throughput**
ULSD/HF-1	unknown	ULSD1/ULSD2	unknown	242,093
HF-1	unknown		unknown	
Jet Fuel	0		unknown	
Av Gas	0		unknown	
Unleaded Fuel	unknown		unknown	50,052
Total	297,300			

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	31.1	gal/person/day; 20,000 gal/day assumed flow
	7,300,000	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	145	same as # households (0.1 lbs/unit)
Pounds per Unit	15	lbs R-410a/R-134a assumed (0.1 lb/house)
	1	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Buckland GHG Calculations

Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	CO2		CH4		N2O	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.23	0.003	0.00136	0.0006	0.000272
Unleaded	0.125	70.22	31.85	0.003	0.00136	0.0006	0.000272
Av Gas	0.12	69.25	31.41	0.003	0.00136	0.0006	0.000272
Jet Fuel	0.135	72.2	32.75	0.003	0.00136	0.0006	0.000272

		CO2		CH4		N2O	
Wood (lb/ton)	17.48	93.8	42.55	0.0072	0.00327	0.0036	0.001633
Solid Waste (mmBTU/ton)	9.95	90.7	41.14	0.032	0.01452	0.0042	0.001905

		Emissions (tons)				
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**	
ULSD/HF-1	242,093	559	0.023	0.005		
Av Gas	0	0	0	0		
Jet Fuel	0	0	0	0		
Unleaded Fuel	50,052	100	0.004	0.001		
Total Fuel CO2e Emissions		**659**	**0.03**	**0.14**		**Total by source (CO2e)**
Wood (mmbtu)	798	17	0.001	0.001	0	17.2
Solid Waste (mmbtu)	258	5	0.002	0.0002	0	5.4
Wastewater Trmt		21.9				21.9
Refrigerant					0.00	0.6
	Total	703	0	0	0	
	TOTAL CO2e	**703**	**0.8**	**1.9**	**0.6**	
	GRAND TOTAL	**706**				

Deering GHG Calculations

Metrics		**Data Source**
Population	189	ACS 2022 5-year, censusreporter.org
% of borough pop.	#REF!	
No. Housing Units	66	censusreport.org
No. Households	45	censusreport.org
Commercial Facilities	N/A	assume all are heated w/ liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	13	cords/yr (total)

Heating Fuel Fraction		**Data Source**
Wood Stove	4%	NANA Survey, 2022 (Table 7)
Fuel Oil	90%	NANA Survey, 2022 (Table 7)
Other	4%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Tank Farm Info/Fuel Use Info				
Bulk Tank Farm Info		(from NAB Energy Plan)		
Total Fuel Use	116,858	gallons per year		
(less xfer to region)	0	gallons per year		
Tank Capacities			**% of Total**	**Throughput**
ULSD/HF-1	252,000	ULSD1/ULSD2	80%	101,982
HF-1			0%	0
Jet Fuel	0		0%	0
Av Gas	0		0%	0
Unleaded Fuel	63,000		20%	14,876

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	31.75	gal/person/day; 6,000 gal/day assumed flow
	2,190,000	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	66	same as # households (0.1 lbs/unit)
Pounds per Unit	7	lbs R-410a/R-134a assumed (0.1 lb/house)
	0	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Deering GHG Calculations

Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	CO2		CH4		N2O	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.225982	0.003	0.00136079	0.0006	0.00027216
Unleaded	0.125	70.22	31.8515831	0.003	0.00136079	0.0006	0.00027216
Av Gas	0.12	69.25	31.4115939	0.003	0.00136079	0.0006	0.00027216
Jet Fuel	0.135	72.2	32.7497052	0.003	0.00136079	0.0006	0.00027216
Wood (lb/ton)	17.48	93.8	42.5474009	0.0072	0.0032659	0.0036	0.00163295
Solid Waste (mmBTU/ton)	9.95	90.7	41.1412501	0.032	0.0145151	0.0042	0.00190511

		Emissions (tons)				
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**	
ULSD/HF-1	101,982	235	0.010	0.002		
Av Gas	0	0	0	0		
Jet Fuel	0	0	0	0		
Unleaded Fuel	14,876	30	0.001	0.0003		
Total Fuel CO2e Emissions		**265**	**0.27**	**0.65**		**Total by source (CO2e)**
Wood	290	6	0.0005	0.0002		6.3
Solid Waste	76	2	0.001	0.0001		1.6
Wastewater Trmt		6.6				6.6
Refrigerant					0.0002	0.3
	Total	279	0.012	0.002	0.000	

TOTAL CO2e	**279**	**0.3**	**0.7**	**0.3**
GRAND TOTAL	**281**			

Kiana GHG Calculations

Metrics		Data Source
Population	422	ACS 2022 5-year, censusreporter.org
% of borough pop.	6%	
No. Housing Units	135	censusreport.org
No. Households	90	censusreport.org
Commercial Facilities	N/A	assume all are heated w/ liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	88	cords/yr (total)

Heating Fuel Fraction		Data Source
Wood Stove	13%	NANA Survey, 2022 (Table 7)
Fuel Oil	78%	NANA Survey, 2022 (Table 7)
Other	9%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Bulk Tank Farm Info		(from NAB Energy Plan)		
Total Fuel Use	292,145	gallons per year		
(less xfer to region)		gallons per year		
Tank Capacities			% of Total	Throughput
ULSD/HF-1	258,500	ULSD1/ULSD2	97%	248,539
HF-1			0%	0
Jet Fuel			0%	0
Av Gas			0%	0
Unleaded Fuel	7,100	assumed	3%	43,607

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	47.39	gal/person/day; 20,000 gal/day assumed flow
	7,300,000	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	135	same as # households (0.1 lbs/unit)
Pounds per Unit	14	lbs R-410a/R-134a assumed (0.1 lb/house)
	1	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Kiana GHG Calculations

Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

	Heat Content (mmBTU/gal)	Emission Factors					
		CO2		CH4		N2O	
		kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.226	0.003	0.00136	0.0006	0.00027
Unleaded	0.125	70.22	31.852	0.003	0.00136	0.0006	0.00027
Av Gas	0.12	69.25	31.412	0.003	0.00136	0.0006	0.00027
Jet Fuel	0.135	72.2	32.750	0.003	0.00136	0.0006	0.00027

Wood (lb/ton)	17.48	93.8	42.55	0.0072	0.0033	0.0036	0.0016
Solid Waste (mmBTU/ton)	9.95	90.7	41.14	0.032	0.0145	0.0042	0.0019

		Emissions (tons)				
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**	
ULSD/HF-1	248,539	574	0.024	0.005		
Av Gas	0	0	0	0		
Jet Fuel	0	0	0	0		
Unleaded Fuel	50,707	101	0.004	0.001		
Total Fuel CO2e Emissions		**675**	**0.70**	**1.66**		**Total by source (CO2e)**
Wood (mmbtu)	1,931	41	0.003	0.002		41.62
Solid Waste (mmbtu)	169	3	0.001	0.0002		3.55
Wastewater Trmt		21.9				21.9
Refrigerant					0.00	0.59
	TOTALS	**741**	**0.032**	**0.007**	**0.000**	

TOTAL CO2e	**741**	**0.8**	**2.2**	**0.6**
GRAND TOTAL	**745**			

Kobuk GHG Calculations

Metrics		Data Source
Population	133	ACS 2022 5-year, censusreporter.org
% of borough pop.	#REF!	
No. Housing Units	52	censusreport.org
No. Households	36	censusreport.org
Commercial Facilities	N/A	assume all are heated with liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	13	cords/yr (total)

Heating Fuel Fraction		Data Source
Wood Stove	5%	NANA Survey, 2022 (Table 7)
Fuel Oil	74%	NANA Survey, 2022 (Table 7)
Other	21%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Fuel Use Information				
Bulk Tank Farms Info		(from NAB Energy Plan)		
Total Fuel Use	58,429	gallons per year		
(less xfer to region)	0	gallons per year		
Tank Capacities (not incl. AVEC)			**% of Total**	**Throughput**
ULSD/HF-1	40,100	ULSD1/ULSD2	91%	41,485
HF-1			0%	0
Jet Fuel			0%	0
Av Gas			0%	0
Unleaded Fuel	4,000		9%	16,944

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	37.59	gal/person/day; 5,000 gal/day assumed flow
	246,992	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	52	same as # households (0.1 lbs/unit)
Pounds per Unit	5	lbs R-410a/R-134a assumed (0.1 lb/house)
	0	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Kobuk GHG Calculations

Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	CO2		CH4		N2O	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.23	0.003	0.00136	0.0006	0.000272
Unleaded	0.125	70.22	31.85	0.003	0.00136	0.0006	0.000272
Av Gas	0.12	69.25	31.41	0.003	0.00136	0.0006	0.000272
Jet Fuel	0.135	72.2	32.75	0.003	0.00136	0.0006	0.000272

Wood (lb/ton)	17.48	93.8	42.55	0.0072	0.00327	0.0036	0.001633
Solid Waste (mmBTU/ton)	9.95	90.7	41.14	0.032	0.01452	0.0042	0.001905

		Emissions (tons)				
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**	
ULSD/HF-1	41,485	96	0.004	0.0008		
Av Gas	0	0	0	0		
Jet Fuel	0	0	0	0		
Unleaded Fuel	16,944	34	0.0014	0.0003		
Total Fuel CO2e Emissions		**130**	**0.13**	**0.32**		**Total by source (CO2e)**
Wood	286	6	0.0005	0.0002		6.17
Solid Waste	53	1	0.0004	0.0001		1.12
Wastewater Trmt		0.74				0.74
Refrigerant					0.000	0.23
	TOTALS	**137**	**0.006**	**0.001**	**0.000**	

TOTAL CO2e	**137**	**0.2**	**0.4**	**0.2**
GRAND TOTAL	**138**			

Noorvik GHG Calculations

Metrics		Data Source
Population	654	ACS 2022 5-year, censusreporter.org
% of borough pop.	#REF!	
No. Housing Units	155	censusreport.org
No. Households	120	censusreport.org
Commercial Facilities	N/A	assume all are heated w/ liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	70	cords/yr (total)

Heating Fuel Fraction		Data Source
Wood Stove	9%	NANA Survey, 2022 (Table 7)
Fuel Oil	78%	NANA Survey, 2022 (Table 7)
Other	13%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Fuel Use Information				
Bulk Tank Farm Info		(from NAB Energy Plan)		
Total Fuel Use	350,574	gallons per year		
(less xfer to region)		gallons per year		
Tank Capacities			**% of Total**	**Throughput**
ULSD/HF-1	386,293	ULSD1/ULSD2	84%	298,866
HF-1		(NWASB/AVEC/ANICA)	0%	0
Jet Fuel			0%	0
Av Gas			0%	0
Unleaded Fuel	72,269		16%	51,708

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	15.29	gal/person/day; 10,000 gal/day assumed flow
	100,459	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	155	same as # households (0.1 lbs/unit)
Pounds per Unit	16	lbs R-410a/R-134a assumed (0.1 lb/house)
	1	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Noorvik GHG Calculations

Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	CO2		CH4		N2O	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.226	0.003	0.00136	0.0006	0.000272
Unleaded	0.125	70.22	31.852	0.003	0.00136	0.0006	0.000272
Av Gas	0.12	69.25	31.412	0.003	0.00136	0.0006	0.000272
Jet Fuel	0.135	72.2	32.750	0.003	0.00136	0.0006	0.000272
Wood (lb/ton)	17.48	93.8	42.547	0.0072	0.00327	0.0036	0.001633
Solid Waste (mmBTU/ton)	9.95	90.7	41.141	0.032	0.01452	0.0042	0.001905

		Emissions (tons)				
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Refrigerant**	
ULSD/HF-1	298,866	690	0.028	0.006		
Av Gas	0	0	0.000	0.000		
Jet Fuel	0	0	0.000	0.000		
Unleaded Fuel	153,999	307	0.013	0.003		
	Total Fuel CO2e Emissions	**997**	**1.03**	**2.47**		**Total by source (CO2e)**
Wood	1,535	33	0.003	0.001		33.08
Solid Waste	262	5	0.002	0.0002		5.51
Wastewater Trmt		0.30				0.30
Refrigerant					0.000	0.68
	TOTALS	**1,035**	**0.046**	**0.010**	**0.000**	

TOTAL CO2e	**1,035**	**1.1**	**2.9**	**0.7**
GRAND TOTAL	1,040			

Selawik GHG Calculations

Metrics		**Data Source**
Population	557	ACS 2022 5-year, censusreporter.org
% of borough pop.	#REF!	
No. Housing Units	160	censusreport.org
No. Households	120	censusreport.org
Commercial Facilities	N/A	assume all are heated w/ liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	312	cords/yr (total)

Heating Fuel Fraction		**Data Source**
Wood Stove	39%	NANA Survey, 2022 (Table 7)
Fuel Oil	50%	NANA Survey, 2022 (Table 7)
Other	11%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Fuel Use Information				
Bulk Tank Farm Info		(from NAB Energy Plan)		
Total Fuel Use	409,003	gallons per year		
(less xfer to region)		gallons per year		
Tank Capacities			**% of Total**	**Throughput**
ULSD/HF-1	518,400	ULSD1/ULSD2	98%	340,647
HF-1			0%	0
Jet Fuel			0%	0
Av Gas			0%	0
Unleaded Fuel	8,500		2%	68,356

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	20	gal/person/day; 11,000 gal/day assumed flow
	4,015,000	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities		
No. Units	160	same as # households (0.1 lbs/unit)
Pounds per Unit	16	lbs R-410a/R-134a assumed (0.1 lb/house)
	1	5% per year leak rate (assumed) [lb/yr]
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]

Selawik GHG Calculations

Emission Factor Information

GHG	***GWP***
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	CO2		CH4		N2O	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.23	0.003	0.00136	0.0006	0.000272
Unleaded	0.125	70.22	31.85	0.003	0.00136	0.0006	0.000272
Av Gas	0.12	69.25	31.41	0.003	0.00136	0.0006	0.000272
Jet Fuel	0.135	72.2	32.75	0.003	0.00136	0.0006	0.000272
Wood (lb/ton)	17.48	93.8	42.55	0.0072	0.00327	0.0036	0.001633
Solid Waste (mmBTU/ton)	9.95	90.7	41.14	0.032	0.01452	0.0042	0.001905

		Emissions (tons)				
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**	
ULSD/HF-1	340,647	787	0.032	0.006		
Av Gas	0	0	0.000	0.000		
Jet Fuel	0	0	0.000	0.000		
Unleaded Fuel	68,356	136	0.006	0.001		
Total Fuel CO2e Emissions		**923**	**0.95**	**2.27**		**Total by source (CO2e)**
Wood (mmBTU)	6,864	146	0.011	0.006		147.97
Solid Waste (mmBTU)	223	5	0.002	0.0002		4.69
Wastewater Trmt		12.05				12.05
Refrigerant					0.000	0.70
	TOTALS	**1,085**	**0.051**	**0.013**	**0.000**	

TOTAL CO2e	**1,085**	**1.3**	**4.0**	**0.7**
GRAND TOTAL	1,091			

Shungnak GHG Calculations

Metrics		Data Source
Population	244	ACS 2022 5-year, censusreporter.org
% of borough pop.	#REF!	
No. Housing Units	73	censusreport.org
No. Households	46	censusreport.org
Commercial Facilities	N/A	assume all are heated w/ liquid fuels
Birch	25	lb/ft3, dry
	26	mmBTU/cord
Spruce	18	mmBTU/cord
Cord	128	ft3
Wood Use	5	cords/yr/household
	270	cords/yr (total)

Heating Fuel Fraction		Data Source
Wood Stove	74%	NANA Survey, 2022 (Table 7)
Fuel Oil	21%	NANA Survey, 2022 (Table 7)
Other	5%	NANA Survey, 2022 (Table 7)
Fuel Oil/ULSD	139,000	BTU/gal (40 CFR 98)

Fuel Use Information				
Bulk Tank Farm Info		(from NAB Energy Plan)		
Total Fuel Use	233,716	gallons per year		
(less xfer to region)		gallons per year		
Tank Capacities			**% of Total**	**Throughput**
ULSD/HF-1	198,600	ULSD1/ULSD2 (FO)	86%	198,531
HF-1			0%	0
Jet Fuel			0%	0
Av Gas			0%	0
Unleaded Fuel	32,800		14%	35,185

Solid Waste	0.1	kg/person/day (burned)
	0.220	lb/person/day (burned)

Wastewater Treatment		
Wastewater Volume	41	gal/person/day; 10,000 gal/day assumed flow
	3,650,000	gal/yr
COD Load	300	mg/L
CO2 Emission Factor	2.4	kgCO2/kgCOD removed

Refrigerant Quantities			
No. Units	73	same as # households (0.1 lbs/unit)	
Pounds per Unit	7	lbs R-410a/R-134a assumed (0.1 lb/house)	
	0	5% per year leak rate (assumed) [lb/yr]	
R-410a/R-134a GWP	1,759	(CO_2e) [avg btwn both refrigerants]	

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Emission Factor Information

GHG	*GWP*
CO2	1
CH4	25
N2O	298

		Emission Factors					
	Heat Content	CO2		CH4		N2O	
	(mmBTU/gal)	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU	kg/mmBTU	lb/mmBTU
ULSD/HF-1	0.139	73.25	33.23	0.003	0.00136	0.0006	0.000272
Unleaded	0.125	70.22	31.85	0.003	0.00136	0.0006	0.000272
Av Gas	0.12	69.25	31.41	0.003	0.00136	0.0006	0.000272
Jet Fuel	0.135	72.2	32.75	0.003	0.00136	0.0006	0.000272

Wood (lb/ton)	17.48	93.8	42.55	0.0072	0.00327	0.0036	0.001633
Solid Waste (mmBTU/ton)	9.95	90.7	41.14	0.032	0.01452	0.0042	0.001905

		Emissions (tons)				
Fuel	**Total Use**	**CO2**	**CH4**	**N2O**	**Other**	
ULSD/HF-1	198,531	458	0.019	0.004		
Av Gas	0	0	0.000	0.000		
Jet Fuel	0	0	0.000	0.000		
Unleaded Fuel	35,185	70	0.003	0.001		
Total Fuel CO2e Emissions		**528**	**0.54**	**1.30**		**Total by source (CO2e)**
Wood	5,942	126	0.010	0.005		128.1
Solid Waste	98	2	0.001	0.0001		2.05
Wastewater Trmt		10.95				10.95
Refrigerant					0.000	0.32
	TOTALS	**668**	**0.032**	**0.009**	**0.000**	
	TOTAL CO2e	**668**	**0.8**	**2.8**	**0.3**	
	GRAND TOTAL	**672**				