Priority Climate Action Plan for the Raleigh-Cary and Durham-Chapel Hill Metropolitan Statistical Areas

February 2024

Developed by:
Central Pines Regional Council

CENTRAL PINES
REGIONAL COUNCIL

In Cooperation with
the NC Clean Energy Technology Center
and Planning Communities and
Stakeholders from Across An 8-County Region
Chatham
Durham
Franklin
Graham
Johnston
Orange
Person
Wake

Funded by the United States Environmental Protection Agency

Appreciation

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Acronyms and Abbreviations

Acronym	Definition
AFOLU	Agriculture, Forestry, and Other Land Use
CBO	Community Based Organization
CCAP	Comprehensive Climate Action Plan
CEJST	Whitehouse Climate and Economic Justice Screening Tool
CPRC	Central Pines Regional Council
CPRG	Climate Pollution Reduction Grant (see also EPA CPRG)
EPA	Environmental Protection Agency (see also USEPA)
EPA CPRG	Environmental Protection Agency's Climate Pollution Reduction Grant
EVSE	Electric Vehicle Supply Equipment, also commonly known as electric vehicle charging station or port
ICLEI	International Council for Local Environmental Initiatives (also known as ICLEI-Local Governments for Sustainability)
GHG	Greenhouse Gas
GHG Inventory	Greenhouse Gas Emissions Inventory
LIDAC	Low Income Disadvantaged Communities
Metro-area	Metropolitan Area
MSA	Metropolitan Statistical Area
MMCDE	Million Metric Tons of Carbon Dioxide Equivalent
$mtCO_2e$	Metric Tons of Carbon Dioxide Equivalent ("carbon dioxide equivalent" is a way to tally all of the different gases that are climate-warming, taking into account their differing climate-warming properties)
NC	North Carolina
NCCC	North Carolina Clean Corridor
NCCETC	North Carolina Clean Energy Technology Center
NOx	Nitrogen oxides, including NO and NO_2, which are air pollutants (does NOT include Nitrous Oxide, a greenhouse gas)
Solar PV	Solar Photovoltaic
USEPA	United States Environmental Protection Agency

Section 1: Introduction

Central Pines Regional Council has worked with its partners and hundreds of regional stakeholders to produce this priority climate action plan (PCAP) to support investment in policies, practices, and technologies that reduce pollutant emissions, create high-quality jobs, spur economic growth, and enhance the quality of life in the Raleigh-Cary and Durham-Chapel Hill area. This project has been funded wholly or in part by the United States Environmental Protection Agency (EPA) under assistance agreement 02D56123 to Central Pines Regional Council (formerly named Triangle J Council of Governments or TJCOG). The contents of this document do not necessarily reflect the views and policies of the EPA, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

The measures contained herein should be construed as broadly available to any entity within the geographic scope of this PCAP eligible to receive funding under the EPA's Climate Pollution Reduction Grants (CPRG) Implementation Grant General Competition and other funding streams, as applicable.

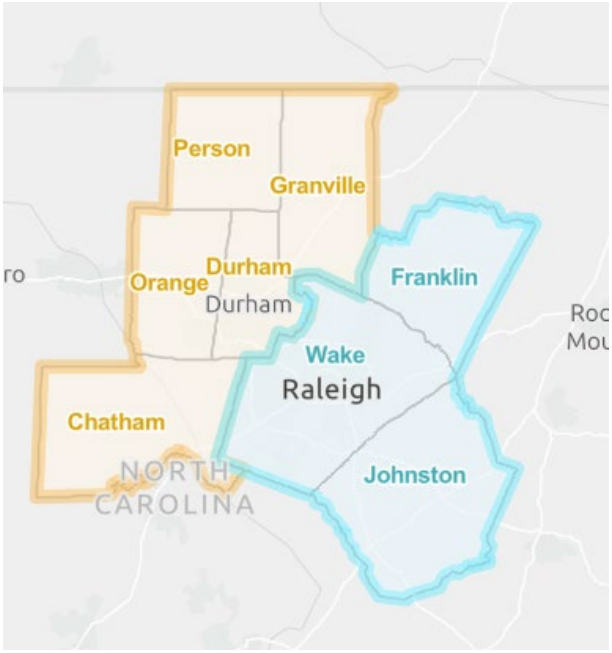
This work is being done as part of EPA's Climate Pollution Reduction Grant Planning Grants for MSA's. This document, the Priority Climate Action Plan, is the first deliverable and is due March 1, 2024. The second deliverable is due summer/fall of 2025 and is called the Comprehensive Climate Action Plan, or CCAP.

The geographic scope of this plan includes two metropolitan statistical areas (MSAs), the Raleigh-Cary MSA, made up of Wake, Franklin, and Johnston Counties, and the Durham-Chapel Hill MSA, made up of Person, Granville, Orange, Durham, and Chatham Counties. While only the Raleigh-Cary MSA originally triggered acceptance into the CPRG planning effort, Central Pines Regional Council (formerly named Triangle J Council of Governments) worked with the regional entities to gain acceptance to add the Durham-Chapel Hill MSA for no additional planning funds because our metro area is functionally very unified economically and culturally. We determined that our area is best defined by both MSAs, and because regional ties are strong, we determined that our best ability to work together on regional climate work would be to work together.

Our region of North Carolina includes urban, suburban, and rural areas with different economies and needs. For example, Franklin, Granville, Person, Johnston, Orange, and Chatham Counties are counties with historically strong agricultural sectors. We are also a region that is experiencing a high rate of change. Johnston County is an

example of a community that has within the past decade grown incredibly in size and population. Much agricultural land in Johnston County has become suburban. We believe that greenhouse gas reduction tactics that acknowledge and respect the ways that urban/suburban and rural areas can be mutually supportive, each bringing needed services to the other, are appealing for our region to explore.

Figure 1. Eight County Planning Area for the Priority Climate Action Plan



Like many other cities and regions, our region's greenhouse gas emissions are dominated by two sources: 1) buildings (residential, commercial, and industrial) and 2) transportation. (See Section 2 for more detail.) Given the context of the CPRG implementation opportunity—this highlights a few considerations. The first is that in North Carolina new building energy efficiency standards are set at the state level, with no local control of these standards. Second is that many of the transformative transportation-related projects would take longer to implement than the five-year CPRG implementation window that this opportunity focuses on.

Our region has a strong commitment to climate action and strong local government leadership. Appendix A is a crosstabulation of plans and projects in our area that are broken into the key climate emission categories of transportation, buildings, waste, agriculture-forestry-and-other-land-use (AFOLU). You can see the commonalities across the planning area, with different icons to differentiate plans from programs,

as well as where efforts to integrate equity into policy and program design and implementation, with equity-emphasis denoted in green.

Similarly, the State of NC has a strong commitment to climate action, including the October 2019 North Carolina Clean Energy Plan. As one of two North Carolina-based MSA areas receiving a Climate Pollution Reduction Grant for planning, from the beginning our intention has been to coordinate closely with the State and the other MSA in North Carolina that is working on a planning grant, the Charlotte-Concord-Gastonia MSA, which is being led by Centralina Regional Council.

Additionally, as we progress to the implementation phase, we intend to acknowledge, uplift, and support the strong local government leadership scaffolding that makes up and connects the Raleigh-Cary-Durham-Chapel Hill area through the Greensboro-Winston Salem area to the Charlotte area. This local government leadership can enable a **North Carolina Clean Energy Leadership Corridor** (NCCELC) that will connect and enliven collaborative efforts through and along this corridor that contains over 5 million of North Carolina's almost 11 million residents, 1.5 million of which are potentially disadvantaged residents.

This PCAP is organized into eight sections:

1. Introduction
2. Greenhouse Gas (GHG) Emissions Inventory
3. Priority Measures
4. Low-Income/Disadvantaged Community Benefits Analysis (LIDAC)
5. Community Based Organizations (CBO) Workshop Summaries
6. Review of Authority to Implement
7. Coordination, Outreach, and Feedback
8. Conclusion

Section 2: Greenhouse Gas Emissions Inventory Summary

CPRC has worked with the NCCETC to develop an inventory of priority sources of GHG emissions within the Raleigh-Cary and Durham-Chapel Hill eight-county area. Appendix B includes the full report developed by the North Carolina Clean Energy Technology Center. This section summarizes this report.

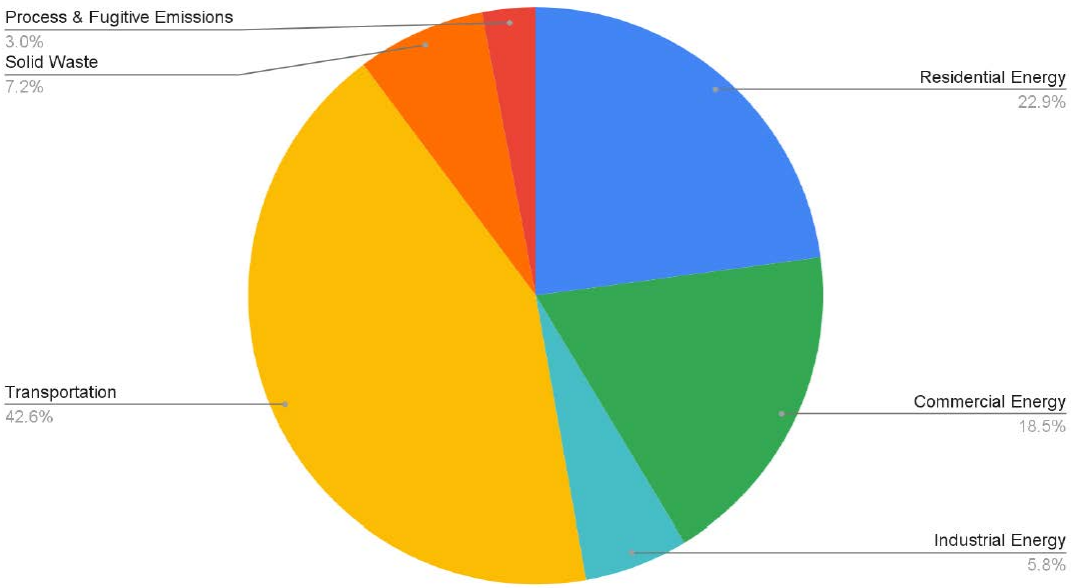
The Raleigh-Cary and Durham-Chapel Hill area inventory includes the following sectors and greenhouse gases:

Sectors	***Greenhouse Gases (across all sectors)***
Residential Energy Commercial Energy Industrial Energy Transportation Solid Waste Process and Fugitive Emissions Agriculture Forestry and Other Land Use	carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), fluorinated gases (F-gases), including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3)

Table 1. GHG Emissions in $mtCO_2e$ by Sector for the Raleigh-Cary and Durham-Chapel Hill Eight-County Area

Sector	2022 Baseline
Residential Energy	5,653,480
Commercial Energy	4,557,250
Industrial Energy	1,444,720
Subtotal of R+C+I, 11,655,450	
Transportation	10,514,764
Solid Waste	1,784,502
Process and Fugitive Emissions	743,234
Agriculture Forestry and Other Land Use	-5,379,212
TOTAL	24,697,950

Figure 2. GHG Emissions in $mtCO_2e$ by Sector for the Raleigh-Cary and Durham-Chapel Hill Eight-County Area



The full greenhouse gas emissions inventory is in Appendix A.

IMPORTANT NOTE/CAVEAT:
Duke Energy was not able to provide actual energy use in the 8-county area in the time needed to deliver the PCAP within EPA's required deadlines. Duke Energy cited a 2016 NC Utility Commission Rule as the reason they could not share aggregated data without official permission, granted during an official public meeting, from the NC Utility Commission. Duke Energy must ask the Utility Commission for this permission in an official filing. Therefore, as is outlined in more detail in Appendix A, the EPA SLOPE tool was used herein for county-based energy usage estimates. Since GHG can vary according to data source, when seeking to determine progress on any individual community-wide city or county climate action plan please use that city's or county's own emissions inventory estimates because their methodology and data sources may differ from those used in the GHG Emissions Inventory in Appendix A. Every effort will be made to work with Duke Energy and NC Utilities Commission to obtain actual 8-county energy use data for the forthcoming Comprehensive Climate Action Plan (CCAP)

Section 3: Priority Measures

Priority Climate Action Plans apply to a specific geography. In the case of the State of North Carolina—the statewide PCAP applies to all areas of the state. For this Raleigh-Cary and Durham-Chapel Hill PCAP, the tactics listed are applicable only to our eight-county planning area.

Priority Measures identified in a Priority Climate Action Plan are eligible for the EPA CPRG Implementation funding. This means that priority measures that are contained in either the Raleigh-Cary or Durham-Chapel Hill Priority Climate Action Plan or the State of North Carolina Priority Climate Action Plan are eligible for applications for CPRG implementation funding from eligible entities in our eight-county planning area.

North Carolina has identified broad priority measures that apply to all areas of the state, including those within the two NC-based MSA areas. Table 2 summarizes the State of NC priority measures. Raleigh-Cary and Durham-Chapel Hill area priorities are captured in these broad measures. We include Table 2 to incorporate the priority measures by reference and to show support for the State of North Carolina's efforts to develop tactics that will best serve the state. We acknowledge that a couple of the State's measures are not applicable in our region because they focus on coastal issues and industries like ports that do not exist in our region; however, we have included them for the sake of completeness.

In Table 3, we have added two more measures to ensure that we reflect the high level of interest and enthusiasm we have for the Electrify model, which is good for business, homeowners, and multi-family dwelling residents, and reduces substantial amounts of greenhouse gas emissions. The second priority measure listed in Table 3 is one that was raised by a few jurisdictions, and that is asphalt coating with TiO_2.

Table 2. The State of North Carolina PCAP Priority Measures

Priority Measure	Cumulative GHG emission reductions ($MMTCO_2e$)	
	2025 – 2030	**2030 – 2050**
Transportation		
1. Increase the number of zero emission and electric vehicles on the road through partnerships, technical assistance, financial 2. Identify, install, and maintain a public electric vehicle charging network accessible to all North Carolinians.	2.69 - 3.54	63.1 - 143.5
3. Increase the number of zero emission and electric vehicles in state and local government fleets.	0.05 - 0.07	1.3 - 2.9
4. Pursue programs to increase efficiency and reduce GHG emissions at port/freight terminals.	0.01 – 0.05	0.11 – 0.55
5. Pursue programs to improve the quality of life and reduce GHG emissions for all North Carolinians. (The purpose of this measure is to leverage and adopt innovative methods, technologies, and programs to reduce VMT, increase access to multimodal transportation, increase support for bike and pedestrian-friendly infrastructure, and create equitable access to healthier living and working environments across the state.)	0.004	0.02
Electricity		
6a. Implement residential and community solar through EnergizeNC.	0.015 - 0.15	0.74 -1.2
6b. Develop programs and incentives to facilitate small scale solar installments by local governments, commercial entities, institutions, and others.	0.008	0.04
7. Implement measures to increase energy resilience in NC communities.	0.02	2.08
Buildings		
8. Reduce per square foot energy usage in buildings in NC	95.3	476.7

9. Decarbonization through building electrification and removal of GHG emissions sources, including refrigerants	35.9	179.5
Industry		
10. Develop programs to support or incentivize implementation of energy efficiency, thermal strategies, and emissions reduction measures in NC industry	2.1-3.9	10.5-19.4
Waste		
11. Reduce food waste entering the waste management system to reduce the methane emissions from food waste landfilling, direct food to communities in need, and create organic resources through composting or digestion.	0.89	4.45
12. Decarbonize waste collection to reduce GHG emissions during the collection and transport of wastes through electrification of fleets or through engine conversion from diesel to electric motors.	0.04	0.140
13. Measures to reduce fugitive emissions at landfills and improve collection efficiency and utilize as a renewable energy source	0.1125	0.90
Natural and Working Lands		
14. Coastal Protection and Restoration	4.4 - 4.8	23.5 - 25.9
15. Protect, use, and develop agricultural and forest land.	15.4	77.0

The measures in this section have been identified as "priority measures" for the purposes of pursuing funding through CPRG implementation grants. This list is not exhaustive of the Raleigh-Cary and Durham-Chapel Hill area's priorities. Instead, the selected priority measures included in this PCAP meet the following criteria:

- The measure is implementation-ready, meaning that the design work for the policy, program, or project is complete enough that a full scope of work and budget can be included in a CPRG implementation grant application.
- The measure can be completed in the near term, meaning that all funds will be expended, and the project completed within the five-year performance period for the CPRG implementation grants.
- The measure advances the following priorities:
    - Significant greenhouse gas emission reductions
    - Significant co-benefits
    - Addresses needs in low income and disadvantaged communities

For each priority measure, an appendix to this PCAP provides additional details about the following information:

- An estimate of the cumulative GHG emission reductions from 2025 through 2030;
- An estimate of the cumulative GHG emission reductions from 2031 through 2050;
- Implementation schedule and milestones;
- Geographic scope;
- Metrics for tracking progress;
- Cost estimates for implementation;
- Co-benefits; and
- Methods and assumptions.

Table 3 summarizes the Raleigh-Cary and Durham-Chapel Hill Area PCAP priority measures in addition to those measures from the State of North Carolina that are incorporated by reference. Appendices C and D contain more information on these two measures.

Table 3. The Raleigh-Cary and Durham-Chapel Hill Area PCAP Priority Measures in Addition to the Priority Measures in the State of NC PCAP

Priority Measure	Cumulative GHG emission reductions (MMTCDE)		Implementing Agency or AgencieS	Geographic Scope	LIDAC?Y=Yes; N=No; P=Possible	Location For More
	2025 – 2030	2031 – 2050				
Buildings						
Regional Electrify Program for Single Family and Multifamily Homes While this program falls under the State of NC's general PCAP tactics 8 and 9 for buildings, we believe it is important to highlight it by selecting it as the main priority measure for our metro area.	0.11 (0.05 of which is LIDAC)	0.43	Central Pines Regional Council with strong partnership from regional local governments and private sector partners	8-county planning area (plus additional areas across the state as is feasible with implementation funding and partnering)	Y	Below and Appendix C
Industry						

Asphalt Penetrating Sealer with TiO_2	0.07 (This is an estimate, and this value is not intended to be used for applications for EPA funding. Applicants will need to supply their own calculations based on the latest reliable academic or industry citations.)	See discussion below	City of Raleigh and City of Durham have expressed interest; however the lead is not yet formalized (NYF).	NYF	P	Below and Appendix D

Priority Measure: Regional Electrify Program for Single Family and Multifamily Homes

In 2022 several of our region's local governments joined together to form the Triangle Sustainability Partnership. One on-going key area of collaboration and interest among local governments in our region is the energy used in buildings. In addition to buildings being one of the largest sources of greenhouse gas emissions, since North Carolina's energy code is defined at the state level local governments who are interested in helping to promote more energy efficient and low-carbon buildings that will save their residents and businesses money every month on their energy bill have more limited options than localities in states were building energy standards can be locally set.

The first joint effort of that group was to do a Solarize the Triangle campaign. This campaign organized by Central Pines Regional Council with a private sector partner was intended to help those homeowners who were interested in purchasing solar photovoltaic (PV) installations for their homes to get started in that process by working with a selected solar contractor who had committed and were contracted to provide high-quality panels, inverters, installation, warranty, and customer

service at a bulk pricing level, which got lower when each of eight purchasing tiers were achieved by the overall program. Solarize uses the power of the crowd to reduce the costs of high-quality solar. This program was so successful that a second campaign for Solarize the Triangle, called Solarize the Triangle '23 was started and is wrapping up soon. The reception to this program was exceptionally positive for many reasons including wonderful partnership with community groups who promoted it, including the Interfaith Creation Care of the Triangle, in addition to the twelve towns, cities, and counties who worked hard to promote the program. One of the most exciting components of this program is that several partners are now working together with nonprofits who serve low-income homeowners to provide solar PV systems to low-income single-family homes and land trust-owned homes purchased to be permanent affordable rental housing. This helps our communities to reduce climate-warming air emissions and to save low-income residents money every month on their power bills. The Solarize the Triangle effort has received one local and one national award. The success left the partners wondering what could be next in their work to help their communities have buildings that reduced carbon emissions and on-going costs for those paying the power bills.

The City of Asheville, NC and Buncombe County, NC are working on a project called Electrify Asheville Buncombe County where several components similar to our region's Solarize the Triangle are being used to help homeowners and multi-family complexes to increase their energy efficiency and to make the switch to an energy efficient heat pump. Asheville and Buncombe County are launching their online platform in February 2024 and our region intends to learn from their experience in launching an Electrify Program in our region.

With this priority measure our eight-county region will seek CPRG Implementation funding do the following to launch an Electrify Program:

- Create an online platform where the participant can answer simple questions about their home or buildings to get started.
- Facilitate low or no cost home energy audits.
- Once an audit is completed the owner will be presented with options that may be of interest (see list below) along with any programmatic, State, or Federal financial incentives that may lower the cost of participation.
- Work with contractors to set technical standards and do training to assure that materials, pricing, installation, and delivery of the following options are predictable and high-quality:
    - Heat Pumps
    - Weatherization (heating and cooling related) Energy Efficiency Retrofits

    - Energy efficient electric appliances like stoves and hot water heaters
    - Electric lawn equipment like mowers and weed eaters
    - E-mobility like electric bikes and scooters
    - Electric vehicle supply equipment, also known as electric vehicle charging units for the home or housing complex
- Create financial incentives for low-to-moderate income residents to participate.
- Work with the North Carolina Clean Energy Fund to reduce the costs of loans for those who would like to participate in this program but who need a financing mechanism at a lower interest rate.
- Work with community colleges, CBOs, and in coordination with State Extension agents to create pathways for education, jobs, and engagement.
- Create integrations with other programs and funding streams, where practical, to, for example, allow for solar and batteries to be added to the program (as is available through other funding sources like Solar for All, which is a program for which the State of North Carolina has applied, but has not been notified of funding) or to create opportunities for greater uptake of State of North Carolina weatherization programs.

A few notable components of this program are:

1) It is designed to help anyone to participate, no matter what their income level. Most homeowners find making home changes to be burdensome for technical, time, or financial reasons. The Electrify Program is designed to address all of these barriers to entry.
2) In addition to reduced energy bills, it is well known that changing a gas stove to an electric stove reduces exposure in the home to combustion byproducts that increase the incidence of asthma. This program can make homes healthier.
3) This program is designed to operate sustainably beyond the grant term by creating partnerships with vendors.
4) The bulk of the soon-to-be-requested CPRG implementation funding for this project will be for financial incentives and grants for low to moderate income homeowners and for reducing the costs of loans.

Regarding the calculation for the 2031 to 2050 time period--we have assumed that the participation rate will be lower after the initial grant funded period, however we can assume growth in participation of the program at a lower rate through 2040. For the period of 2041 to 2050 we assume that there will be enough market transformation to make prediction difficult, so while we can estimate the ongoing

savings from participation from 2025 to 2040, we are not assuming any additional households will be added to the program from 2041 to 2050.

Priority Measure: Asphalt Penetrating Sealer with TiO_2

This measure has been included because of the interest from a few of the jurisdictions in our area and because it is an innovative measure that could be deployed over a wide area.

According to several jurisdictions in our region, retrofitting asphalt with a preservation technology or penetrating sealer increases the asphalt's life by five years (from 12 to 17 years, or a 41% increase in life). Adding TiO_2 to the preservation technology additionally reduces roadway temperature and preliminary data indicates that there may be additional greenhouse gas emissions reductions. Staff found that the data on the TiO_2 additive's greenhouse gas emissions reductions was too preliminary to use for reliable quantification estimation at this time and recommends that any forthcoming projects using that technology work with university academics to do studies that can be included in peer-reviewed scientific publications.

A construction industry magazine called Pavement Interactive estimated that "the energy needed to construct one lane of road one kilometer in length is the equivalent of burning 23,000 gallons of conventional gasoline." Because maintenance of asphalt roads doesn't require starting from scratch each time (because the base and other components have a longer lifecycle than the surface), it is difficult to use this value to estimate the lifecycle carbon emission reduction obtained from a 41% increase in the life of the asphalt surface. However, if one assumes just 15% of that 23,000 gallons of gasoline value (3,450 gallons) is attributable to the asphalt surface, then one example using the City of Raleigh's approximate total linear miles of roadway (2,300 miles or 3,701 km), that is the equivalent of approximately 13 million gallons of gasoline saved which translates to approximately 113,500 $mtCO_2e$ or 0.11MMTCDE for a single pilot covering 2,300 miles of roadway with an asphalt penetrating sealer, which does not include any additional reductions that may come from the TiO_2 additive. Because this number of miles would take some time to implement beyond the first six years, we assume that the first six years from 2025 to 2030 would be 60% of that value at 68,100 $mtCO_2e$ or 0.07MMTCDE. These values are approximate and should not be used for an application to the EPA for CPRG implementation funding, as they are placed

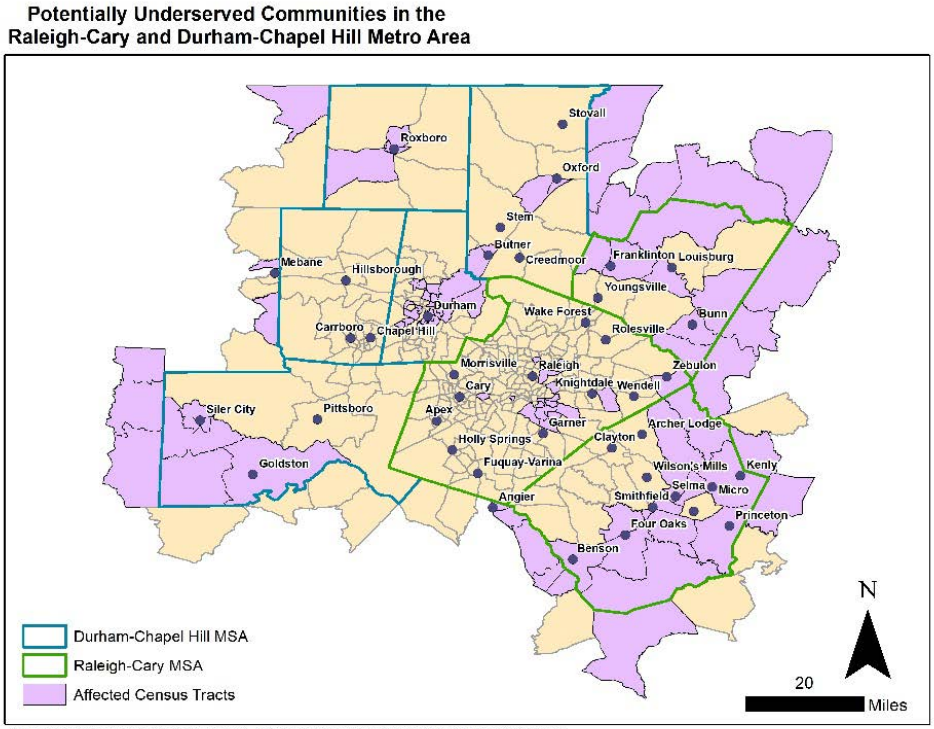
here for illustrative purposes only for the reader to consider the possible magnitude of reductions possible with this kind of measure.

It should be noted that the TiO_2 additive, in addition to possible cooling from being a reflective surface, shows reduction in pollutants like nitrogen oxides (NOx) which combine with volatile organic compounds to form a lung irritant called ground-level ozone which is bad for the health of sensitive populations (like those with asthma). High ground-level ozone has been correlated with increased emergency room visits. Nitrogen oxides are the driving pollutant for the formation of ground-level ozone in every major metropolitan area of the United States. The primary source of NOx is the emissions from gasoline-powered cars and trucks. So any tactic that also has the co-benefit of reducing NOx would be meaningful for local air quality and resident health.

Section 4: Low-Income and Disadvantaged Community Analysis

Implementing the measures included in this PCAP will significantly benefit low-income and disadvantaged communities (LIDACs). This section identifies each LIDAC within the PCAP jurisdiction area (Raleigh-Cary and Durham- Chapel Hill MSA), how the Raleigh-Cary and Durham- Chapel Hill area meaningfully engaged with LIDACs in developing this PCAP, and how Raleigh-Cary and Durham- Chapel Hill area will continue to engage into the future.

Figure 3. Potentially Underserved Communities in the Raleigh-Cary and Durham-Chapel Hill Metro Area



Identification of and Engagement with LIDACs

Central Pines Regional Council (CPRC) developed a map very early on to identify the LIDAC communities in its 8-county grant using the Whitehouse Climate and Economic Justice Screening Tool (CEJST). This map is shown in Figure 3. A complete

listing of census tracts that are considered potentially disadvantaged are in Appendix E.

CPRC created an engagement plan for seeking feedback on community priorities during the development of PCAP. As one of the initial ambitious tactics of this engagement plan, a Request for Proposals (RFP) was released in fall 2023 with a simple and easy application (to minimize the application burden) requesting proposals from local community-based organizations (CBOs) and nonprofits working specifically with LIDAC communities in the 8- county CPRG grant region.

Table 4. Potentially Disadvantaged Census Tract Information in the Eight-County Planning Area

	Total Population	Census Tracts Identified as Disadvantaged	Disadvantaged Population	% Disadvantaged	Criteria of Concern	Avg > age 64	Avg Non-White
Chatham County	71,338	5 (of 13)	22,201	31%	Low Income, Bldg Loss Rate, Energy Burden, Transit Barriers, Pollution Exposure, Health Risk	23%	30%
Durham County	311,848	20 (of 60)	92,012	30%	Low income, Ag Loss Rate, Energy Burden, Pollution Exposure, Housing Burden, Historic Underinvestment, Health Risks, Linguistic Isolation, Unemployment	12%	58%
Franklin County	66,362	7 (of 12)	30,802	46%	Low Income, Energy Burden, Transit Barriers, Housing Burden, Health Risks, Unemployment	17%	40%
Granville County	59,328	4 (of 13)	14,286	24%	Low income, Bldg Loss Rate, Transit Barriers, Pollution Exposure, Health Risks, Unemployment	17%	46%
Johnston County	196,870	14 (of 25)	76,781	39%	Low income, Ag Loss Rate, Energy Burden, Transit Barriers, Housing Burden, Pollution Exposure, Health Risks, Unemployment	13%	35%
Orange County	144,836	0 (of 28)	-	0%	NA	13%	30%
Person County	39,345	4 (of 7)	19,133	49%	Low Income, Ag Loss Rate, Energy Burden, Transit Barriers, Pollution Exposure, Health Risks, Unemployment	18%	37%
Wake County	1,069,079	18 (of 185)	122,185	11%	Low Income, Ag Loss Rate, Pollution Exposure, Housing Burden, Health Risks, Linguistic Isolation, Unemployment	12%	37%
TOTAL	**1,959,006**	**72 (of 343)**	**377,400**	**19%**		**16%**	**39%**

Table Reference: Developed by Planning Communities, Raleigh- CPRC's Consultant for CPRG, 2023.

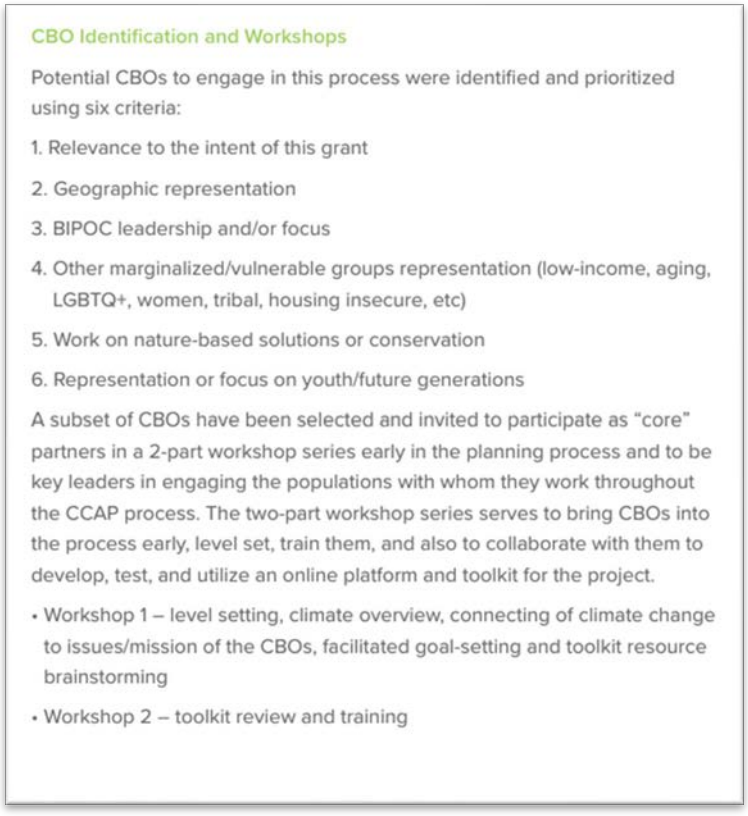
The goal was that the CBO grantees, given their deep relationships with the communities they serve, would successfully and meaningfully engage their local communities on multiple levels:

1. Create a shared understanding of climate conditions, risks, and opportunities.
    - Exchange knowledge on climate conditions, sources of greenhouse gas (GHG) emissions, challenges, and opportunities.
    - Discuss the intersection of climate change, risks, and opportunities with other resource needs, socioeconomic challenges, and priorities of the region.
2. Prioritize equitable engagement and underserved communities.

- Inform a climate planning process that will directly reflect the challenges, opportunities, and resource needs of the region's most vulnerable community members.
- Obtain input on how to address historic environmental injustices and inequities.

3. Identify implementable climate and community solutions.
   - Identify climate solutions that reduce GHG emissions while also addressing chronic socioeconomic stressors and enhance community resilience.
   - Gather feedback to assure solutions identified are implementable.
4. Build lasting collaborative regional climate action capacity.
   - Strengthen networks and resources for collaborative implementation of climate solutions.

Figure 4. CBO Workshops

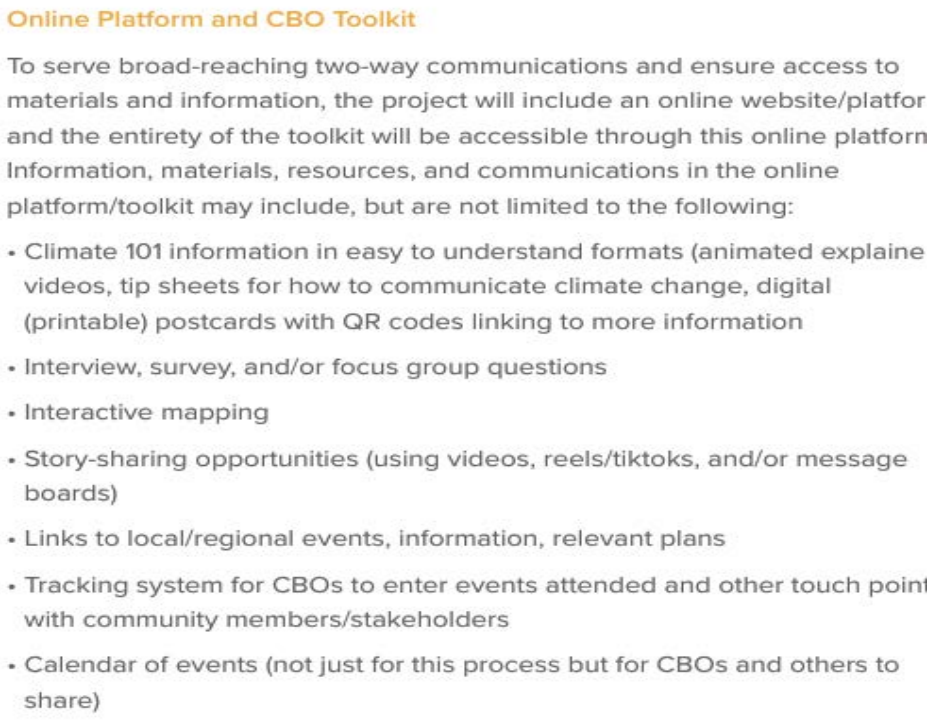


Unfortunately, the RFP did not get any response, likely due to fast turnaround essential to comply with EPA's PCAP deadline of March 1, 2024. As a response, the team pivoted quickly by organizing a series of two half-day in-person workshops to engage CBOs. The first workshop was held in December 2023 and the second in January 2024. Both had a good attendance and strong representation across communities. The CBOs invited for these workshops were identified through an exhaustive process of aligning target stakeholder groups and climate issues with their work. Figure 4 provides a snapshot of the CBO selection process as well as a broad overview of the content of the two workshops.

Section 5 of this document contains a full summary of the workshops.

At the second workshop, CPRC staff floated the idea of establishing a CBO Steering Committee to help the grant staff stay connected with the CBOs and get consistent feedback from them and the LIDAC communities they serve throughout the life of CPRG. The CBOs were receptive to this, and it was decided that CPRC will kick off the Steering Committee in spring 2024.

Figure 5. Online Platform and CBO Toolkit



A large proportion of time at the second workshop was spent discussing a draft online toolkit to continue engaging LIDAC communities in multiple ways. This toolkit shall have several features listed in Figure 5.

CBOs will be able to apply for funding using simple online form to conduct engagement in their communities. This funding will also cover costs such as childcare, travel, meals etc. to make it as easy and convenient as possible for the residents to attend and participate. The CPRC staff received the first request for funding from a CBO that participated in both the workshops in February 2024 and was working with them at the time of submission of this grant to review and approve the funds.

Section 6 of this document contains a summary of the complete engagement for the PCAP effort, which will also inform the subsequent Comprehensive Climate Action Plan.

Strategies for engagement with LIDACs are summarized below:

- Online resources:
  - CPRG web page: https://bit.ly/CPClimate
  - CBO toolkit (link to this location is at the top of the CPRG web page): https://experience.arcgis.com/experience/040997706fb448eb8acddf1a69402a2f/page/CBO-Toolkit/
  - Email list;
  - Social media posts;
  - Portal for submitting ideas (embedded in CBO toolkit);
  - Community survey (scroll to bottom and notice tabs at bottom): https://bit.ly/CPClimate
- Four (4) Community Climate Conversation meetings geographically across the MSAs with options for in-person, online, and staff office hours participation;
- Targeted outreach to known community-based organizations; and
- Attendance at known community events to disseminate information about how to provide input.

Section 5: Community Based Organization Workshop Summaries

CBO Workshop 1 | December 14, 2023

Summarization done by Planning Communities, an engagement and outreach consultant to CPRC

SUMMARY

Workshop Agenda:

Community and Climate

Welcome
Overview of project
phases/timeline Meeting
purpose and overview
Introductions
Presentation: Climate concepts/related topics
Group Exercise – How climate actions relate to your community Facilitated Goal-setting – Outreach and engagement
Morning Recap and post-lunch preview

Lunch and networking

Toolkit Development

Introduce toolkit/platform
Facilitated Discussion – What would you like to see included in the toolkit?

Next Steps

Participants

CBOs:

Meech Carter, NC League of Conservation Voters (NCLCV)
Maura Dillon, Community Organizing for Racial Equity (CORE)
Zoe Gabrielson, Southern Environmental Law Center
Bonita Green, Merrick-Moore CDC
Angie Haugen, Wake Up Wake County
Richard Johnson, Southeast Raleigh Promise

Jodi Lasseter, NC Climate Justice Collective
Da'Quan Love, NAACP
Ren Martin, NC Interfaith Power & Light
Naeema Muhammed, NC Environmental Justice Network (virtual)
Emily Sutton, Haw River Assembly
Erik Valera, El Centro Hispano
Imani Vincent, Museum of Life + Science Tim Wollin, StepUp Durham

CPRC:

Emily Barrett, CPRC
Shuchi Gupta, CPRC
Zachary Lang, CPRC

Consultant Team:

Karen Campblin, Planning Communities
Kari Hewitt, Planning Communities
Cindy Holmes, Sustain Triangle
Anne Phillips, Just Cities Collective
Teresa Townsend, Planning Communities

Welcome, Project Overview and Timeline, Purpose, and Climate Overview:
See slide deck

Group Exercise Outcomes
Question 1: What is the mission of your organization?

This workshop included representatives from 14 different CBOs, each with its own mission. The following captures how each representative described their organization's mission.

- Merrick-Moore CDC - improve the overall quality of life for the poor, underprivileged, and disenfranchised by strengthening bonds
- Central Pines Regional Council - regional local govt that serves 7 county region and 47 member governments
- Southern Environmental Law Center - nonprofit environmental law firm that is rooted in the South. Work with partners to advocate for impactful environmental solutions, and the team includes lawyers, policy and science experts, communications, and more, to best meet partners' needs and work towards solutions in the South that can have broad impacts.

- Haw River - right to fishable, swimmable, drinkable water for all people. We are the voice of the Haw- work to protect the entire watershed and communities who depend on it in an 8 county area.
- NC Climate Justice Collective - we cultivate a multi-racial intergenerational grassroots movement ecosystem to address the root causes of climate change through popular education and cultural organizing.
- NAACP - achieve equity, political rights, and social inclusion by advancing policies and practices that expand human and civil rights, eliminate discrimination, and accelerate the well-being, education, and economic security of Black people and all persons of color.
- El Centro Hispano - strengthen the community, build bridges, and advocate for equity and inclusion.
- CORE - empowering local communities to be leaders - transforming people and organizations, shifting power, educating/building awareness of racial equity issues.
- Southeast Raleigh Promise - to provide equitable access to opportunities for Southeast Raleigh residents to grow and thrive (as relates to education, housing, economic vitality, community health, well-being).
- WakeUp Wake County - grassroots advocacy organization that educates, convenes, and mobilizes residents and community leaders around the intersection of land use, affordable housing, transportation, and climate change for sustainable planning toward equitable and environmentally conscious growth.
- NC League of Conservation Voters - advocate at the legislature and in regulatory spaces for equitable environmental policies. Organize PowerUp NC in BIPOC communities through grassroots power building.
- NCIPL - advocate for environmental justice through the lens of faith, creating equitable action towards climate justice.
- Museum of Life and Science - affect societal change on issues related to climate, health, and equity

Question 2: Who do you serve?

Participants were also asked to describe who they serve in their work. The bullets below capture their responses, which reflect a broad demographic and geographic range. Some work with a more targeted population, while others serve communities throughout the state and beyond. And some, like Haw River Assembly, consider the non-human environment as part of their constituency in addition to human populations.

- Merrick-Moore CDC - Merrick-Moore, Bragtown, Walltown; partner with local non-profits, ECWA, KBD, MLS, TD
- Central Pines Regional Council - work with municipalities and other member governments in 7 county region
- NC Climate Justice Collective - center all work in the leadership of youth, Black, Indigenous, and people of color, women, low wealth people, and LGBTQI+ people to create strategic alignment - focus is leadership development and capacity building of impacted communities.
- Southeast Raleigh Promise - SE Raleigh residents - 6 census tract area
- NC EJ Network - serve impacted communities in way that can make a difference - how it impacts quality of life and effect policy change
- StepUp - low-income communities, justice-involved people, anyone having a hard time landing employment who would like more community support and resources
- NAACP - NC State Conference serves to advance Black North Carolinians
- SELC - community groups and enviro justice advocates, environmental coalitions and groups, and other partners across the southeast region. Much of our work includes litigation or legal advocacy on behalf of these orgs, but we also participate in legislative and executive/administrative advocacy, knowledge and coalition building, and more.
- WakeUp - residents, community leaders, community partners in Wake County
- Haw River - serve communities within the Haw, protecting habitats and aquatic populations of flora and fauna, but also human populations that depend on the Haw for drinking water, swimming, fishing. Any communities in the watershed fighting environmental hazards or enviro degradation or enviro injustices.
- CPRC - member govts and the communities they serve
- El Centro Hispano - serves the diverse Hispanic/Latinx community, immigrant community, and builds bridges to the broader community at large.
- NC League of Conservation Voters - statewide advocacy, community building in Winston-Salem, Raleigh, and Fayetteville
- NCIPL - people of faith and conscience and those who are disproportionately impacted by the climate crisis. We work on a local, state, national, and international level.
- Museum of Life and Science - community, families moving forward, Merrick Moore, South Carolina, Wingstree, Durham, guests at museum, students (middle, high, college, graduate), Eastern NC

Question 3: How might climate change impact your mission and those you serve? (Or maybe - how is it ALREADY impacting them?) What are some of the chronic stressors

people are experiencing and how might they be exacerbated by climate change impacts?

Participants had a robust conversation about impacts of climate change already being experienced or anticipated to be experienced by those in the communities they serve as well as connections to ongoing challenges, or chronic stressors, communities are experiencing that may be exacerbated by climate change impacts. Some common themes that emerged include:

- Climate change as a threat multiplier
- Connections between housing affordability, transportation, and jobs - having to live further away from jobs to access affordable housing but increases transportation costs/burdens.
- Health impacts - air quality, water quality, safety of outdoor workers (including agriculture/construction), heat impacts, mental health impacts
- Development/growth at odds with environmental protection and affordability
- Rising energy costs and energy burden
- Displacement and gentrification concerns, especially when for purpose of non-sustainable infrastructure/development
- Extreme storms and flooding - particularly damaging to aging homes and infrastructure and those with limited resources to recover/rebuild

The following are raw notes from facilitated discussion on this question.

- Threat multiplier
- Job sustainability
- Generational homes
- Being able to afford to live close to where you work
- displacement/gentrification
- Property values
- Air quality
- affordable housing - land affordable in vulnerable areas
- Development - further out - greater impact on land/habitat resources; also impacts transportation need, community health and safety, water quality, land fill infrastructure
- Transportation - affordable development not around transit; more cars - further commute, health impact, community impact
- Landfills filling up fast
- Drinking water supply
- Growth damaging environment
- Poverty

- Housing
- Aging
- Increased costs of doing business
- Infrastructure - flooding and heat
- Historic flooding blocking weatherization of homes, extreme energy burdens and fossil fuel buildouts, loss of tree cover and rise of urban heat islands, Person County disproportionate impacts
- On a local level, we see areas such as Beaufort County facing flooding that devastates homes. We see rising temperatures and rising energy prices, burdening people as well as congregations. The increasing threat of fossil fuel expansion in the MVP southgate extension.
- As a museum, see how important it is to stay involved with rising concerns about affordable housing, food equity, urban heat, agriculture, pollution, etc because they are all interconnected - it's only fair for the younger generation who is actively learning about human impact on earth.
- "Clean" energy and false solutions
- Business operations impacted
- Animal waste
- Air quality
- Health impacts
- Siler City as a heat island - people without air conditioners
- Heat island, flooding in SE Raleigh
- Drought - concentrated levels of effluent dominate the volume of the Haw- drinking water supply
- Flood - hazardous waste sites, brownfields, sludge fields, in low income areas
- High storms - development sites designed for 25 year storm - no longer effective, sediment released destroys aquatic habitat and life in streams nearly impossible to recover - velocity of water scours banks, trees cave in, and banks erode
- Lack of access to safe water to swim in, due to pollution or privatization
- PFAS
- Extreme heat and energy burden
- Inadequate infrastructure
- Hard to navigate on their own
- The communities that are a part of NC Climate Justice Collective are directly impacted by: flooding, drought, hurricanes, extreme heat and the related issues of high energy burden, displacement, workers' health, loss of livelihood....our communities are fighting against forest destruction (due to the wood pellet industry), methane gas (due to CAFOs), fracked gas infrastructure projects, and coal ash pollution

- "You deserve healthy air"
- Economic impact - rising energy bills, older homes, jobs and economy
- Worker health impacts - agriculture and construction
- Stressors - condition of dwellings and accessibility of affordable housing
- Climate change touches all of our program areas; it affects people, natural places, wildlife and communities. Our work incorporates EJ & climate justice, which is increasingly important
- Mental and physical health outcomes

Question 4: What resources will you need to support those you serve and/or ability to continue to provide necessary services?

Participants also discussed at their breakout tables what resources are currently needed or will be needed to support their work and those they serve. Some highlights of those discussions are as follows:

- Accessible data and information resources
- Opportunities for networking, collaboration, and resource sharing
- Workforce development and green jobs training
- Strategies for policy change at local and state level
  - Getting those impacted into decision-making positions
  - Integrating climate justice considerations into local and state policies
  - Getting the legislature to hear the voices of those most impacted by their decisions
- Funding - direct funding of local incentives and projects, and also resources on grant opportunities and grant writing resources
- Consistent messaging and framing of issues that is empathetic and aligns with community values and concerns (ex: health framing)
- Accessible, equitable, and multilingual education and training
- Space/forums for connections, dialogue, and two-way conversations
- Engagement/partnership/sponsorship/investment from corporate and utility partners

The following are raw notes from facilitated discussion on this question.

- Connections through data
- Equitable workforce development (including spanish language classes)
- Ancillary businesses that support green economy
- BIPOC focus
- Legal teeth - need for actionable and enforceable mechanisms
- Interconnected nature of need
- Money/funding

- Collaboration among CBOs
- Partners with expertise in rural-urban solutions

- Networks that assist and support
- Energy incentives “social workers” - resources to support them
- Solutions that are valuable in the community
- Speak the language of those you are talking to
- NAACP uses health framing to connect through messaging
- Framing the opportunities to be a part of the solution
- Merrick-Moore has monthly meetings that have opportunities for education - flooding, stormwater, air pollution
- Resource sharing and culture building
- environmental/climate change group directory
- Incentives for energy changes in local communities (ex: funds to repair homes not eligible for weatherization)
- Funding to continue energy audits, which are being done by retired professionals that are aging out
- Funding for congregations that cannot afford to start projects that will help with electrification and other efforts
- Broadcast and administer grant opportunities regarding climate change resilience and mitigation
- Method and funding for hiring a facilitator of group collaboration, like People Power NC (NC energy coalition)
- Green home infrastructure updates
- Establish Food Sovereignty
- Participate in cohorts to affect policy
- Provide education to homeowners
- Advocate with local government for infrastructure improvements
- Research projects - air quality, carbon reduction
- Green jobs - transportation a key challenge
- People who liver further out - need adequate public transportation
- Consistent messaging
- Work existing plans into actionable ordinances that are enforceable
- Must include state legislation to prevent or reverse preemption laws
- Funding to do GSI projects in flood prone areas
- Fighting MVP Southgate - permit approval can’t be denied on grounds of climate change
- Can GSI be done on private land? How to navigate that
- April - NCDEQ renews NCG01 and NCG25

- Train folks to be the revolution
- Data
- Staff time to facilitate connections/convening
- Developers, community orgs, and others to work collaboratively
- Moving beyond diagnosing the problem
- Messaging that is inclusive and non-judgmental
- Empathetic approach
- Invite others, like Duke Energy

- Nuance plays out on local planning and transportation boards - need more representation of impacted communities on these boards
- Implementation of existing plans and strategic planning should pull from these plans, such as NC Clean Transportation Plan and NC VMT Reduction Study/Toolkit
- Training
- Support for capacity
- Corporate sponsorship
- Investment in workforce and business development
- Use Justice40 program to change policy/rulemaking to make companies reduce/eliminate impacts to communities
- Safety equipment for those working outside
- Accessible educational resources
- Legislators don't hear from folks who are impacted by their decisions
- Framing for your audience
- E-bike rebates
- Infrastructure that moves us away from car dependency
- More grant writers
- Funding to support educators
- Community conversations
- Climate change oriented power-mapping (NCLCV - working on a toolkit and outreach plan)
- Staff turnover is an issue
- Forums - space for dialogue/making connections
- Two-way conversations - feedback/results back to community
- Prevent green gentrification
- Advocacy perspective - remember that some existing systems, policies, funding can be changed
- Create new processes where people are not tokenized but meaningfully engaged
- Black North Carolinians - still seeing impacts of redlining and many are still first or second generation post-segregation

- Education and freedom of choice
- SELC has NC Clean Connected Communities Initiative
- Think about integration of climate into state general construction permit and stormwater permit
- Communication channel for core CBOs

After the breakout table discussions, the full group reported back some of their key takeaways and discussed the many challenges and opportunities outlined above. This was followed by a networking lunch and brief intro to what the online toolkit could look like with some brainstorming on what it might include. These discussions will shape how CPRC and its CBO partners might approach outreach and engagement throughout the PCAP and CCAP development process, as well as the online toolkit of resources to be made available to CBO partners to extend the reach of this engagement to all those they serve.

This workshop served as a valuable forum for bringing together several organizations working on interrelated issues and the workshop that follows will be an opportunity to continue building that coalition. Additionally, participants will have the opportunity to be trained on the online platform and toolkit that is being developed to reflect the resource needs shared in Workshop 1, and also inclusive of resources shared by participants during and after the workshop.

CBO Workshop 2 | January 19, 2024

Summarization done by Planning Communities, an engagement and outreach consultant to CPRC

SUMMARY

Workshop Agenda:

Re-intros & level setting
Toolkit overview
    Walk-through of each section of the platform and toolkit
      Walk through topic area survey example
      Requesting Funds and tracking your engagement
      Formation of a CBO Steering Committee
Group Messaging and Brainstorming
Lunch and Networking
Report Back and Exchange
Ongoing Toolkit Support

Thank you and Next Steps

Participants

CBOs:

Meech Carter, NC League of Conservation Voters (NCLCV)
Maura Dillon, Community Organizing for Racial Equity (CORE)
Bonita Green, Merrick-Moore CDC
Richard Johnson, Southeast Raleigh Promise
George Jones, Partners for Environmental Justice
Megan Kimball, SELC
Jodi Lasseter, NC Climate Justice Collective
Erik Valera, El Centro Hispano
Imani Vincent, Museum of Life and Science
Alyanna Wilson, Partners for Environmental Justice
Caroline Honsley, Sierra Club
Denzel Burnside, WakeUp Wake County
Emily Sutton, Haw River Assembly

CPRC:

Emily Barrett
Shuchi Gupta
Zachary Lang

Consultant Team:

Kari Hewitt, Planning Communities
Teresa Townsend, Planning Communities
Cindy Holmes, Sustain Triangle
Anne Phillips, Just Cities Collective

Messaging Discussion:

Participants broke out into four groups to discuss some potential "climate connections" and messaging related to key topic areas for the climate plan - buildings, transportation, waste, and agriculture/forestry/land use. Each table was given a topic and a matrix with 4 questions to address:

- Who do CBOs need to talk to? Identify 2-3 specific populations (ex: youth, seniors, BIPOC) that you typically work with.
- What are 1-2 key messages to communicate in engaging these populations around this topic?

- What are 2-4 activities that your organization could carry out in the coming weeks/months to engage with these populations around this topic? Are there opportunities to work together across orgs?
- What else do your orgs need in order to do this effectively?

The breakout discussions were extremely generative. The following captures notes from the breakout discussions.

Buildings

Who to talk to?

- Legislators
- Community land trusts
- Tenants Advocacy Groups
- Landlords

Key Messages:

- Accountability for doing harm
- Reducing urban heat island
    - Building materials
    - Surrounding landscaping
- Managing stormwater - permeable surfaces in development
- Dense development disturbing environmental habitat/ water tables
    - Building in dense places: more run off of water, creating flooding and causing damage
- Need for housing now needs to be balanced with protecting health and environment
- NC #1 place to do business - need efficient healthy buildings to support
- Consider how officials are measuring legislative impact through econ impact
- New jobs (but healthy jobs)
- Weatherization funding - events with legislators
    - Preparing older homes for climate impacts
- Pushing elected local officials to understand and listen to lived experience
- Breaking down barriers:
    - Fighting feedback fatigue
    - Trust barrier with latinx community

Activities:

- School house rocks for legislators
    - Making what is going to happen through song
- Bus tour

    - invite local officials into neighborhood (history, issues, data) shared during tour, include staffers, the doers
    - Impact on rezoning / development of affordable housing
- Opportunities to get officials out of their offices and have office hours in community places
    - Coffee with city officials
    - Cookies and crochet example
- Connect people to Energy funds for all.org

Additional Resources Needed:

- Incomplete sidewalk issue, not required of developers
- What organizations are out there doing what (and what resources they have)
- Bus/transportation for bus tours
- Printed materials to hand out
- List of who (officials and staffers) - living documents
- Community members ready to share their stories and lived experiences
- Bus tour/ meeting related
    - Refreshments, bathroom, etc
    - Maybe stop for a meal
- Networking and partnerships
- Readiness Funds Resource - gap funding for when major upgrades are needed
- “Tenant nights” resources
- Properties that are rented out but owner is not investing in repairs/improvements
- Durham Neighborhood Compass
- Healthy Homes and Green Infrastructure Coalition
- “Resources for seniors” - a good resource

Agriculture, Forestry, and Land Use

Who to talk to?

- Developers
- Utilities
- Government
    - Make sure officials have the tools they need/make sure they are working toward climate resilience
- Local Residents
    - Farmers, indigenous, youth, etc.

Key Messages:

- Government : change legislature ordinances, zoning
- Density (buffers): Affordable housing and land preservation
    - value proposition/benefits - means of protecting areas/ incentives
- Climate co-benefits : connecting - one health water, air quality, carbon capture
    - Care about mental health, community violence
    - Indigenous - access to medicine, cultural/ceremonial
    - Interconnecting community values
    - Tree canopy
- Agroforestry
- Nature based solutions - integrated land use
- Land/Environment Balance
- Housing - missing middle
- Natural right to recreation (swimming/water)
- Economic/Financial politics
    - Budget reflects your values!
    - Take risks for more sustainable development
- Having successful models to show developers
- In Wake County - no local food system/decline in ag production, but leadership is proud of agrarian land preservation
- Need to model food sovereignty
- Overcoming the stigma of slave history in context of black farming

Activities:

- Local engagement
    - Developing leaders to take office
- Teaching who has the power to make the decisions
- Diversifying the board/commision (planning, parks design, adjudication)
- Political will created by community
- Effective engagement
- Tools/training + the language
    - Language that is welcoming
    - How to engage emotionally driven activists to communicate effectively

Additional Resources Needed: N/A

Waste

Who to talk to?

- BIPOC

- Seniors (especially in faith communities)
- Low income communities
- Youth

Key Messages:

- That we have respect and knowledge of peoples history
    - Establish trust
    - Consideration that behavior is not created in a vacuum
- Establish 2 way street of communication
    - That we'll meet where they are
- We need to reimagine what waste is and its purpose, shift in perspective
- Redefining what it means to use waste
- Focus on people
- Really hone in on the climate pollution reduction aspect

Activities:

- WCLN session in Feb
    - Add a waste/illegal dumping session
- Repurposing Initiatives:
    - Education for kids - do a big community focused clean up that they could lead
    - Integrate a senior program aspect
    - Container gardens
    - Composting element
    - Finding ways to create economic incentives
        - Provide for people
- Education Series - involve Rev Taylor

Additional Resources Needed

- Money for this program
- Staff coordinator(s)
- Physical space for communities to discuss what they feel they need for effective waste management

Transportation

Who to talk to?

- Transit users
- Bike-Ped Commision
- Clean connected communities

    - Faith based communities
    - Parents
- School Systems
- Business Community
- Super Commuter Users
    - People who drive over 110 mile/day
- Electrify transportation
- Zero Car Household
- NC DOT - Decision Makers
- Older adults
- Rural populations

Key Messages:

- Listening to community concerns first
- Climate - transportation - how it impacts health, saving money, efficiency
- Emphasize transportation choices
- Transportation as freedom
- Walking and biking to school + health
- Make streets safe for all users
- More conversations between programs and infrastructure
- Don't shame people
- Need policy level intervention instead of putting it on people to change behavior
- Convenience of using a different mode of transportation

Activities:

- SERP Youth ambassadors attend events to share information
    - Have shared info about covid, might be able to share about climate
- Clean Connected Communities
    - Monthly virtual Meetings
    - Transportation 101 this month
        - Passenger rail
        - Safety
        - Invite NC DOT to meeting
        - Working with partners
- 2 rural meetings in March - in person - talking about transportation needs
    - Connecting communities to resources
- Advocacy days with NCDOT

Additional Resources Needed:

- Invest in everyone
- AARP might have resources
- Conversations about mode of transportation switch
- Money is available
    - Think about outcomes based programming at beginning of receiving
    - Using funding effectively with outcomes in mind
    - monitor/evaluation with goal in mind
- VW settlement for electrification of fleet
- NC State Clean Tech Center
- Outreach helps to get a bigger audience
- Can't just put the burden on people, policy needed to create change

Toolkit follow-up:

CBO partners shared some additional feedback on toolkit needs and resources, as well as potential activities for engagement. Notes from this discussion are highlighted below:

- Leadership training
    - Teaching people/providing template(s) for speaking at a public meeting
    - How to talk to elected officials, legislators, decision-makers
    - Work with high school and college students to learn how to advocate - youth ambassadors
    - Power mapping and guidance - grassroots organizing training
    - Local Progress - Run for Something (Denzel has connection)
- Virtual legislative outlook
- Workforce and economic development resources
- Coalition building/communications:
    - No need for separate platform - use a listserv and living/shared document for resource sharing
    - This CBO group to continue to meet (as a "steering committee") - potentially meet 2nd Friday of each month?
        - Organize around regional topics, purposeful partnerships, maybe a communication calendar
        - Collective impact model
    - "Movement ecosystem"

- Other Engagement Activities
    - Infusing climate conversation into existing programs/ layer with other events
    - Convening at churches - rotating meeting at churches
    - Block party
    - Community garden - education and outreach
        - Air monitors and citizen science opportunities
    - All We Can Save dialogue Circles
    - Cultural organizing strategy - roadshow - music, spoken word, performance art, teaching
    - Youth Climate Summit
- Consider surveying people pre and post events/activities to gauge improved understanding of issues/potential actions

Section 6. Review of Authority

Central Pines Regional Council has reviewed existing statutory and regulatory authority to implement the two additional priority measures that are included in this PCAP in addition to the State of NC priority measures that are included by reference.

Central Pines Regional Council is one of sixteen Councils of Government that span the entire state of North Carolina. NC legislation in 1969 created the Councils of Governments as a "system of multi-county regional planning districts to cover the entire state" (GS-143-341) after Congress passed the Intergovernmental Cooperation Act. The statutory authority for regional councils of government is located in G.S. 160A-470, et. seq. For example, regional councils of government are specifically authorized by statute "[t]o apply for, accept, receive, and dispense funds and grants made available to it by the State of North Carolina or any agency thereof, the United States of America or any agency thereof, any unit of local government (whether or not a member of the council), and any private or civic agency[,] … [t]o contract with consultants[,] … [t]o contract with the State of North Carolina, any other state, the United States of America, or any agency thereof, for services[,] … [t]o promote cooperative arrangements and coordinated action among its member governments … [and] [a]ny other powers that are exercised or capable of exercise by its member governments and desirable for dealing with problems of mutual concern to the extent such powers are specifically delegated to it from time to time by resolution of the governing board of each of its member governments which are affected thereby, provided." G.S. 160A-475. North Carolina statute views its Councils of Governments and Regional Councils as local governments, and as such the code that governs Regional Councils/Councils of Government is the same as the code that governs their member governments.

Additionally, CPRC is authorized to administrate and be a partner in the implementation of the **Regional Electrify Program for Single Family and Multifamily Homes** Priority Measure. Further, as this is a non-regulatory measure that is voluntary and incentive-based, all our member local governments and those members of our sister Council of Government in the Kerr-Tar Regional Council of Governments may participate within their capacity as local governments.

Regarding the Priority Measure called **Asphalt Penetrating Sealer with TiO_2** any local government that wishes to implement this may do so within the confines of the NC General Assembly's procurement law for local governments and the standards and practices of their local government.

Section 7: Coordination, Outreach, and Feedback

Central Pines Regional Council conducted extensive intergovernmental coordination and stakeholder outreach in developing this PCAP. Central Pines Regional Council strived to be as inclusive as possible in stakeholder identification and outreach. Our perspective is that if you live, work, or own a business in one of the eight counties you are an important stakeholder.

This section describes the framework Central Pines Regional Council used to support robust and meaningful engagement strategies to ensure comprehensive stakeholder representation and overcome obstacles to engagement, including linguistic, cultural, institutional, geographic, and other barriers.

Figure 6: Engagement Purpose and Goals

The Regional Local Government Steering Commitee, named in the Acknowledgements Section, is a group of local government employees who represent the eight-county planning area. Starting in October of 2023 they met every other week during the development of the PCAP. The Steering Committee members

guided staff and helped spread the word about the four regional Community Climate Conversations and engaged with participants at those conversations.

The participating local governments raised a number of climate action strategies for discussion. Through polling of local governments to focus on strategies that could be implemented within a five-year timeframe, the following four strategies were supported by at least three jurisdictional representatives as high priority for the PCAP and subsequent EPA funding of CPRG implementation:

1. Programs to incentivize and overcome barriers to entry for **home energy efficiency and fuel conversion**, especially with program design to encourage low to moderate income household participation, like Electrify (described in Section 3).
2. There was also keen interest in how climate mitigation could be interwoven with community resilience efforts like the creation of resilience hubs with **solar PV being placed on key community buildings with battery backup power**.
3. One theme that was also consistent among the local government steering committee is the value of not just community-wide changes to drive efficiency and fuel transition, but also obtaining funding for **local government operational changes that reduce energy use and save costs—for example, energy audits and efficiency and fuel transition for buildings and fleets**.
4. There was also high interest in **public electric vehicle charging stations** emphasizing equitable placement.

There was also support of electric lawn equipment change-outs and support of e-mobility like e-bikes and scooter incentives.

One local government also highlighted that with forthcoming water, and possibly wastewater, plant retrofits needed to treat per-fluoroalkyl substances (PFAS), ensuring that local governments can afford to select the most energy efficient solutions will be key.

There was an acknowledgement that rural communities are at a different point in this process than communities with dedicated energy or sustainability staff and climate or energy plans. In many cases projects that assist with climate action can be seen as community amenities that can assist with economic development like electric vehicle charging infrastructure.

In addition to the regional local government steering committee, we heard a strong interest from the Durham Chapel Hill Carrboro MPO (DCHC) staff for bus electrification and from the Capital Area Metropolitan Planning Organization (CAMPO) staff for the Triangle Bikeway and Managed Freeways.

Additional Stakeholder Engagement

Staff worked with a contractor, Planning Communities, to develop and implement a stakeholder outreach and engagement strategy. This included the goals in Figure 6, including both digital and in-person strategies to engage around the overall CPRG planning effort. Efforts included:

- Placement on the CPRC website: https://www.centralpinesnc.gov/environment-resilience/climate
- Creation of a stakeholder engagement website: https://bit.ly/CPClimate
- In December 2023 and January 2024, two in-person half-day community-based organization workshops were held, described in Sections 4 and 5. These workshops were used for PCAP input and to inform how CPRC could work with CBOs for on-going stakeholder engagement for the Comprehensive Climate Action Plan.
- A CBO Toolkit for engaging communities: https://experience.arcgis.com/experience/040997706fb448eb8acddf1a69402a2f/page/CBO-Toolkit/
- January 2024, four in-person Community Climate Conversations were held in different locations and times of day to facilitate participant choice that matched their lifestyle and needs. Locations were chosen to minimize travel times for any given location within the eight-county planning area.
    - These meetings were advertised via social media, regional local government partners, community-based organizations, radio spots, digital banner ads on a Spanish-language news website
    - Spanish language translation was provided at these meetings.
    - A complete summary of the meetings and feedback are in Appendix G.
- A number of entities reached out via phone and email to provide feedback. Additional feedback received can be found in Appendix H.

Summary of Stakeholder Feedback

Residents and CBOs are very interested in reducing building energy burden and being involved. There is also a high level of support for transportation-related solutions including support for transit, greenways, and protected bike lanes and bicycling infrastructure.

One category of feedback that was received on more than one occasion was that education and youth engagement is a category of climate action that is important and somewhat missing in how we framed our conversations. While CPRC and Planning Communities staff did communicate that this effort is organized around sources of greenhouse gas emissions, and the tactics that can quantifiably reduce those emissions, we wanted to acknowledge that there is strong community support for integrating education into climate funding.

The **survey results** showed wide support for all measures across the solutions presented for the transportation, buildings, waste, agriculture, forestry, and land use, industry, and electric generation sectors. More interesting than the high level of support was where the respondents indicated that more information was needed. For example, people indicated that they needed more information about rideshare (80 people), micromobility (71 people), electrify buildings (93 people), waste to energy (89 people), transit-oriented development (71 people), promoted mixed-use development (78 people), and regional solar farm (97 people). This may indicate where education, engagement, or better explanation surrounding the survey is needed. Low participation in the survey from Franklin, Granville, and Johnston counties demonstrates a need for more intensive outreach and engagement in those counties.

Figure 7. A Selection of Comments from the Community Climate Conversations

- "Strategies should include: building electrification; connected and clean, sustainable transportation, transit and walkable and bike-friendly communities; mixed use development; composting and waste reduction."
- "Clear cutting for development should be disallowed and tree canopy should be protected."
- "New RDU airport expansion plans does not include solar or EV chargers – this plan should be revised to add these and other clean energy amenities. Excellent potential here to expand alternative energy sources."
- "Recognize that all of the issues affecting climate change and the strategies are interrelated and a holistic, big picture approach is important and where organizations are moving towards."
- "Require mayors, town and county commissioners to attend a number of hours on climate crisis and solutions."

Outreach and Coordination Documentation

Table 5 provides a log of interagency and intergovernmental coordination and stakeholder and public engagement efforts associated with developing this PCAP. Meeting and outreach materials and resources are available at https://experience.arcgis.com/experience/040997706fb448eb8acddf1a69402a2f/page/Climate-Conversations/.

Table 5. Outreach and Coordination Log

Date(s)	Organizations Involved	Coordination/Outreach Method	Location	Outcome(s) and Next Steps
09/06/2023 10/04/2023	Durham Environmental Advisory Board	Emily Barrett attended a virtual meeting to go over and update the group on the CPRG effort.	Virtual	See Durham EAB comments in Appendix F
11/17/2023	Solid Waste Consortium	Emily Barrett attended an in-person meeting to go over the CPRG effort.	In-person at CPRC on the Durham-Wake County border, with some participants calling in	General interest in electric trash trucks and investigating if waste to energy is a feasible regional alternative. Also broad acknowledgement of value of working together on messaging on recycling and composting. Interest in composting pilots.
10/30/2023 11/13/2023 11/27/2023 12/11/2023 01/08/2024 01/22/2024 02/05/2024 02/19/2024	Regional Local Government Steering Committee	Virtual Meetings	Virtual	Summary provided above in this section (Section 7).
12/14/2023 01/19/2024	Community-Based Organization Workshops	In-person at CPRC Offices on the border of Durham and Wake Counties.	In-person	See Section 5 of this document.
01/22/2024 01/23/2024 01/23/2024 01/25/2024	Community Climate Conversations	Large in-person events with stations and support for an online survey	Pittsboro, NC Creedmoor, NC Wendell, NC Durham, NC	See Appendix G and Survey responses at bottom of this page: https://bit.ly/CPClimate

Section 8: Conclusion

This PCAP is the first major deliverable under the CPRG planning grant awarded to Central Pines Regional Council. Central Pines Regional Council and its partners will continue planning, engagement, and action to reduce emissions; invest in sustainable infrastructure, technologies, and practices; build our economy; and enhance the quality of life in the Raleigh-Cary and Durham-Chapel Hill area. In 2025, Central Pines Regional Council will publish a comprehensive climate action plan (CCAP) that establishes equitable and sustainable economic development strategies that reduce emissions across all sectors. The CCAP will include near- and long-term emissions projections, a suite of emission reduction measures, a robust analysis of measure benefits, plans to leverage federal funding, and a workforce planning analysis. In 2027, Central Pines Regional Council will publish a status report that details implementation progress for measures included in the PCAP and CCAP, any relevant updates to PCAP and CCAP analyses, and next steps and future budget and staffing needs to continue implementation of CCAP measures.

If you have comments or questions about this PCAP or suggestions for the upcoming CCAP and status report, contact Emily Barrett and Shuchi Gupta at ebarrett@centralpinesnc.gov and sgupta@centralpinesnc.gov

Appendices

Appendix A | Crosstabulation of the Raleigh-Cary and Durham-Chapel Hill Plans and Projects

Appendix B | Greenhouse Gas Emission Inventory for the Eight-County Raleigh-Cary and Durham-Chapel Hill Area

Appendix C | Regional Electrify Program for Single Family and Multifamily Homes

Appendix D | Asphalt Penetrating Sealer with TiO2

Appendix E | LIDAC

Appendix F | Durham EAB Comments

Appendix G | Community Climate Conversation Summary

Appendix H | Other Comments Received

Appendix A | Greenhouse Gas (GHG) Reduction Tactics in Existing Plans and Programs | Crosstabulation

Jurisdictions | 8 counties, 9 municipalities

(These 9 municipalities are included because they are in the 8-county planning area and have known plans and programs that include greenhouse gas reducing actions. We are happy to include additional municipalities in the forthcoming Comprehensive Climate Action Plan.)

Durham Chapel Hill MSA (5 counties)	Chatham	Durham	Granville	Orange	Person				
Raleigh Cary MSA (3 counties)	Johnston	Franklin	Wake						
Municipalities	Apex	Cary	Chapel Hill	Durham	Holly Springs	Hillsborough	Morrisville	Raleigh	Wake Forest

Legend	
Plan (Climate or otherwise)	
Community Program	
Other	
This color of shading indicates an equity dimension in the tactic	

GHG Reduction Tactics | 6 Categories

Transportation | Buildings | Waste | Agriculture-Forestry-Other-Land-Use (AFOLU) | Industry | Electrical Generation

Notes

This cross tabulation provides a very high-level view of GHG tactics adopted by a jurisdiction.

This inventory considers only Plans and Programs already in place by jurisdictions. Source plan links are included in each category.

Only the 1-3 most recent and comprehensive Plan(s) adopted by jurisdiction were considered in developing the cross tabulation, mostly due to time constraints.

TRANSPORTATION | TACTICS	Chatham County	Durham County	Orange County	Granville County	Person County	Franklin County	Johnston County	Wake County	Apex	Cary	Chapel Hill	Durham	Holly Springs	Hillsborough	Morrisville	Raleigh	Wake Forest	TRANSPORTATION TACTICS
Increase hybrids and EV's in public fleet	✓	✓	✓						✓	✓	✓	✓		✓	✓	✓		Increase hybrids and EV's in public fleet
Increase public adoption of EV's and/or public charging stations	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓		Increase public adoption of EV's and/or public charging stations
Expand public transportation options (rail, transit, bus rapid transit)		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Expand public transportation options (rail, transit, bus rapid transit)
Expand bikeability	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Expand bikeability
Rideshare option availability	✓	✓	✓		✓						✓	✓		✓	✓	✓		Rideshare option availability
Promote walkability	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Promote walkability
Multimodal options availability		✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		Multimodal options availability
Programs such as idling reduction		✓	✓								✓			✓	✓	✓		Programs such as idling reduction
Promote micromobility/microtransit options by education, outreach and/or incentives		✓	✓					✓		✓	✓	✓		✓	✓	✓	✓	Promote micromobility/microtransit options by education, outreach and/or incentives
Community education and outreach program to promote reduction in Vehicle Miles Travelled by transportation demand management (TDM)		✓	✓							✓	✓	✓		✓	✓	✓		Community education and outreach program to promote reduction in Vehicle Miles Travelled by transportation demand management (TDM)
Provide incentives and subsidies (e.g. free transit passes) to promote TDM and encourage alternative commute modes		✓									✓	✓		✓	✓	✓		Provide incentives and subsidies (e.g. free transit passes) to promote TDM and encourage alternative commute modes
Interconnected and improved infrastructure		✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Interconnected and improved infrastructure
Improve freight efficiency																✓		Improve freight efficiency

Source Plan Links >>>	Chatham County	Durham County	Orange County	Granville County	Person County	Franklin County	Johnston County	Wake County	Apex	Cary	Chapel Hill	Durham	Holly Springs	Hillsborough	Morrisville	Raleigh	Wake Forest	*<<< Source Plan Links*
	Climate Action Plan, 2017	Adopted Comprehensive Plan, 2023	OC Transit Plan Final, 2022	Comprehensive Plan, 2018	Comprehensive Transportation Plan, 2011	2014 Comprehensive Transportation Plan	Envision Johnson 2040: Comprehensive Land Use Plan	Plan Wake, 2021	Advance Apex: The 2045 Plan	Draft CAP (Jan 2024)	Climate Action and Response Plan, 2021	Adopted Comprehensive Plan, 2023	Comprehensive Plan	Transportation Plan and Programming	Master Sustainability Plan, 2022	Community Climate Action Plan, 2021	2022-27 Strategic Plan	
			Commuter Options Program		Program- Transportation Assistance Grants	Parks and Recreation Master Plan, 2019- 2028		Wake Transit Plan, 2021	Apex Sustainability Program				Sustainability Action Plan, 2023	Future Train Station	Microtransit Program		Comprehensive Transportation Plan, 2021	
			Climate Action Plan, 2023											Comprehensive Sustainability Plan, 2023				
			Idling Reduction Campaign															

BUILDINGS | TACTICS	Chatham County	Durham County	Orange County	Person County	Granville County	Wake County	Johnston County	Franklin County	Durham	Chapel Hill	Holly Springs	Hillsborough	Apex	Cary	Raleigh	Morrisville	Wake Forest	BUILDINGS | TACTICS
Utilize renewable sources of energy	✓	✓	✓				✓		✓	✓		✓		✓	✓	✓		Utilize renewable sources of energy
Install and encourage renewable sources (solar and geothermal)	✓	✓	✓			✓	✓		✓	✓		✓	✓	✓	✓	✓		Install and encourage renewable sources (solar and geothermal)
Carbon Neutrality/Clean Energy Goal	✓	✓	✓			✓			✓	✓	✓	✓			✓			Carbon Neutrality/Clean Energy Goal
Conduct Energy Audits	✓	✓	✓						✓			✓	✓		✓	✓	✓	Conduct Energy Audits
Energy efficiency measures to reduce fossil fuel consumption	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	Energy efficiency measures to reduce fossil fuel consumption
Energy efficiency measures to reduce electricity consumption	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	Energy efficiency measures to reduce electricity consumption
Incentives/rebates for energy efficieny retrofits by residents and businesses		✓	✓				✓		✓	✓		✓		✓	✓		✓	Incentives/rebates for energy efficieny retrofits by residents and businesses
Home weatherization programs for low income/disadvantaged/frontline residents		✓	✓						✓	✓					✓		✓	Home weatherization programs for low income/disadvantaged/frontline residents
Encourage and incentivize green residential buildings	✓						✓			✓	✓	✓		✓	✓			Encourage and incentivize green residential buildings
LEED certified / green public buildings	✓	✓	✓						✓	✓		✓		✓	✓	✓		LEED certified / green public buildings
Water conservation efforts *(water purification is GHG intense)*	✓	✓	✓						✓	✓				✓	✓			Water conservation efforts *(water purification is GHG intense)*
Community educational programs / events on energy conservation and efficiency		✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	Community educational programs / events on energy conservation and efficiency
Urban heat island monitoring and mitigation		✓	✓						✓						✓			Urban heat island monitoring and mitigation
Incentivize energy efficiency in new construction & existing building renovations		✓							✓	✓		✓		✓	✓	✓	✓	Incentivize energy efficiency in new construction & existing building renovations
Support and promote adoption of community renewable energy programs such as Solarize.		✓	✓						✓	✓	✓	✓		✓	✓	✓		Support and promote adoption of community renewable energy programs such as Solarize.
Source Plan Links >>>	Climate Action Plan, 2017	Adopted Comprehensive Plan, 2023	Climate Action Plan, 2023			2030 Board Goals and Key Strategic Actions Energy Design and Management Guidelines, 2022	Envision Johnson 2040: Comprehensive Land Use Plan		Adopted Comprehensive Plan, 2023	Climate Action and Response Plan, 2021	Comprehensive Plan Going Solar Program	Comprehensive Sustainability Plan, 2023	Apex Sustainability Program Apex Solar Projects	Draft CAP (Jan 2024)	Community Climate Action Plan, 2021	Master Sustainability Plan, 2022	Energy Savings Programs	*<<< Source Plan Links*
	Chatham County	**Durham County**	**Orange County**	**Person County**	**Granville County**	**Wake County**	**Johnston County**	**Franklin County**	**Durham**	**Chapel Hill**	**Holly Springs**	**Hillsborough**	**Apex**	**Cary**	**Raleigh**	**Morrisville**	**Wake Forest**	

WASTE | TACTICS	Chatham County	Durham County	Orange County	Person County	Granville County	Wake County	Johnston County	Franklin County	Durham	Chapel Hill	Holly Springs	Hillsborough	Apex	Cary	Raleigh	Morrisville	Wake Forest	WASTE | TACTICS
Community Waste Reduction Grants																		Community Waste Reduction Grants
Encourage and promote recycling																		Encourage and promote recycling
Provide discounted compost bins to residents to encourage composting																		Provide discounted compost bins to residents to encourage composting
Event Recycling and/or Bin Loan Program																		Event Recycling and/or Bin Loan Program
Food Scraps Composting & Drop-Off Sites																		Food Scraps Composting & Drop-Off Sites
Address construction and demolition waste																		Address construction and demolition waste
Reduce waste generation at public events																		Reduce waste generation at public events
Community programs / educational events such as GoGreen																		Community programs / educational events such as GoGreen
Reduction in waste to landfills/zero waste																		Reduction in waste to landfills/zero waste
Bioenergy Recovery project																		Bioenergy Recovery project
Source Plan Links >>>	Climate Action Plan, 2017	Adopted Comprehensive Plan, 2023	Climate Action Plan, 2023 Road-to-Zero-Waste Master-Plan Food Waste Drop-Off Sites			Grants Program			Adopted Comprehensive Plan, 2023	Climate Action and Response Plan, 2021	Comprehensive Plan Garbage and Recycling Program	Comprehensive Sustainability Plan, 2023 Garbage Collection Program	Composting Programs Recycling Programs Sustainability Initiatives Report	Recycling Program Compost Bin Sale Program Draft CAP (Jan 2024)	Community Climate Action Plan, 2021 Backyard composting program Recycling Programs	RPCR (Recycling Participation and Contamination Reduction) program Master Sustainability Plan, 2022	Wake Forest Sustainability 101 Programs	*<<< Source Plan Links*

AFOLU | TACTICS	Chatham County	Durham County	Orange County	Person County	Granville County	Wake County	Johnston County	Franklin County	Durham	Chapel Hill	Holly Springs	Hillsborough	Apex	Cary	Raleigh	Morrisville	Wake Forest	AFOLU | TACTICS
Discourage clear cutting	✓	✓							✓			✓				✓		Discourage clear cutting
Protect land (including agricultural) from residential development		✓	✓		✓	✓	✓		✓			✓				✓		Protect land (including agricultural) from residential development
Encourage reforestation in general / with native trees that squester higher carbon	✓	✓	✓						✓	✓		✓		✓	✓	✓		Encourage reforestation in general / with native trees that squester higher carbon
Education efforts to protect tree canopy		✓	✓				✓		✓	✓	✓	✓		✓	✓	✓		Education efforts to protect tree canopy
Preservation efforts to protect tree canopy	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓	✓		Preservation efforts to protect tree canopy
Protect open space and natural resources		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		Protect open space and natural resources
Promote sustainable agricultural (rural and urban farming) practices	✓	✓	✓		✓	✓	✓		✓	✓				✓	✓			Promote sustainable agricultural (rural and urban farming) practices
Develop mixed use centers (including employment centers)		✓			✓	✓	✓		✓	✓					✓			Develop mixed use centers (including employment centers)
Green Infrastructure development	✓	✓	✓			✓	✓		✓	✓		✓			✓	✓		Green Infrastructure development
Source Plan Links >>>	Climate Action Plan, 2017	Adopted Comprehensive Plan, 2023	Climate Action Plan, 2023. Lands Legacy Program	Person County Recreation, Arts and Parks Master Plan Update Final Report, 2014	Comprehensive Plan, 2018	Enhanced Voluntary Agricultural District Program Plan Wake, 2021 Agricultural Conservation Easement Program Farmland Preservation Program 2030 Board Goals and Key Strategic Actions	Envision Johnson 2040: Comprehensive Land Use Plan	Parks and Recreation Master Plan, 2019- 2028	Adopted Comprehensive Plan, 2023	Climate Action and Response Plan, 2021 Charting Our Future, 2020	Comprehensive Plan	Comprehensive Sustainability Plan, 2023		Draft CAP (Jan 2024) Urban Farm Program	Community Climate Action Plan, 2021 CCAP Implementation Report, 2023	Master Sustainability Plan, 2022		*<<< Source Plan Links*

INDUSTRY | TACTICS	Chatham County	Durham County	Orange County	Person County	Granville County	Wake County	Johnston County	Franklin County	Durham	Chapel Hill	Holly Springs	Hillsborough	Apex	Cary	Raleigh	Morrisville	Wake Forest	INDUSTRY | TACTICS
Improve efficiency of utility systems																		Improve efficiency of utility systems
Encourage green industries																		Encourage green industries
Source Plan Links >>>	Climate Action Plan, 2017						Envision Johnson 2040: Comprehensive Land Use Plan			Climate Action and Response Plan, 2021								*<<< Source Plan Links*

ELECTRICAL GENERATION | TACTICS	Chatham County	Durham County	Orange County	Person County	Granville County	Wake County	Johnston County	Franklin County	Durham	Chapel Hill	Holly Springs	Hillsborough	Apex	Cary	Raleigh	Morrisville	Wake Forest	ELECTRICAL GENERATION | TACTICS
Promote cleaner energy sources for electricity generation				***Duke Proposal / Regulatory Process underway***														Promote cleaner energy sources for electricity generation
Promote renewable energy sources for electricity generation																		Promote renewable energy sources for electricity generation
Assess renewable energy generation potential (i.e., generating capacity) for solar photovoltaics and wind energy projects on public properties and identify priority sites for planning and implementation																		Assess renewable energy generation potential (i.e., generating capacity) for solar photovoltaics and wind energy projects on public properties and identify priority sites for planning and implementation
Source Plan Links >>>		Renewable Energy Action Plan, 2022	Climate Action Plan, 2023	Advancing the future of energy in Person County					Carbon Neutrality and Renewable Energy Action Plan, 2021			Comprehensive Sustainability Plan, 2023			CCAP Implementation Report, 2023			*<<< Source Plan Links*

Central Pines Region Greenhouse Gas Inventory Report

EPA Grant Number: 02D56123

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Prepared by the NC Clean Energy Technology Center

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Section 1: Introduction

This report was produced by the North Carolina Clean Energy Technology Center (Center) in collaboration with the Central Pines Regional Council (CPRC). The purpose of this report is to create a greenhouse gas inventory for the CPRC's eight-county planning area as a part of CPRC's PCAP report for the Climate Pollution Reduction Grant (CPRG). The eight-county planning area includes the following North Carolina counties: Chatham, Durham, Franklin, Granville, Johnston, Orange, Person, and Wake (collectively, "the Region"). This inventory will estimate anthropogenic emissions of primary greenhouse gasses including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

This report contains a baseline inventory for the counties for the 2022 calendar year. This report, and its results will be utilized by CPRC when determining which sectors to target for greenhouse gas reduction activities. The State of North Carolina's Clean Energy Plan references a 2005 baseline year for reducing electric power sector greenhouse gas emissions, despite the desire to work in concert with the state - the region requested an updated greenhouse gas inventory.

This report is divided into three sections. Section 1 provides a brief description of the report and why it was conducted. Section 2 describes the methodology of the project and emissions calculations, as well as data sources used in completing the inventory. Section 3 contains the 2022 baseline greenhouse gas inventory for the eight individual counties, as well as the combined results for the entire CPRC planning area.

Section 2: Methodology

The North Carolina Clean Energy Technology Center (Center) gathered greenhouse gas emissions data from various sources and input that data into the International Council on Local Environment Initiatives (ICLEI) carbon accounting tool, ClearPath. Data sources were identified and, where necessary, the team determined reasonable tools for estimation of emissions data.

2.1: Description of Tools Used

The Center team identified several main tools to complete this greenhouse gas (GHG) inventory. ClearPath, an online platform for establishing baselines and tracking emissions data over time, would be used to log the initial GHG emissions and may be used in the future to monitor progress as Central Pines implements its carbon pollution reduction programs. SLOPE is an online tool used in this analysis to help fill gaps in data from the energy sector, but may also be used in the future to model potential outreach and program scenarios. ICLEI's LEARN tool is a web-based system to provide estimating baselines and changes to agriculture, forestry, and other land uses. The US EPA Greenhouse Gas Reporting resources include Facility Level Information on GreenHouse gasses Tool (FLIGHT), which is useful to determine process and fugitive emissions in localities.

2.1.1: ClearPath

ICLEI - Local Governments for Sustainability[1] is a worldwide network for governments of localities to share resources and promote sustainability. One of the products offered along with ICLEI is ClearPath.[2] ClearPath is an online software platform for completing GHG Inventories, forecasts, and action plans. ClearPath can manage emissions tracking by allowing users to set baselines, forecast emissions changes, and monitor progress toward goals. This product was chosen by Central Pines Regional Council for this Inventory process and the Center team agrees that this software is up to the task and well chosen.

ClearPath uses the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (US Community Protocol to account for a report on GHG emissions. This protocol establishes requirements and recommendations for best practices when developing community GHG inventories.

The ClearPath tool was also used to convert raw data, such as vehicle miles traveled (VMT), into metric tonnes of CO_2e emissions using the Intergovernmental Panel on Climate Change's (IPCC) 5th Assessment 100 year values. ClearPath has a number of default settings called "Factor Sets" that can be changed or overwritten, based on the data available to the user and the project needs. The Center team used the most recently available Factor Sets for any default

[1] ICLEI - Local Governments for Sustainability, Homepage, from: https://iclei.org/
[2] ClearPath, ICLEI Tools Page, from: https://icleiusa.org/clearpath/

input where data was not available. For example, the Center team used the default settings for transportation sector vehicle type inputs. A limitation of the ClearPath program within the Waste Category was the absence of a construction debris subcategory. The Center team converted the construction debris to municipal solid waste, as that was the most fitting other category.

2.1.2: SLOPE

The State and Local Planning for Energy (SLOPE)[3] program was developed by the National Renewable Energy Laboratories (NREL) to serve as an online platform to support decarbonization planning at the state and local level. The program offers scenario plans as well as a data viewer that can be used to estimate the impacts of various decarbonization strategies, as well as model the effects of outside actions on decarbonization progress at the state and local level.

The Center team used SLOPE to obtain 2022 emissions estimates for the GHG Inventory. SLOPE can also provide equity information to aid in targeted efforts to reach underserved or vulnerable communities, the effects of energy efficiency programs on customer bills, electric vehicle adoption potential and the impact of EVs on the grid. The program can provide renewable estimates as well, including comparing rooftop solar potential to utility-scale generation and comparing costs of renewable power generation to fossil generation.

2.1.3: LEARN

The Land Emissions and Removals Navigator (LEARN)[4] is a tool developed by ICLEI to allow localities to estimate forest and agricultural baselines and changes due to different operations within the affected locality's borders. The tool uses methods in the ICLEI Greenhouse Gas Protocol and National Land Cover Database data to produce approximations of annual GHG impacts over a user-selected time period. LEARN creates a report with emissions and sinks due to land use changes.

The Center team used this tool to establish a baseline for land-related emissions changes using the most recent datasets available.

2.1.4: FLIGHT

The Facility Level Information on GreenHouse gasses Tool (FLIGHT)[5] is a tool developed by the US EPA to provide greenhouse gas emissions information from large facilities. The dataset used is based on facility required reports to the US EPA. At the time of research, the most recent dataset available was from 8/18/2023. FLIGHT reports emissions from power plants, petroleum and natural gas systems, refineries, chemical operations, pulp and paper, minerals, metals, waste, and "other" emitting facilities which include universities with central plants. The Center team obtained waste data and energy sector data, therefore those categories were not added to the inventory to avoid double-counting.

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[3] SLOPE: State and Local Planning for Energy, NREL Website, from: https://maps.nrel.gov/slope
[4] LEARN, Land Emissions and Removals Navigator Tool, from: https://icleiusa.org/LEARN/
[5] GHG Data Tools, EPA Greenhouse Gas Page, from: https://ghgdata.epa.gov/ghgp/main.do

2.2: Data Used for Inventory

2.2.1 Transportation Data

The Center team, through partners at the counties in the Region, contacted the NC Department of Transportation (NC DOT) and requested transportation emissions data. The team obtained a list of annual vehicle miles traveled statewide, delineated by county. The data received was comprehensive, spanning all 100 counties from 2009 to 2022. The team took the 2022 annual data for the selected counties on the inventory. For data entry into Clearpath, the team applied ICLEI's default recommended percentages of various vehicle types (e.g. Gasoline passenger vehicles: 60.6%, Diesel passenger vehicles: 0.3%, Gasoline light trucks: 32.4%, etc.) to the total county-level vehicle miles traveled information. The entirety of the 2022 NC DOT VMT Report is contained in Appendix A.

2.2.2: Waste Data

Through publicly available data provided by the North Carolina Department of Environmental Quality[6], the Center team obtained NC County Waste Disposal Reports for Fiscal Year 2021-2022 (which was the most recent available as of January 2024) for each of the eight counties within the Region. The Waste Disposal Reports detail landfilled, exported, and imported waste within the county in categories of municipal solid waste (MSW) and construction debris (CD). The Reports calculate the total of waste disposed by activity within county's borders as:

[Equation 1]: Total waste generated by county activity
Waste Generated = Landfilled Waste + Exported Waste - Imported Waste

The waste that is stored and or processed within a county's borders would be calculated as:

[Equation 2]: Total waste stored within a county
Stored Waste = Landfilled Waste + Imported Waste

Because this analysis focuses on activities and operations within a county, the total waste generated formula, Equation 1 above, was used to calculate inputs for entry into ClearPath. Due to limitations within the ICLEI calculation software, the team converted the construction debris into municipal solid waste on a basis of equal tonnage. NC County Waste Disposal Reports are included in Appendix B.

2.2.3: Energy Data

The Center team began energy data acquisition with research into the utilities provided to each county by electric utilities, natural gas utilities, and propane suppliers. In addition to Duke Energy providing electricity to customers, each county is served in part by at least one electric cooperative and potentially one or more municipal power authorities. For natural gas, the Center

[6] Solid Waste Management Reports, NC Department of Environmental Quality, from: https://www.deq.nc.gov/about/divisions/waste-management/solid-waste-section/resources-and-data/solid-waste-management-annual-reports

team contacted Dominion Energy and Piedmont Natural Gas (a subsidiary of Duke Energy) as well as representatives for propane retailers.

Table 1. Cooperative and Municipal Electric Utilities by County

County	Cooperative	Municipal
Chatham	Central EMC, Randolph EMC	N/A
Durham	Piedmont EMC, Wake EMC	N/A
Franklin	Wake EMC	Louisburg, Wake Forest
Granville	Piedmont EMC, Wake EMC	Wake Forest
Johnston	South River EMC, Tri-County EMC,* Wake EMC	Benson, Clayton, Selma, Smithfield
Orange	Piedmont EMC	N/A
Person	Piedmont EMC	N/A
Wake	Wake EMC	Apex, Wake Forest

*Tri-County EMC provided service to too few homes (<10) to tabulate for this inventory.

The Center team contacted Duke Energy, Dominion Energy, and each of the electric cooperatives individually. The Center reached out to ElectriCities, the member organization of municipal power providers in North Carolina, to make a single information request that would cover all municipal power providers. The format of the request was to provide electric consumption by county and customer class (residential, commercial, and industrial).

Several electric cooperatives were able to provide some data, but the format of the data was not as granular as this analysis would require; the utilities reported their annual energy sales for 2022, but did not separate by customer class. Similarly, data acquired from the municipal power authorities reported energy for the entire entity without delineating customer classes. The Center team is following up to determine how much of this data would be available with further work on the utility side and whether adjustments are needed within the request. For example, some counties have a limited number of large industrial customers whose exact usage may reveal trade secret data. Therefore, the Center team would consider it reasonable to combine all non-residential usage to further aggregate customers and provide a larger measure of protection to sensitive customers.

Duke Energy cited a code of conduct set forth by the North Carolina Utilities Commission that prevents regulated utilities from disclosing county-level energy information. According to the

Center's research and inquiries, the Commission would have to permit Duke to disclose that data for inventory. The Center team is working with the Commission Public Staff and representatives from Duke Energy to initiate this process (see Section 2.3.1).

Due to the limitations of the electric data available, including the inability for Duke (as the largest electricity provider) to provide data for the inventory, the Center coordinated with the Central Pines Regional Council to determine a reasonable estimation process. The Center team investigated two tools: Google's Environmental Insights Explorer and NREL's State and Local Planning for Energy (SLOPE, see Section 2.1.2 above). The team compared known 2020 greenhouse gas data from previous inventories conducted by the county governments to each of the tools and found that the SLOPE tool had less variance. Therefore, SLOPE was used for estimations needed.

The Center team contacted Piedmont Natural Gas (a Duke Energy Subsidiary), Dominion Energy, and representatives from the Southeast Propane trade association. Piedmont was largely unresponsive to inquiries made by the Center team. Because the Utilities Commission will need to be involved with data disclosure permission for electric energy usage, the Center intends to add natural gas to list of disclosure requests for the Commission. Repeated attempts to contact the trade association for North Carolina propane sales and individual propane sellers did not result in fruitful data acquisition.

Because primary data was not available, the Center team used NREL's SLOPE tool to provide all energy sector estimates. For future inquiries into combustion fuels, the Center team plans direct contact with providers as well as continuing work with the Utilities Commission and Commission Public Staff (see section 2.3.2 for additional information). SLOPE Scenario output used in the Center team's research are included in Appendix C.

2.2.4: Agriculture, Forestry, and Other Land Use

The Center team used the ICLEI's LEARN (Land Emissions And Removals Navigator) tool to produce approximations of land use change-related annual emissions and sinks for each of the eight counties in the Region. The tool allows selection at the county level, then the user must select a proximate location of known data sources from the National Land Cover Database. Due to proximity and similarity of features, the Center team used the "Tennessee" entry on that database to generate the LEARN Reports. The Center team's tool inputs included modeling non-forestry tree cover change due to the mixed nature of much of the Region's development.

Because the comparison also includes a temporal factor, the Center team selected the two most recent data points available: 2016 and 2019 to obtain the approximation of emissions changes over that time period in the Region. The data produced by the LEARN tool is an annual average of emissions and sinks. The LEARN summary reports in their entirety are included in Appendix D.

2.2.5: Process and Fugitive Emissions

EPA's FLIGHT provides data for large facilities. The Center team used it to determine emissions for processes. The tool uses a query structure with various parameters to achieve the desired information. The Center team used the search parameters: year = 2022, state = NC, GHGs = All, datatype = All Emitters. The query produced 15 results within the Region, three of which

were power plants and four others were waste facilities. See Appendix E for the full FLIGHT information report.

To avoid double-counting, the Center team specifically excluded power generation facilities, whose emissions would be captured in energy data collection, and waste facilities, whose information would be included directly in the waste reports discussed above.

Fugitive emissions information was not included in this analysis. Datasets were generally unavailable. Fugitive emissions from the power sector are assumed to have been included with energy emissions estimates. Emissions from agricultural applications are assumed to be included in the agriculture and forestry land use change estimates.

2.2.6: Conversion Notes

ClearPath, by default, takes inputs in metric tonnes of carbon dioxide equivalent. All data gathered or estimated would be converted into that medium. FLIGHT's information is presented in metric tons, requiring no conversion. SLOPE's data output is in millions of metric tons; a straightforward factor conversion was used. LEARN's AFOLU output was in US short tons; the Center team converted to metric tonnes using equation 3 below. Once converted, the Team rounded all output to the nearest whole metric ton and used that to input into ClearPath.

[Equation 3]: Conversion of tons from US to Metric
1 US Ton = 0.9071847 Metric Ton

Section 2.3: Future Data Procurement and Plans

Data obtained by the Center team was at times incomplete or not granular enough to fulfill the goals of the project. While the transportation data and waste data were comprehensive, the energy (electricity, natural gas, propane, fuel oil, etc.) was estimated using the SLOPE tool. The Center has plans for further inquiry and research into the exact channels and methods to acquire and tabulate the estimated data.

2.3.1: Electricity Consumption Data

The team at the Center reached out to the service providers for energy in the Region that were part of the inventory. Team members reached out to Duke Energy, Central Electric Membership Corporation (EMC), Randolph EMC, Piedmont EMC, Wake EMC, South River EMC, and Electricities, an association of the municipal electric utilities in the area. The request to each power utility was the same: provide 2022 electric consumption for the affected counties, reported by customer class and by county.

Electricities and the EMCs were both helpful with overall electric sales and/or consumption data. The team used the data provided to check against the estimates provided by SLOPE. The differences were minor, and both the Center team and the CPRC team were satisfied with the outcome for an initial greenhouse gas inventory, with the understanding that future refinement would follow.

Several of the utilities cited privacy concerns for large industrial customers, whose energy consumption profile may unintentionally reveal trade secret data. The Center team elected to assuage those concerns by requesting combined commercial and industrial data. However, the data received was not as specific as the team had hoped, therefore the team elected to rely on SLOPE (see 2.2.3 above) for the initial analysis and work with the utilities to find an agreeable method of obtaining residential and non-residential data for each county.

An especially large hurdle were regulatory limitations imposed on Duke Energy by the North Carolina Utilities Commission. Revealing county level customer class data appears to be a violation of the Commission's code of conduct, and obtaining such information requires Commission action. The project team is working with the Commission's Public Staff, as well as representatives for Duke Energy to move this process forward. The Center team will simultaneously request access to granular information from regulated natural gas utilities also.

2.3.2: Combustion Fuel Data

Within the eight county Region of this study various fuels are combusted to provide heat, hot water and/or steam for residential, commercial and institutional buildings as well as to support the electric and thermal energy needs of industry. The primary fuels combusted across the region include natural gas, propane, fuel oil, and coal.

To calculate the greenhouse gas emissions from fuel combustion, it is necessary to acquire consumption data for each fuel and for each county. Unlike many regulated pollutants for which emissions may be controlled through combustion or exhaust control technologies, GHGs, with

few exceptions, are emitted uncontrolled from combustion sources regardless of fuel type. As such, the GHG emissions (per unit of energy) are primarily based on the carbon content of the fuel versus the equipment in which the fuel is used. Therefore, when calculating and compiling a GHG emission inventory from fuel combustion, it is not necessary to categorize the type of facility or combustion unit (i.e., furnace, boiler gas turbine or reciprocating engine) consuming the fuel. Instead, for a robust GHG emission inventory from fuel combustion it is necessary to obtain a comprehensive aggregated inventory of natural gas, propane, fuel oil, and coal consumption for each county.

Utilizing county-wide fuel-specific consumption data, GHG emissions can be calculated by employing emission factors published by the US Environmental Protection Agency (US EPA),the US Energy Information Administration.(EIA) or other GHG protocol emission factors. For example, the EIA-publishes the following CO_2 (main constituent of GHG) emission factors for the primary fuels combusted in the eight-county region:

- Natural Gas – 0.053 metric tons/MMBtu
- Propane – 0.063 metric tons/MMBtu
- Residual heating fuel oil – 0.075 metric tons/MMBtu
- Coal (aggregate for all types) – 0.096 metric tons/MMBtu

It should be noted that besides the four primary fuels discussed above, it is important for a complete inventory to identify facilities within each county that may also combust other fuels such as municipal solid waste, tire-derived fuel and biomass as these fuels also contribute to GHG emissions.

Obtaining all of the fuel data required for a GHG emission inventory can be a challenge. For some fuels, such as coal, fuel oil, tire-derived fuel, and biomass, there are a limited number of facilities in each county (if any at all) that combust these fuels. One source of identifying where these fuels may be combusted is by reviewing the EPA FLIGHT tool (discussed above).

Natural gas and propane consumption data, at the county level, would need to be provided by the natural gas utilities and propane providers, respectively. As discussed previously in this report, this has proven to be a challenge and sufficient time needs to be budgeted to allow the process of acquiring that data through appropriate means, as also discussed above,

Section 3: Results

3.1: Eight-County Planning Area

Table 2: Eight-County Planning Area Emissions by Source	
Emission Source	CO2e (MT)
Residential Energy	5,653,480
Commercial Energy	4,557,250
Industrial Energy	1,444,720
Transportation	10,514,764
Solid Waste	1,784,502
Process and Fugitive Emissions	743,234
AFOLU*	-5,379,212
Total	24,697,950

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 1. Eight-County Emissions by Source

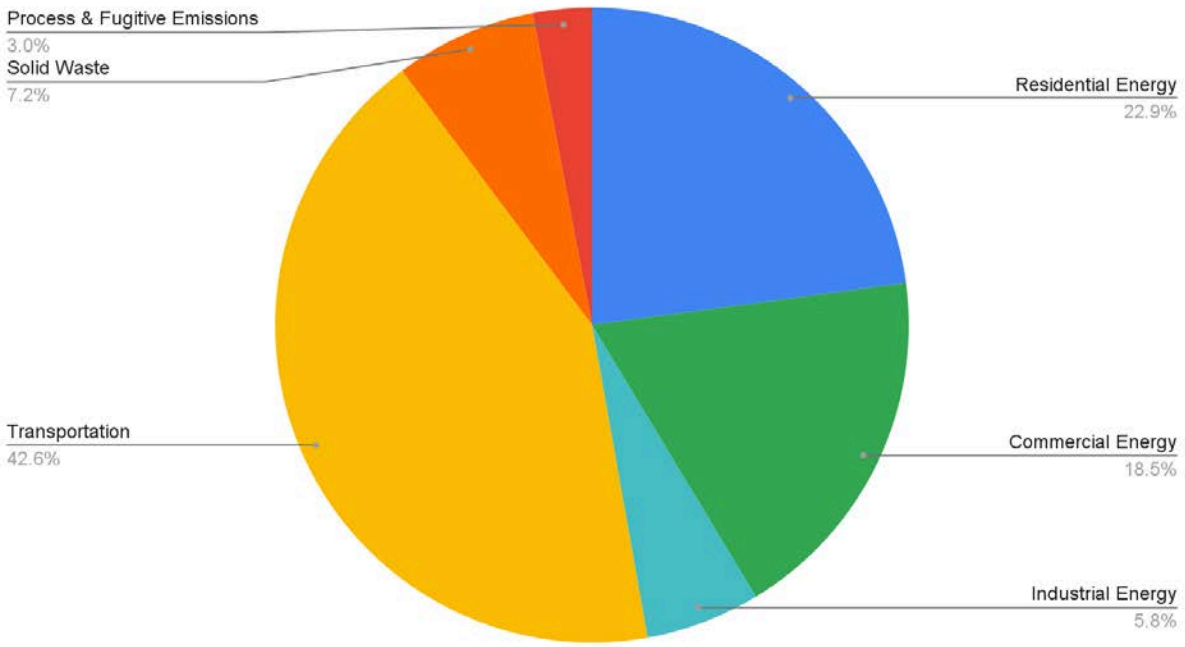
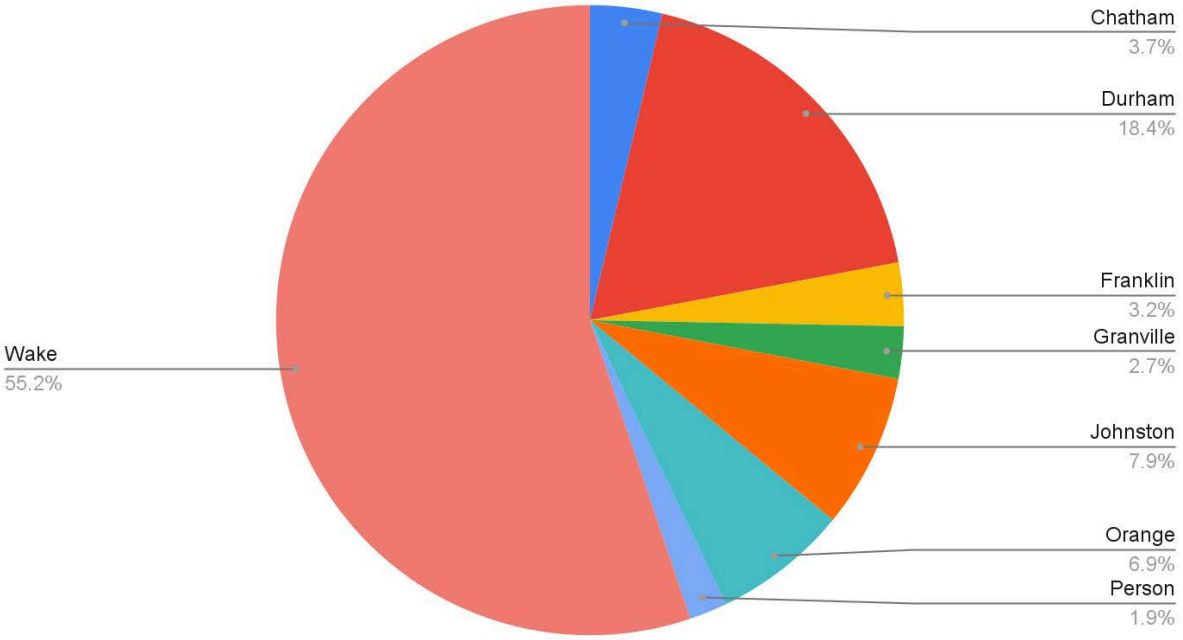


Table 3. Emissions by County	
County	CO2e (MT)
Chatham	915,332
Durham	4,532,083
Franklin	802,648
Granville	662,920
Johnston	1,960,848
Orange	1,715,933
Person	479,815
Wake	13,628,371
Total	24,697,950

Figure 2. Emissions by County

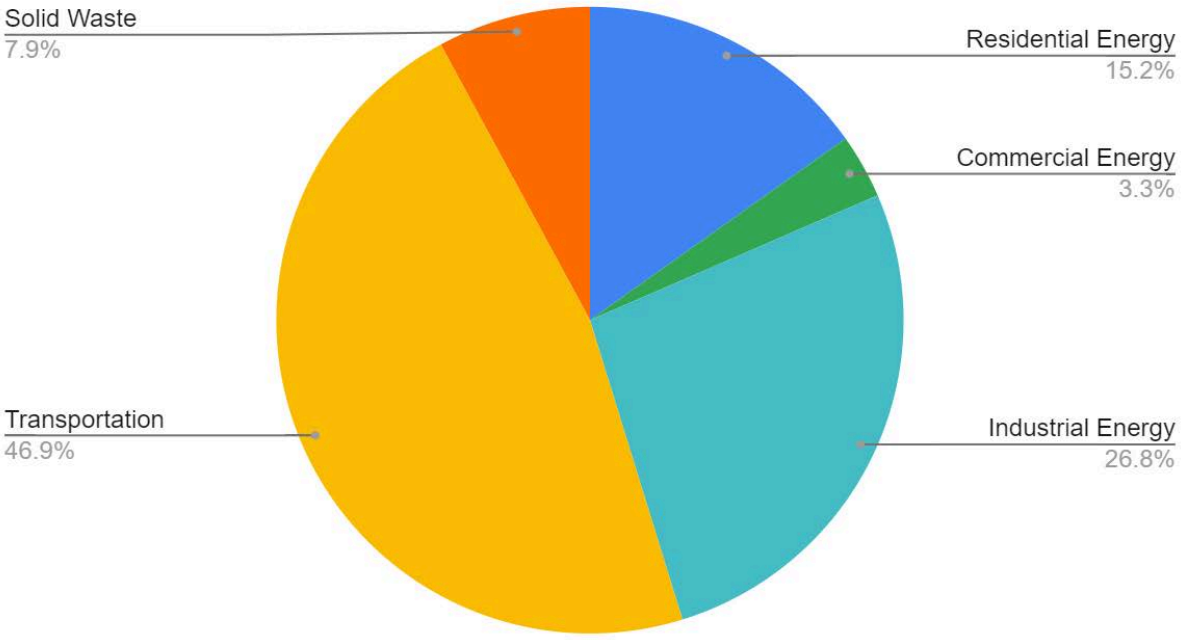


3.2: Chatham County

Table 4. Chatham County Emissions by Source	
Source	CO2e (MT)
Residential Energy	138,800
Commercial Energy	30,340
Industrial Energy	244,900
Transportation	429,050
Solid Waste	72,242
AFOLU*	-940,945
Total	915,332

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 3. Chatham County Emissions by Source

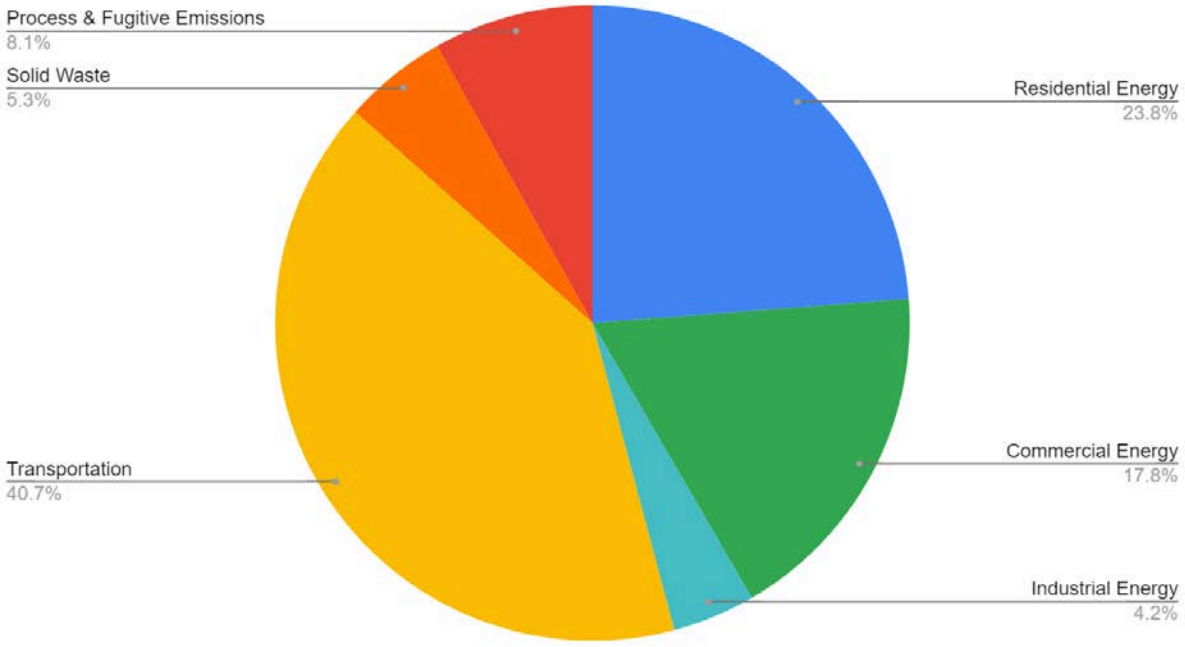


3.3: Durham County

Table 5. Durham County Emissions by Source	
Source	CO2e (MT)
Residential Energy	1,078,000
Commercial Energy	808,500
Industrial Energy	191,100
Transportation	1,845,517
Solid Waste	239,861
Process and Fugitive Emissions	369,105
AFOLU*	-413,089
Total	4,532,083

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 4. Durham County Emissions by Source

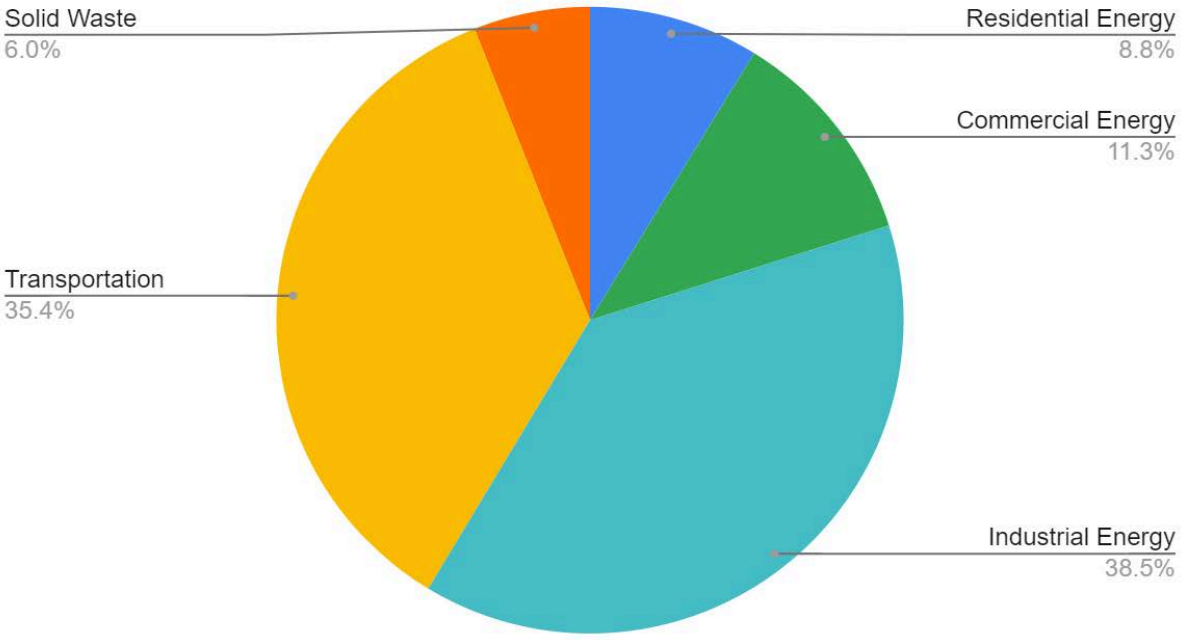


3.4: Franklin County

Table 6. Franklin County Emissions by Source	
Source	CO2e (MT)
Residential Energy	70,420
Commercial Energy	91,030
Industrial Energy	309,100
Transportation	283,899
Solid Waste	48,199
AFOLU*	-643,575
Total	802,648

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 5. Franklin County Emissions by Source

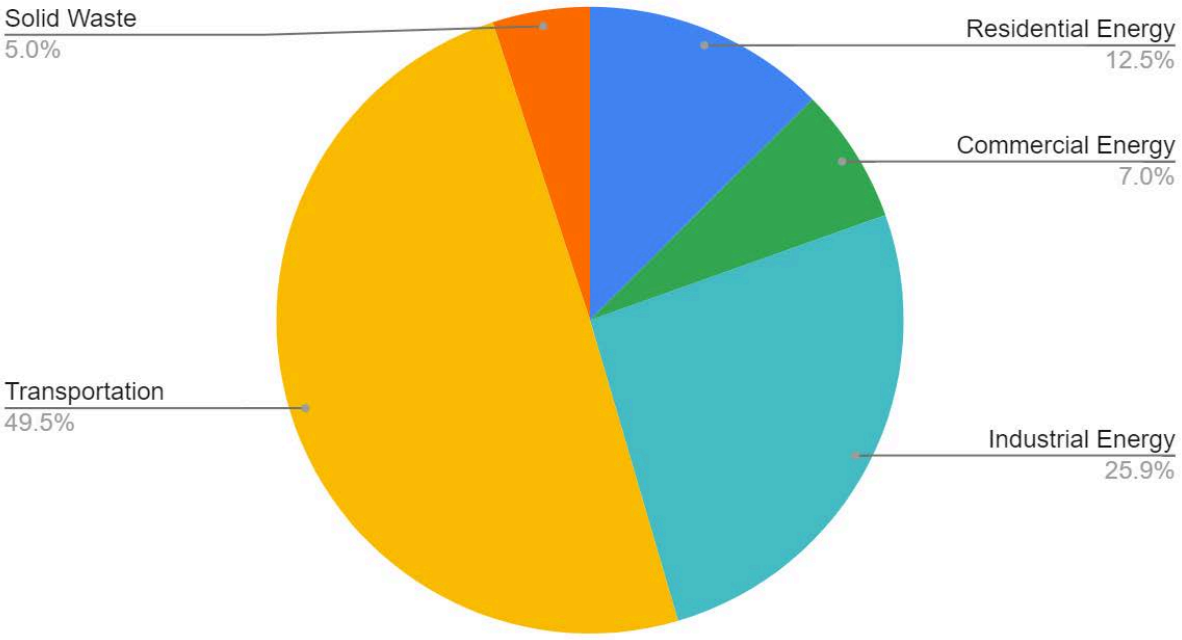


3.5: Granville County

Table 7. Granville County Emissions by Source	
Source	CO2e (MT)
Residential Energy	83,180
Commercial Energy	46,490
Industrial Energy	171,700
Transportation	328,284
Solid Waste	33,266
AFOLU*	-778,694
Total	662,920

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 6. Granville County Emissions by Source

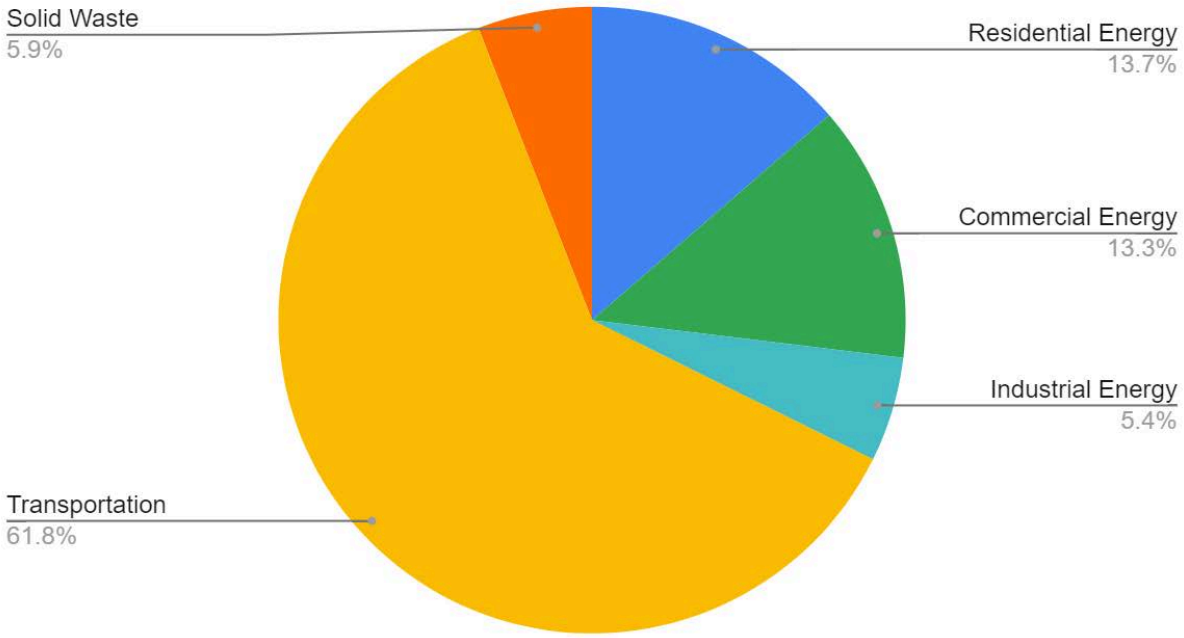


3.6: Johnston County

Table 8. Johnston County Emissions by Source	
Source	CO2e (MT)
Residential Energy	267,700
Commercial Energy	260,200
Industrial Energy	106,000
Transportation	1,211,331
Solid Waste	115,617
AFOLU*	-817,211
Total	1,960,848

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 7. Johnston County Emissions by Source

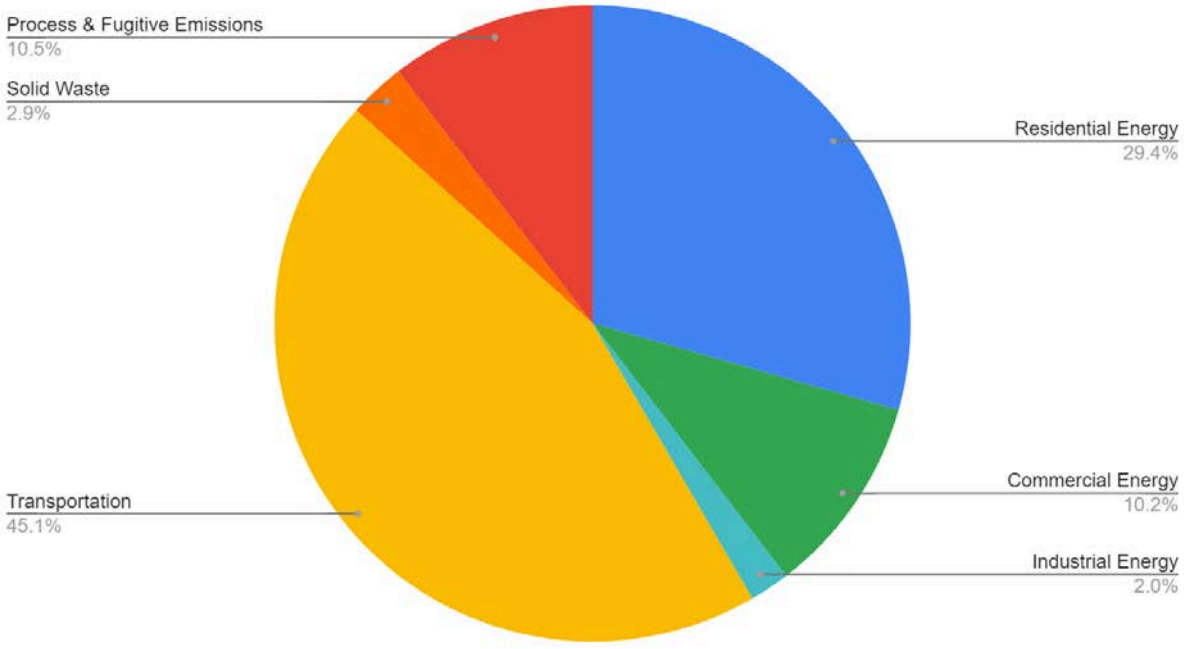


3.7: Orange County

Table 9. Orange County Emissions by Source	
Source	CO2e (MT)
Residential Energy	504,200
Commercial Energy	175,100
Industrial Energy	34,820
Transportation	773,242
Solid Waste	49,080
Process and Fugitive Emissions	179,491
AFOLU*	-564,836
Total	1,715,933

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 8. Orange County Emissions by Source

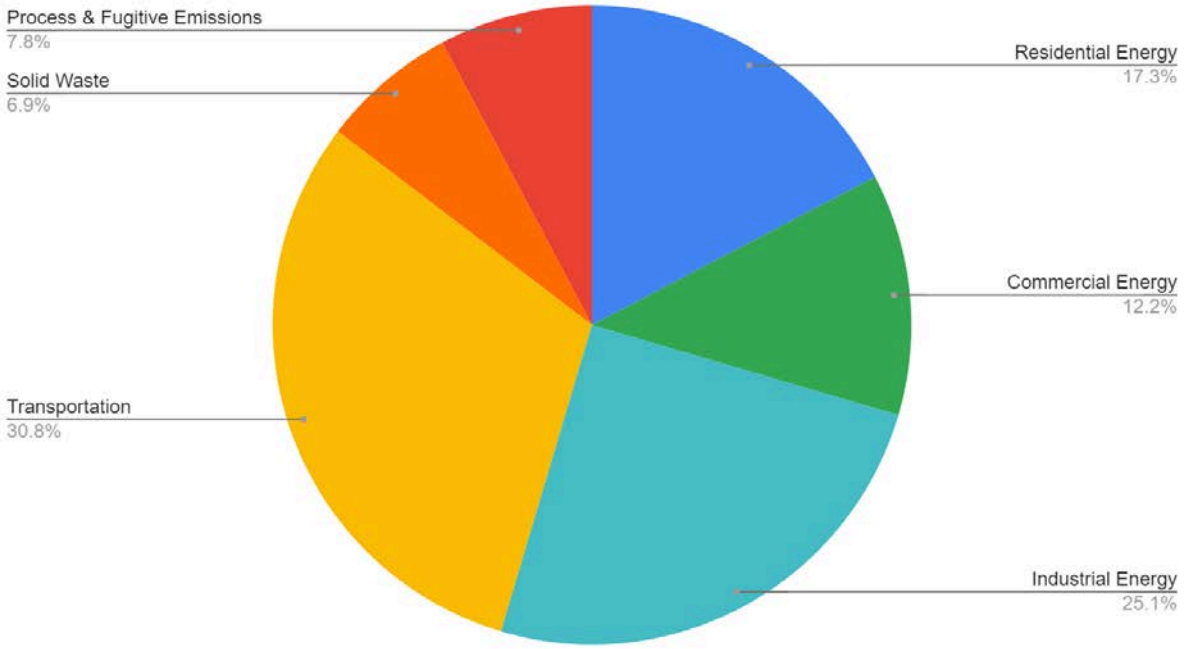


3.8: Person County

Table 10. Person County Emissions by Source	
Source	CO2e (MT)
Residential Energy	83,180
Commercial Energy	58,590
Industrial Energy	120,200
Transportation	147,586
Solid Waste	33,021
Process and Fugitive Emissions	37,238
AFOLU*	-458,037
Total	479,815

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 9. Person County Emissions by Source

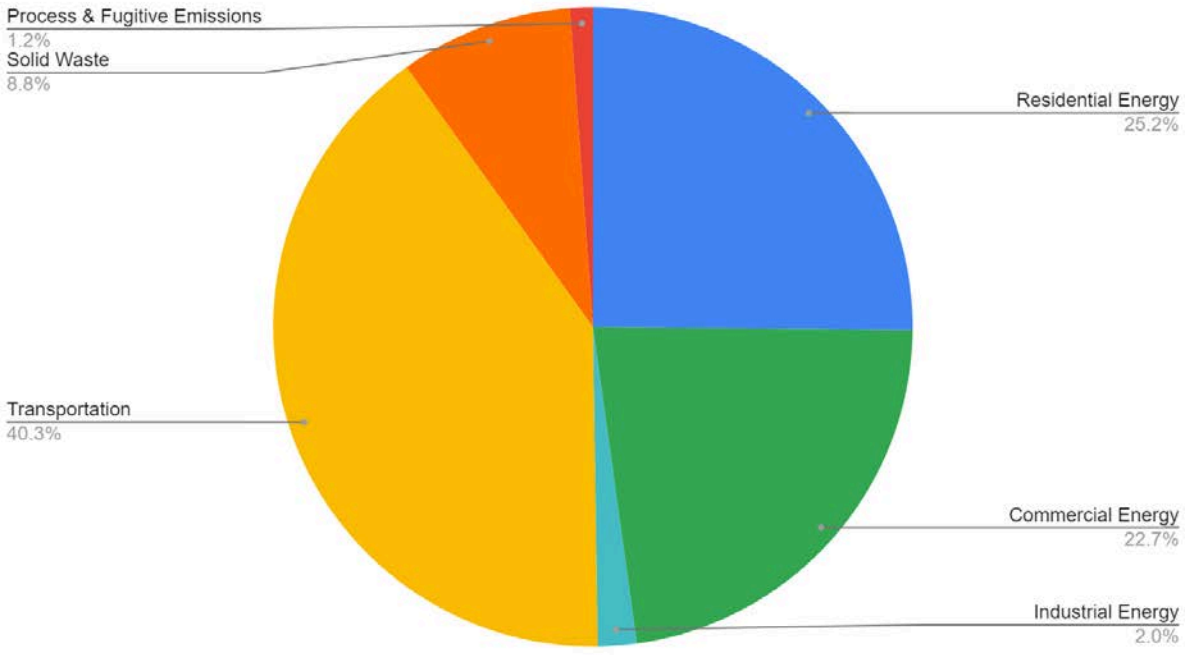


3.9: Wake County

Table 11. Wake County Emissions by Sector	
Source	CO2e (MT)
Residential Energy	3,428,000
Commercial Energy	3,087,000
Industrial Energy	266,900
Transportation	5,495,855
Solid Waste	1,193,216
Process and Fugitive Emissions	157,400
AFOLU*	-762,825
Total	13,628,371

**The AFOLU sector represents a net sink and will therefore not be included in calculated totals.*

Figure 10. Wake County Emissions by Source



Appendices

Appendix A. NCDOT VMT Estimates 2009 - 2022

Appendix B. NCDEQ County Waste Disposal Reports FY 21-22

Appendix C. Scenario Planner State and Local Planning for Energy NREL

Appendix D. LEARN Reports

Appendix E. EPA Facility Level Information on GHG Tool (FLIGHT)

Appendix C-- Regional Electrify Program for Single Family and Multifamily Homes

This appendix explains the methodology and assumptions used for developing the estimated greenhouse gas (GHG) emissions reduced for the Regional Electrify Program for Single Family and Multifamily Homes measure included in the Raleigh-Cary-Durham-Chapel Hill priority climate action plan. See the "GHG Emission Reduction Calculation Spreadsheet" for emission reduction calculations.

Overview

Methods and Assumptions

Emission Reductions Estimate Method:

The Regional Electrify Program offers homeowners seven independent electrification options to reduce GHG emissions including heat pumps, envelop weatherization, efficient induction cook stoves, electric lawn equipment, micro-mobility e-scooters, and in-home charging for electric vehicles. Homeowners may choose more than one option.

The GHG Emission Reduction Calculation Spreadsheet includes:

- The average profile of energy used by households broken down by related end-use and fuel type.
- An estimate of per-household GHG benefits of each option expected if selected.
- An assumption of the number of households that will participate in the program from 2025-2030, and from 2031-2050.
- An estimate of the likelihood that participating households will select each of the available options.

The model calculates the growth annual emissions reductions and integrates that curve to calculate cumulative GHG program benefits for the 2025-2030 and 2030-2050 periods. In general, for GHG benefit potential of each option is based on EPA, DOE, or EIA references where available. To calculate GHG emissions, the model uses EPA-based fuel emissions factors and EPA's EGRID factors for the carbon intensity of grid.

Measure Implementation Assumptions:

For the purposes of measurement and planning, we assume that participation in the first year of the program will be fairly modest with 100 LMI homes and 1,000 non-LMI homes. Thereafter we assume 200 LMI homes per year and 2,000 non-LMI homes per year, with the non-LMI homes increasing by 10% each year for a total of 14,310 homes over the first six years. Thereafter we assume that the following nine years will have a slower uptake and participation due to a likely change in the market and changes in incentives, so each of those years we assume 600 participants per year.

The following key assumptions about measure implementation were used to quantify emissions reductions for this measure:

- Eight-county planning area
- The analysis assumes program uptake from 2025 to 2040 (described above), with ongoing reductions from those homes estimated through 2050.

For inquiries regarding this calculation please contact Emily Barrett at ebarrett@centralpinesnc.gov.

Appendix D – Asphalt Penetrating Sealer with TiO2

This appendix explains the methodology and assumptions used for developing the estimated greenhouse gas (GHG) emissions reduced for the Asphalt Penetrating Sealer with TiO2 measure included in the Raleigh-Cary-Durham-Chapel Hill priority climate action plan.

Methods, Assumptions, and Placeholder Calculations

Emission Reductions Estimate Method:

A construction industry magazine called Pavement Interactive estimated that "the energy needed to construct one lane of road one kilometer in length is the equivalent of burning 23,000 gallons of conventional gasoline." Because maintenance of asphalt roads doesn't require starting from scratch each time (because the base and other components have a longer lifecycle than the surface), it is difficult to use this value to estimate the lifecycle carbon emission reduction obtained from a 41% increase in the life of the asphalt surface. However, if one assumes just 15% of that 23,000 gallons of gasoline value (3,450 gallons) is attributable to the asphalt surface, then one example using the City of Raleigh's approximate total linear miles of roadway (2,300 miles or 3,701 km), that is the equivalent of approximately 13 million gallons of gasoline saved which translates to approximately 113,500 $mtCO_2e$ or 0.11MMTCDE for a single pilot covering 2,300 miles of roadway with an asphalt penetrating sealer, which does not include any additional reductions that may come from the TiO_2 additive. Because this number of miles would take some time to implement beyond the first six years, we assume that the first six years from 2025 to 2030 would be 60% of that value at 68,100 $mtCO_2e$ or 0.07MMTCDE. These values are approximate and should not be used for an application to the EPA for CPRG implementation funding, as they are placed here for illustrative purposes only for the reader to consider the possible magnitude of reductions possible with this kind of measure.

Appendix E: Population in Census Tracts that are Potentially Disadvantaged According to the White House Climate and Economic Justice Screening Tool

Census Tract GEOID10 Identifie	County	Population
37037020500	Chatham County	3,626
37037020600	Chatham County	5,187
37037020300	Chatham County	2,790
37037020401	Chatham County	6,099
37037020402	Chatham County	4,499
37063001304	Durham County	3,411
37063001801	Durham County	8,618
37063000101	Durham County	3,150
37063000900	Durham County	1,710
37063000102	Durham County	4,430
37063001802	Durham County	8,121
37063002015	Durham County	5,801
37063000500	Durham County	4,532
37063001100	Durham County	3,183
37063001400	Durham County	2,397
37063001502	Durham County	5,928
37063002009	Durham County	5,052
37063000200	Durham County	3,343
37063002016	Durham County	5,304
37063001001	Durham County	3,706
37063001002	Durham County	5,931
37063001301	Durham County	1,382
37063001709	Durham County	6,964
37063002300	Durham County	1,633
37063001806	Durham County	7,416
37069060700	Franklin County	6,391
37069060100	Franklin County	4,744
37069060302	Franklin County	2,702
37069060401	Franklin County	2,774
37069060402	Franklin County	4,984
37069060801	Franklin County	4,102
37069060802	Franklin County	5,105
37077970702	Granville County	2,615
37077970703	Granville County	4,389
37077970400	Granville County	3,753
37077970300	Granville County	3,529
37101041201	Johnston County	4,153
37101041202	Johnston County	5,241
37101041300	Johnston County	6,502
37101040500	Johnston County	6,673
37101040100	Johnston County	7,209
37101040400	Johnston County	4,422
37101040700	Johnston County	3,901
37101040800	Johnston County	3,807
37101040600	Johnston County	3,821
37101040201	Johnston County	6,361
37101040202	Johnston County	7,060
37101040301	Johnston County	4,899
37101040302	Johnston County	5,573
37101041400	Johnston County	7,159
37145920300	Person County	5,487
37145920400	Person County	2,875
37145920601	Person County	5,789
37145920602	Person County	4,982
37183052102	Wake County	6,960
37183050900	Wake County	3,193
37183052001	Wake County	4,323
37183054302	Wake County	7,998
37183051101	Wake County	5,363
37183054104	Wake County	12,003
37183052101	Wake County	9,240
37183052002	Wake County	5,931
37183052704	Wake County	6,420
37183054008	Wake County	7,475
37183050700	Wake County	3,142
37183052408	Wake County	3,586
37183051102	Wake County	4,977
37183052806	Wake County	18,085
37183054108	Wake County	7,913
37183050800	Wake County	4,090
37183052701	Wake County	6,389
37183053517	Wake County	5,097
	TOTAL:	377,400

	Total Population	Census Tracts Identified as Disadvantaged	Disadvantaged Population	% Disadvantaged	Criteria of Concern	Avg > age 64	Avg Non-White
Chatham County	71,338	5 (of 13)	22,201	31%	Low Income, Bldg Loss Rate, Energy Burden, Transit Barriers, Pollution Exposure, Health Risk	23%	30%
Durham County	311,848	20 (of 60)	92,012	30%	Low income, Ag Loss Rate, Energy Burden, Pollution Exposure, Housing Burden, Historic Underinvestment, Health Risks, Linguistic Isolation, Unemployment	12%	58%
Franklin County	66,362	7 (of 12)	30,802	46%	Low Income, Energy Burden, Transit Barriers, Housing Burden, Health Risks, Unemployment	17%	40%
Granville County	59,328	4 (of 13)	14,286	24%	Low income, Bldg Loss Rate, Transit Barriers, Pollution Exposure, Health Risks, Unemployment	17%	46%
Johnston County	196,870	14 (of 25)	76,781	39%	Low income, Ag Loss Rate, Energy Burden, Transit Barriers, Housing Burden, Pollution Exposure, Health Risks, Unemployment	13%	35%
Orange County	144,836	0 (of 28)	-	0%	NA	13%	30%
Person County	39,345	4 (of 7)	19,133	49%	Low Income, Ag Loss Rate, Energy Burden, Transit Barriers, Pollution Exposure, Health Risks, Unemployment	18%	37%
Wake County	1,069,079	18 (of 185)	122,185	11%	Low Income, Ag Loss Rate, Pollution Exposure, Housing Burden, Health Risks, Linguistic Isolation, Unemployment	12%	37%
TOTAL	**1,959,006**	**72 (of 343)**	**377,400**	**19%**		**16%**	**39%**

APPENDIX F: Comments from the Durham EAB,
Received from Ben Goldberg Via Email on 12/15/2023

Transportation

- Electrification
    - Electrify fleets
    - Increase EV adoption (ie rental cars, Lyft or Uber)
    - EV Charging infrastructure
    - Charging as a Service
    - Electric car-sharing
    - EV Electrical Engineering Studies - to determine grid capacity, building electrical capacity, how many and what type of chargers are needed, design one-line-drawings to design infrastructure
- Reduce vehicle miles traveled through education and outreach
- Complete Street Infrastructure and Modes
    - Bicycle infrastructure
    - Pedestrian infrastructure (making Durham more walkable)
    - Carpooling incentives
    - Improve public transit
        - Bus rapid transit
    - Completing pathways
    - Microtransit
        - e-bikes, e-scooters, ride-hailing and car sharing

Agriculture

- Carbon sequestration in soils
- Grants for farmers who use regenerative agricultural practices (the initial cost is the main barrier to implementing regenerative agriculture)
    - e.g. funding to buy cover crops, funding for buying organic fertilizer
- Trial programs for testing regenerative agricultural practices in the region
- Paying farmers for the amount of carbon they sequester
- Biochar

Diets

- Plant based
    - "No meat" day

Advocacy to make the electricity grid greener (Duke Energy Carbon Plan)

Water (Water Treatment and Wastewater)

- Conservation
    - Reducing the amount of water processed will reduce energy use

    - Incentives for using less water / tiered pricing structure
- Technologies and processes in plants to reduce emissions
    - Combined heat and power
    - Inputs changing
    - Updating pumps, etc
    - Point-source air filtration, done at the plant
        - Carbon capture, etc
- Energy Audits
- Pump Studies and Pump Performance Monitoring Systems
- Biogas Cogeneration Facilities – Combined Heat and Power (CHP) to capture both thermal and electrical energy from wastewater gas to create heat and power for the plant.
- In-Line Hydropower - in-pipe turbines harness power in distribution pipes
- Sewer and water treatment plant heat recovery - using heat energy from water and sewer pipes to heat and cool buildings
- Water Conservation - Toilet Replacement, WaterSense certified fixtures and appliances
- Workforce Development – Plumbers

Buildings

- Energy efficiency strategies
    - Auditing
    - Weatherization
    - Passive heating and cooling
    - Incentives for builders to use passive heating/cooling to reduce energy demand
    - Trainings for builders on passive heating/cooling
- Incentives and trainings for:
    - Passive heating and cooling
    - Green roofs
    - Heat pump installation
- Electrification
    - Incentivizing heat pump installation municipal, commercial & residential
- Neighborhood-level heating/cooling
- Green roofs
    - Living buildings
- Decarbonize concrete/building materials
- "Grades" for each building rated for sustainability & eco-efficiency

    - Required to display
- Energy retrofitting
- Geothermal
- Performance Contracting
    - according to energy.gov: "a budget-neutral approach to make building improvements that reduce energy and water use and increase operational efficiency"
- District Energy Systems
    - District energy systems are characterized by one or more central plants producing hot water, steam, and/or chilled water, which then flows through a network of insulated pipes to provide hot water, space heating, and/or air conditioning for nearby buildings. District energy systems serve a variety of end-use markets, including downtowns (central business districts), college and university campuses, hospitals and healthcare facilities, airports, military bases, and industrial complexes. By combining loads for multiple buildings, district energy systems create economies of scale that help reduce energy costs and enable the use of high-efficiency technologies such as combined heat and power (CHP). (UNC, Duke and NCSU are powered by district energy systems)
- Refrigerants
    - Switching to alternatives
    - Recovering refrigerants from old equipment
    - Leak detection programs

Renewable energy + storage

- Solar, wind, hydroelectric, etc
    - Incentives, grants, training
    - Solar leasing
    - Purchased power agreements
- Incentivizing working with local energy cooperatives
- Battery storage
- Incentivizing solar on top of parking lots (canopy solar)
    - Powering EV chargers from this
- Rooftop, Ground-mount, Landfill (and other brownfields) and Floating Solar – Planning, engineering, procurement and installation; direct ownership and solar lease
- Solar structures - solar trees, solar picnic tables, solar bus stop shelters

Load Shaving (demand response)

- Related to peak energy use when a lot of things are online
    - Peak is the dirtiest energy (Duke Energy has to turn on their least efficient power plants)
    - Reducing the peaks reduces emissions because of this
- Solutions: efficiency, battery storage, public education
    - not charging EVs, raising AC temp by 1 degree, etc all have a big impact

Education

- Both classroom education about climate + environment in schools
- And community education/public education: resource

Waste Reduction

- Food waste
    - Share un-eaten foods with those that need them (e.g. from restaurants, supermarkets)
    - Public composting program, especially curbside composting
    - Food waste produces lots of methane
- Reduction of transportation of waste by reducing overall waste to landfill
- Alternatives to sending waste to historically marginalized communities
    - Reduce miles traveled
    - And reduce waste
- Circular economy hubs for repair, refurbishment, etc
- Landfill methane capture (CHP)
- Reduce, Reuse, Recycle

Local Food Systems

- Community gardens
- Incentivizing hubs for local food procurement
    - Reducing distance food has to travel, supporting local farms
- USDA processing facility

Landscaping

- Electrify equipment
    - City/County
    - Commercial
- Incentives to adopt less energy-intensive practices

Land Use

- Dense urban development
    - UDO process
- Planting trees!
- Incentives for alternatives to lawns
- Distributed downtowns/15 minute cities
    - https://drawdown.org/solutions/walkable-cities
- Forest protection
- Increasing tree canopy
    - Especially in historically redlined communities
- Rewilding
- Building greenways on old land

Workforce Development (Green Energy jobs)

- i.e. Kempower (EV charger manufacturing)
- Helping fund training for tradespeople doing sustainable work
    - Green-collar jobs

Miscellaneous

- Controls and Analytics – BMS, VAVs, SkySpark, SCADA, Utility Data management tools
- Equitable Engagement

CENTRAL PINES
REGIONAL COUNCIL

Appendix G

Central Pines Regional Council (CPRC)

Community Climate Conversations Summary Report

Overview

The Central Pines Regional Council (CPRC) was awarded a $1 million Climate Pollution Reduction Grant from the U.S. Environmental Protection Agency for the development of a Priority Climate Action Plan (PCAP) to be submitted in February 2024, a Comprehensive Climate Action Plan (CCAP) to be submitted in Fall 2025, and a Status Report in Fall 2027. The plans cover the Raleigh-Cary and Durham-Chapel Hill Metropolitan Statistical areas, inclusive of eight counties in North Carolina: Chatham, Durham, Franklin, Granville, Johnston, Orange, Person, and Wake. CPRC is doing this work with the input and engagement of community members, from the very beginning of this effort through its implementation of the strategies set out in the plans. As a federally funded project, this effort emphasizes engagement with and solutions for the region's most disadvantaged communities, as defined by the Justice40 Initiative. As part of the Justice40 Initiative, the Climate and Economic Justice Screening Tool was developed to identify disadvantaged census tracts that meet thresholds for various categories of burden. The plans will identify, refine, and prioritize climate action solutions across the following topic areas: Transportation; Buildings; Waste; Industry; Electricity Generation; and Agriculture, Forestry, and Land Use.

As part of the outreach and engagement for this planning process, and to directly inform the development of the Priority Climate Action Plan, CPRC convened a series of Community Climate Conversations in four locations and virtually online. The purpose of the Community Climate Conversations was to engage community members from throughout the 8-county region, educate them on climate change and the sources of climate pollution in the region, discuss potential reduction tactics, hear from them about their ideas and priorities, and build capacity and culture around climate action in the region.

In-Person Community Climate Conversations

Four events were held throughout the 8-county region. The Community Climate Conversations were held in locations that would be accessible for residents for all counties, especially in locations in close proximity of Justice40 populations. Community Climate Conversation workshops were held at the following locations, dates and times.

Facility	Location	Date	Time
Agricultural & Conference Center	Pittsboro (Chatham Co.)	January 22, 2024	4:30-7:30pm
Wendell Community Center	Wendell (Johnston Co.)	January 23, 2024	10am-1:30pm
Vance-Granville Community College	Creedmoor (Granville Co.)	January 23, 2024	4:30-7:30pm
Museum of Life & Science	Durham (Durham Co.)	January 25, 2024	9am-12:30pm

Format of Workshops

The regional workshops were structured to be open house format. Participants were welcomed at a sign-in table and directed to visit various stations throughout the space including topic area stations, a creativity station and survey completion station.

Welcome/Orientation

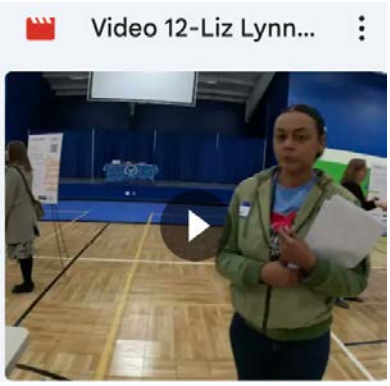
An “Orientation Station” introduced participants to the project, including an introductory video (except at Durham location where a welcome was provided by the Museum of Life and Science host and meeting co-sponsor), grant program details, an “Understanding Climate Change in Our Region” story map, and overview of the topic areas being addressed in the planning process.

Sector/Topic Area Stations

There were stations for each of the six topic areas of the plan. Each station was facilitated by a member of the facilitation team and included a poster describing the topic, a list of example tactics, and a QR code that led participants to a survey where they could weigh in on their support for various tactics and provide their own ideas and feedback. (See Survey Station for more information) Highlights from conversations heard at these stations are provided following the summary of activities.

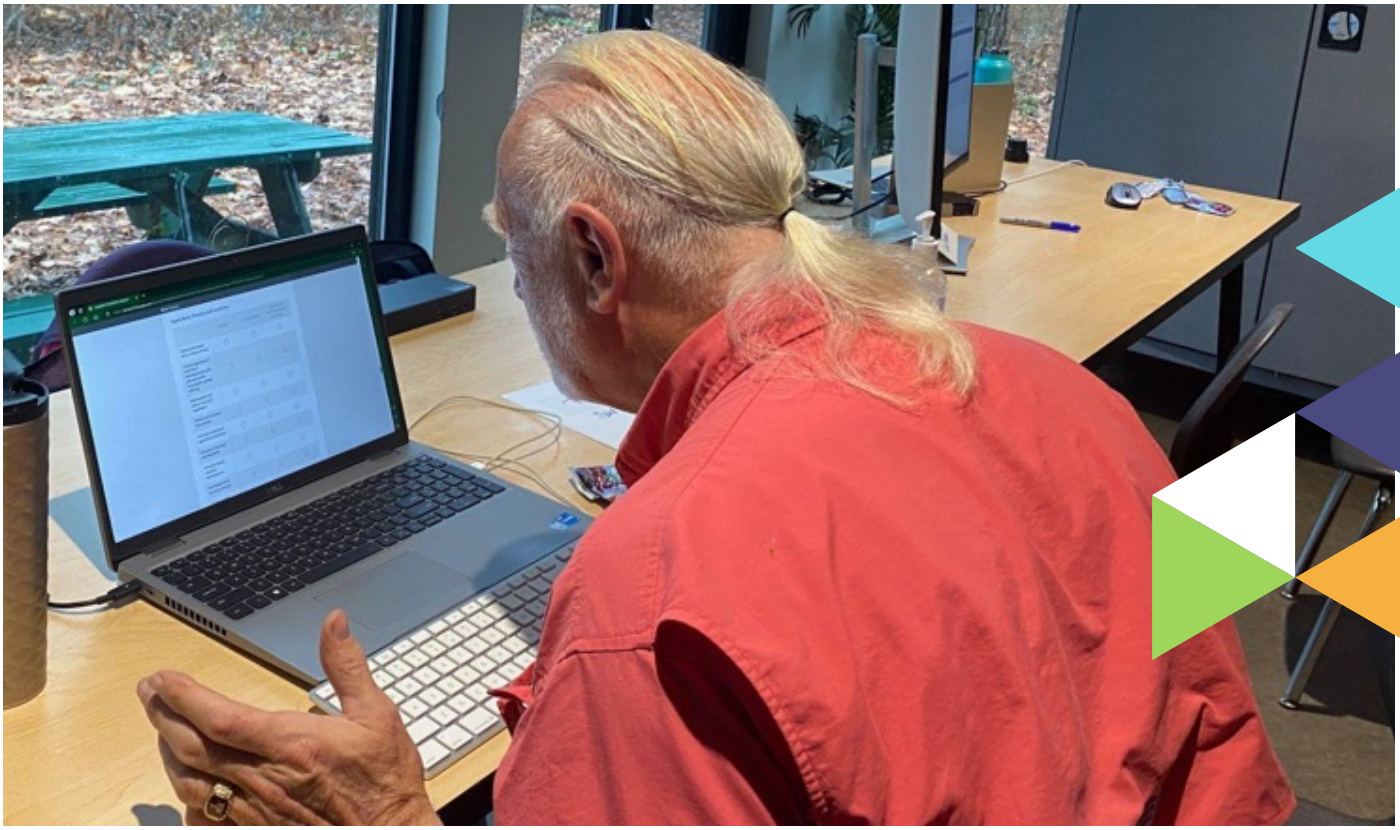
Creativity and Video Recording Station

A “creativity station” was set up as a space where participants of all ages could learn more about climate change, color, draw, and/or record an idea, statement, or vision for the region, answering “What is your greatest hope for what a climate-friendly future looks like?” Materials provided at the station included kid-friendly educational materials, coloring and activity sheets, and blank paper for doodling, writing or sketching out thoughts. Staff at this station also recorded video interviews with participants who wished to share their climate stories, concerns and suggestions in this format. Highlights of these video comments are provided following the overviews of stations and workshop participation.



Climate Conversation Tables (Durham)

Climate Conversation tables were also available at the meeting in Durham where participants could engage in direct conversation with each other about their concerns and ideas around climate change in the region. Members of the CPRG Steering Committee participated at the tables to help facilitate dialogue. Cards were provided for writing down thoughts; this input is included in the conversation highlights.



Survey Completion Station

Community input was also collected through an online survey. Stations were available for participants attending the regional workshops to complete the survey on-site. In addition, the survey was available from January 22 through February 9, 2024 to be completed off-site or for those participating virtually only. A summary of the survey results is attached.

Regional Workshop Participation

Pittsboro
65 total participants: 49 from Chatham County, 7 from Orange County, 5 from Durham County, 4 from Wake County

Wendell
17 total participants: 13 from Wake County[1], 3 from Johnston County, 1 from Nash County

Creedmoor
6 total participants: 4 from Wake County, 1 from Granville County, 1 from Durham County

Durham
60 total participants: 36 from Durham County, 12 from Wake County, 11 from Orange County, 1 from Chatham County

While Pittsboro and Durham had the largest turnout, the participants at Wendell and Creedmoor were very engaged in extended conversations with facilitators/other participants and generated ideas and new partnerships for collaborating on climate action in the region. Additionally, Wake County had the second highest level of participation in the online survey, with Durham having the highest number of online responses (see Survey Summary). Participation in the regional workshops as well as survey responses underscore the continued need to reach out to participants in many of the more rural counties other than Chatham County working through CBO partners and the Steering Committee.

[1] One participant put that they were from Fresno County in California; this participant was counted into the total for Wake County which is where this Community Climate Conversation was held.

Climate Conversations Heard at Topic Stations

PITTSBORO

- Member of advisory committee to County Commissioners shared their work:
  - Have researched best practices, such as those these have been applied in Maryland
    - > Tax incentives for regenerative agriculture
    - > Zoning regulations to shift farming & preserve farms
- Wood pellet industry – should not get IRA funding
- Promote sustainable/ organic farming
- Idea for a Climate Action Fair

WENDELL

- Energy Cost Burden Reduction Proposal shared by Rob Myers – see attached
- Create a group of trained volunteers drawn from non-profits and community groups who will engage with Wake County low- and moderate-income residents to:
  - determine the best ways for the resident to reduce energy cost burdens and produce a plan to reach the resident's goals
    - > use tools like EnergyFundsforAll.org (a web-based tool for identifying IRA and other funds available to homeowners, renters, landlords, etc.) and other resources to determine what funding the resident qualifies for
    - > assist the resident in applying for the funds and finding the resources to implement the energy cost reduction solutions
    - > create entries in the tracking database and update throughout the process
    - > be the resident's single point of contact throughout the process
- NC Clean Tech Energy Center (Shelly Parker) will email to offer organization as a resource for climate technical assistance
- Recommendation to engage with Justice 40 Community coordinators through DOE for Capacity Building and EPA Thriving Communities Program contacts
- USDA is coordinating with farmers on dry wells and solar panels to run pumps
- Citizens Climate Lobby and Advanced Energy (AE) had a conversation to connect and each learn about the work the other was doing of which they had not been aware and identify opportunities to collaborate
  - AE also expressed interest in being a TA resource for other CBO partners
- Down Home NC representative shared business card, very interested in being a potential CBO partner
- A young sustainability professional expressed strong interest in how to deal with the farmland issues and asked about barriers and opportunities for farming / farmers; a Wake County farming family shared with her that money pressures were causing so many to sell land even though they would prefer not to
- Terry Noland with Wake County Planning and CPRG Steering Committee is interested in exploring EO 218 on electricity generation as they prepare to write an ordinance - whether to reference or just allow wind
- Cary is expanding composting collection locations (including one in collaboration with a church and/or non-profit in downtown Raleigh) and will be piloting curbside composting

CREEDMOOR

- The Kerr Tar Council of Governments planner, Charlie Robinette, is very interested in potential opportunities to leverage resources for planning in Granville and surrounding counties, esp. related to mobility, land use, and clean energy[2]

DURHAM

- The Kerr Tar Council of Governments planner, Charlie Robinette, is very interested in potential opportunities to leverage resources for planning in Granville and surrounding counties, esp. related to mobility, land use, and clean energy[2]
- Citizens Climate Lobby (CCL) is supporting bills on a federal level that would help support efforts in NC.
  - Big Wires Act (Sen. John Hickenlooper and Rep. Scott Peters) – Federal bill regarding interregional electric transmission
    - > CCL has a better energy transmission campaign - https://citizensclimatelobby.org/get-loud-take-action/big-wires/#/132/
  - Prove it Act (Sen Chris Coons and Sen. Kevin Cramer) – study regarding carbon border adjustment of certain goods in the US
    - > CCL has Carbon border adjustment mechanism campaign - https://www.coons.senate.gov/download/prove-it-act-118th-congress-one-pager
  - Foreign Pollution Fee Act (Sen. Bill Cassidy MD) – part of the carbon border adjustment initiative
    - > CCL has a Foreign Pollution Fee and Clean Competition Campaign - https://citizensclimatelobby.org/blog/policy/learn-about-the-foreign-pollution-fee-and-clean-competition-acts/ and https://citizensclimatelobby.org/blog/policy/republican-senators-introduce-foreign-pollution-fee-bill/
- CCL also recommended finding and listening to a recent "Waters Summit" with 7 hours of content available online
- Department of Agriculture has grants for flood mitigation to farmers
- Slice 325 is very interested in being a CBO partner in the climate planning process; they helped organize a collaboration with Duke and other partners for NC Grow
- New RDU airport expansion plans does not include solar or EV chargers – this plan should be revised to add these and other clean energy amenities
- Resolve conflicts in agency goals and messaging – a participant concerned about clear-cutting and top-scraping and the damage to soil and its carbon potential shared that NC Forestry has a flyer that talks about "the benefits of clear-cutting"
- For those disadvantaged areas who do NOT want trees planted, can the city use some existing city land or use funds to purchase areas for small parks in the areas?
- To keep these areas from being used for drug use/sales/other crime—have parks well lit with cameras that are maintained
- Would love to see tax incentives for those who have, maintain existing trees on their property. For those who are allowing new trees to be planted on their property, tax incentives or money for maintaining these trees
- Would also love to see random checks on businesses who do not handle their waste in sustainable ways and fines for those businesses

[2] Creedmoor, made video, also at Durham

Quick Takes from Climate Videos

- People related personal stories of climate change effects
- More people are seeing the changes due to climate
- Climate change is affecting air quality and health
- Support was expressed for the actions at the workshops
- Strategies should include: building electrification; connected and clean, sustainable transportation, transit and walkable and bike-friendly communities; mixed use development; composting and waste reduction
- Provide equitable access to clean energy, make solar and energy efficiency improvements affordable for low income homeowners
- Make sure that climate action addresses inequity of climate effects like heat and flooding
- Recognize that all of the issues affecting climate change and the strategies are interrelated and a holistic, big picture approach is important and where organizations are moving towards
- Climate action can offer many benefits including convenient multimodal transportation options, pathways and trails, recreation, jobs and the economy
- Organizations are working together, getting the word out, and more people are paying attention
- More people are learning that climate change is impacting them in their everyday lives and communities are working to take action
- Legislation and federal funding are helping to address climate problems
- Academic institutions are increasing climate change and sustainability education
- A desire was shared to restore a balance of people and planet
- Addressing climate change is important to make the world livable for future generations

"...more people like me are learning that it's not this thing in Antarctica about icebergs melting. It's hitting home, it's real life. My son has asthma so understanding that where we live and the air that we breathe even inside our homes is affecting his health has made me more aware..."

"...my greatest hope for what a climate friendly future looks like is a future in which we have communities that are connected and clean in terms of our transportation system...where people can get around easily with their families where taking a bus or walking or riding a bike is just as convenient as taking a car and our transportation systems are focused on people not on moving cars around."

"What we're doing in our organization is kind of merging what's going on with sustainability climate change and ag, food all as a whole and looking at it as one big picture. So I'm excited for these climate summits so we can all get together and talk about our plans..., brainstorm about different things and see how we can help each other."

"....with the Inflation Reduction Act and other federal incentives, we have a once in a generation opportunity to make significant differences in people's lives, whether it's through securing or reducing their energy bills, securing their food sources ,weatherizing and making their homes energy efficient...."

"...my greatest hope for a climate friendly future is that we're able to have equitable access to clean energy and just effects of climate change where we're not having certain vulnerable populations experiencing some of these worse effects of climate change such as heat and flooding in our region."

"All the actions recommended here today are useful and are going to change our world and I join all of you to support those changes."

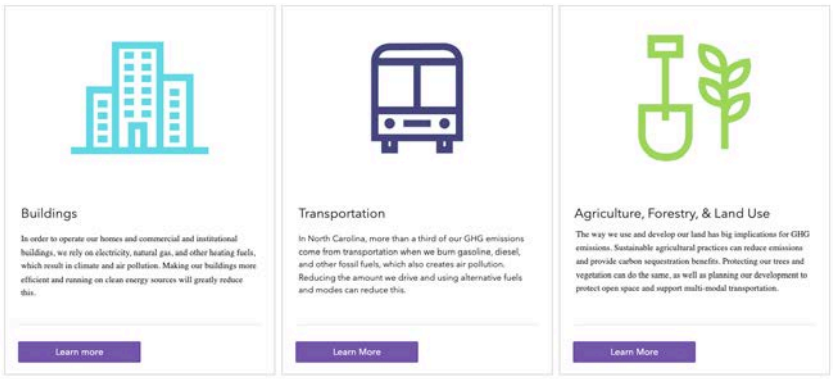
"I guess the most important part is for climate change is you got to get people involved. They have to see the benefit."

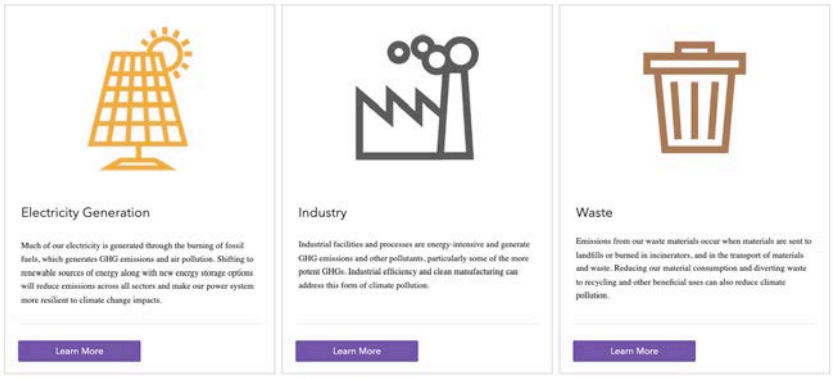
Virtual Community Climate Conversations

In addition to the in-person events, a virtual option was also available which mirrored the in-person events. Introductory information and an introductory video, grant program details, an “Understanding Climate Change in Our Region” story map, and overview of the topic areas being addressed in the planning process were all available online along with a link to the Priority Climate Action Survey. (See Survey Summary) The website also included a dashboard showing real time survey results organized by topic area and county.

Community Climate Conversations

Community Climate Conversations were recently held in four locations across the region. This page highlights information shared in the conversations. See below to learn more about climate change, its impacts to our region, and the greatest sources of our greenhouse gas (GHG) contributions. Explore each of the specific topic areas and share your thoughts about actions we should take throughout our 8-county region to reduce GHG emissions and air pollution.

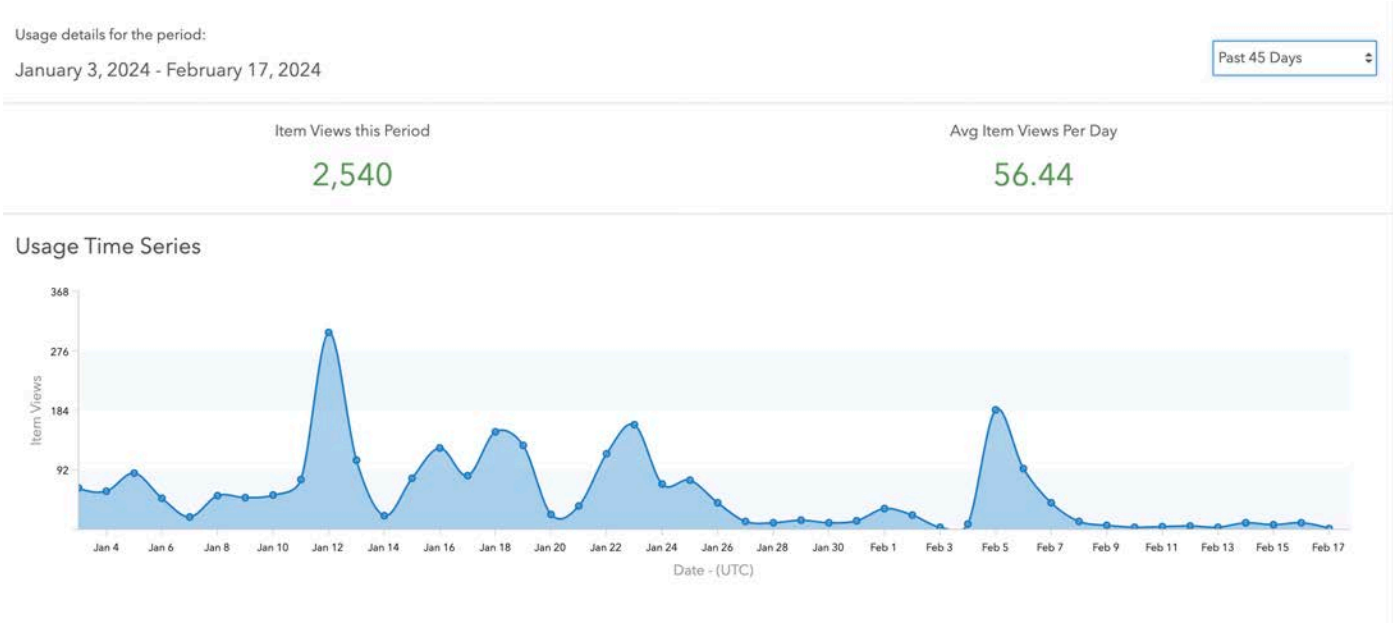




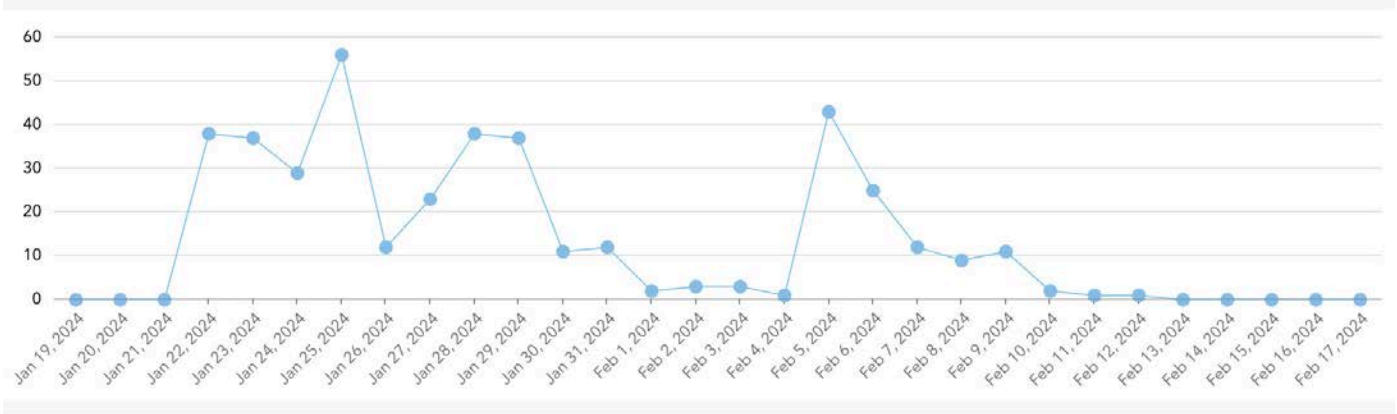
Website and Online Survey Activity

The charts on the following page show the level of activity by day during the applicable periods of availability of the website and the online survey in January and February. Website traffic correlated with digital notifications that were sent out (described following the charts) and with the regional workshops the week of January 22. Spikes in online survey activity corresponded with the regional workshops around the time the survey was first made available and following the final notification that was sent out which focused on promoting the survey.

Website Traffic (1/3 – 2/17)



Survey Submittals (1/19 – 2/17)



Notifications promoting the regional workshops, website and online survey

The in-person and virtual Climate Conversations were promoted in several ways. Notifications were distributed via Constant Contact on the following dates:

- December 28, 2023 – initial announcement of Regional Workshops (sent to 284 contacts)
- January 11, 2024 – reminder #1 (sent to 279 contacts)
- January 19, 2024 – reminder #2 (sent to 278 contacts)
- February 5, 2024 – survey reminder (sent to 443 contacts)

As illustrated in the preceding charts, the notifications prompted substantial website traffic and survey submittals. In addition to digital notifications, CBO partners were encouraged to reach out to their constituents and the CPRG Steering Committee was also asked to spread the word in their roles at work and with their communities throughout the process to encourage the greatest potential level of participation especially given the timeframe and the timing of the CPRG PCAP process.

The collective outreach strategies generated Eventbrite substantial visitor traffic to the registration pages for each of the events. Direct views are originated from the Central Pines Eventbrite pages whereas the remainder of total views originated from links from other outreach activities such as the website, Constant Contact notifications, outreach emails and other sources.

CREEDMOOR

338 total views

13 from Eventbrite

DURHAM

695 total views

64 from Eventbrite

PITTSBORO

557 total views

26 from Eventbrite

WENDELL

411 total views

14 from Eventbrite

1. Submitted Comments or Materials

Wendell

Energy Cost Burden Reduction Proposal

Rob Myers; robmyersnc@gmail.com

Objective

- Assist low and moderate income residents of Wake County to identity funding programs available to them to reduce their costs of energy and implement those solutions energy efficient
- Provide systems for data capture and analysis to monitor and report on progress and point to areas of opportunity for proactive community outreach.
- REDUCE RESIDENTIAL ENERGY CONSUMPTION (DEMAND SIDE) & REDUCE NEED FOR ADDITIONAL FOSSIL FUEL BASED ENERGY GENERATION

Proposal

This proposal is based on two existing programs.

1. The Orange County Home Preservation Coalition: a single step program that connects homeowners with a the correct member of a coalition solution providers to home repairs and modifications to keep low income Orange county residents in their homes. A key component of this program is a shared database run by UNC Community Practice Lab. Besides facilitating the interactions between coalition members, this database and associated data analysis tools provides reports on the success of the program and points to areas of opportunity for proactive community engagement.
2. NC Navigator Consortium: NC Navigator Consortium works with you to choose the right coverage through the Healthcare Marketplace®

The proposal is to create a group of trained volunteers drawn from non-profits and community groups who will engage with Wake county low and moderate income residents to:

- determine the best ways for the resident to reduce energy cost burdens and produce a plan to reach the resident's goals
- use tools like EnergyFundsforAll.org (a web-based tool for identifying IRA and other funds available to home owners, renters, landlords, etc.) and other resources to determine what funding the resident qualifies for
- assist the resident in applying for the funds
- assist the resident in finding the resources to implement the energy cost reduction solutions
- create entries in the tracking database and update throughout the process
- be the resident's single point of contact through out the process

In order to implement this proposal several steps must occur first:

- create a collaborative network of government agencies, non-profits, solution providers, computer system team, and solution providers; this would require identifying leadership and management of the collaborative group
- secure any funding need to setup, run the program and maintain the program
- train an initial set of lead volunteers who can do further training as new volunteers from the community are brought on board
- engage with undeserved community representatives to identify residents in need of reducing energy costs and direct them into the program

Next steps

- Socialize this proposal with local governments, agencies, and universities who are in a position to secure funding and organize the program
- Continue to research and document solutions and funding sources that will help residents reduce energy costs
- Explore governmental bulk purchase of equipment like heat pumps, electric stoves, etc. that would be used in the program & vetting contractors who would do things like conduct energy audits, weatherize homes, and install equipment and appliances.

Jan 22 Climate Conversation sponsored by Central Pines Regional Council, Joy Hewett suggestions:

1. a. Conservation of land and protection of more forests and trees--carbon sinks or sequestration through land holdings; hickory-oak forest which might go into conservation areas are a way to save both rare plants and green space for reducing climate change. The natural heritage sites being mapped out by NC Natural Heritage Program which might go into conservation areas are a way to save both rare plants and green space for reducing climate change. Improve wetland protections—recent Chatham Park environmental impact permits working with DOT were allowed and we need to reverse recent NC legislative changes to wetland protection. The ETJ for Pittsboro needs to meet the standards of Chatham County for protection of the Haw River riparian buffer and sediment and erosion control. UDO's need to protect more tree canopy.
b. conservation through recreation—county parks and recreation (and cultural resources part of new name) has funding from impact fees from new developments and needs more funding from county govt. to provide trails and open space that conserve habitat corridors for wildlife while protecting lands for carbon sequestration, oxygen, cooling shade, etc. Higher percentage of natural resources in counties part of public lands (whether open to public or saved for wildlife natural area).

2. Make electric utilities promote solar and sustainable energy. We need rooftop solar. We need sustainable energy on a grand scale. We don't need nuclear power with radioactive waste. Duke's continued reliance on fossil fuels must be stopped. We need more public interest input to hold the utilities company accountable in regulatory proceedings. Duke's $18-19 billion in profits for one year should be used to solarize the grid so communities are less vulnerable to blackouts. More research on batteries that store green energy. Duke wants to pay households less for solar power they generate and their system must be changed. Solar neighborhoods allowed to share electricity. We need to make Duke Energy go with more renewable energy from the sun, wind, and other clean energy sources and techniques. Duke tries to stall solar power development and as a monopoly limits solar industry.

3. The wood pellet industry should not get IRA funding to destroy our forests --biomass burning is neither green nor clean.

4. Transportation-- getting more mass transit in Chatham, getting DOT to provide more innovation instead of the single car road system they currently engineer; more electric or hybrid vehicles; futuristic 'trolly' line or an energy strip in roads that can either power electric vehicles or some public transport system. (Student engineers who create new transport models without fossil fuel consumption need encouragement.) Monorail system between towns and cities with a system of keyed transport to individual locations and back or bus lines. Get automotive industry to stop building taller, longer trucks.

5. Require mayors, town and county commissioners to attend a number of hours on climate crisis and solutions; need to get town councils on board with more conservation of natural resources and tree canopy and less development promotion. Reduce the amount of concrete used county wide. Natural surfaces absorb rain and storm water and concrete is not environmentally friendly.

6. Limit clearcutting as cheap alternative for development and use "carrot or stick" regulations to promote saving tree canopies and ecosystems.

7. Require public buildings like schools to be built with passive solar, solar panels, and water cachements in place to reduce water consumption, recycle. Retrofit government buildings to be insulated, open air. Windows open flow. Stop county offices from lacking temperature control at the individual level; for example, community college system heating and air conditioning regulated from central location in Sanford without local control--rooms so hot people can't concentrate or so cold people bring heaters in

summer! Rooms need workable thermostats (highs and lows controlled) so energy can be appropriate for setting instead of the idea a central control is efficient. It's not.

8. Food waste methane --more efforts to reduce restaurant food waste going in landfills; compost encouraged both on large scale and individual households. Get HOAs and apartment complexes to have ways to compost food scraps.

9. Promote more sustainable and organic farming. Soils can hold carbon intact so promote healthy soils with microbes, compost, earthworms and natural fertilizers instead of synthetic or fossil fuel fertilizer. Do more to protect agricultural lands with tax and other incentives to protect conserved farmland from development. More money or grants for sustainable farms.

10. Stop HOAs from restricting rooftop solar or clothes lines for drying clothes.

11. Education to promote community building for promoting climate crisis solutions and changing industry and government systems that still rely on fossil fuels or reduce greenery and trees neededfor carbon sequestration. Educating individuals to reduce energy consumption is not enough; giving everyone ideas on what they can do to improve a more system wide reduction is needed.

Joy Hewett
Jan.22, 2024
Silk Hope, NC

2. Climate Conversation Videos

Video 7-Mark Hai...

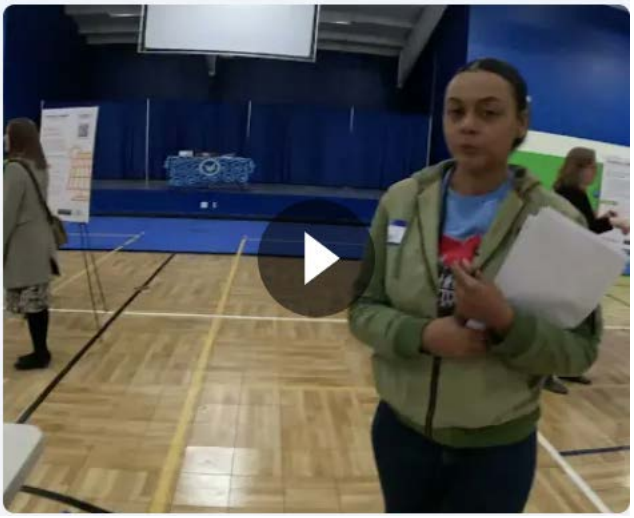
Video 8-Sarah Ro...

Video 9- Laura C...

Video 10-Mike Sh...

Video 11- Charles ...

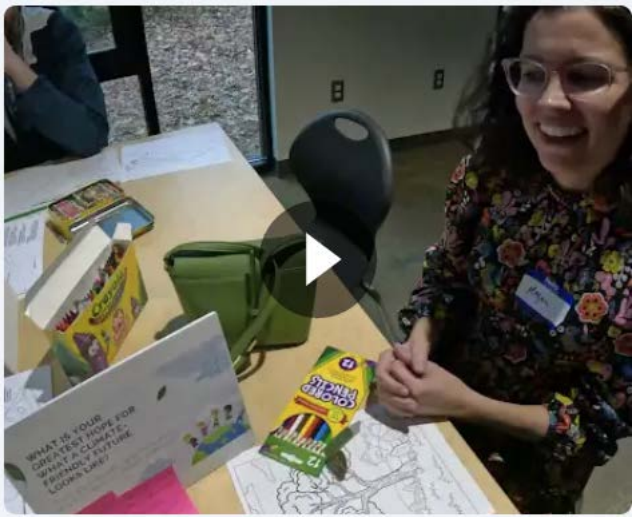
Video 12-Liz Lynn...



Video 1- Betsy Ro...

Video 2- Emily Ba...

Video 3- Megan K...

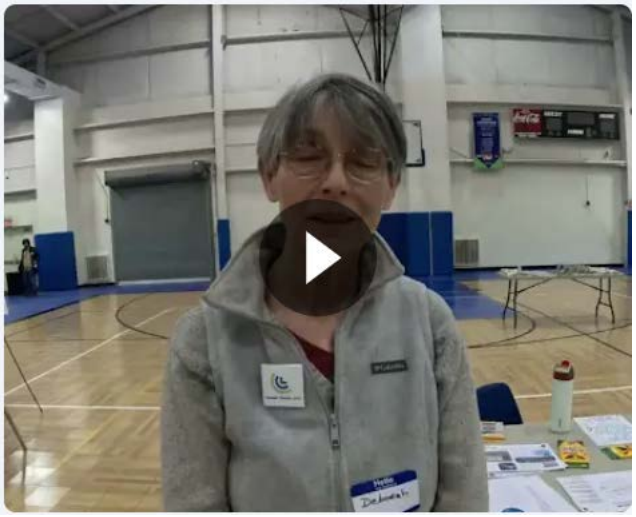


Video 4- Tina Bes...

Video 5- .mov

Video 6- Taylor H...

Video 13- Debora...



Video 14-Anya G...

Video 15- Jessica...

Video 16-Phyllis L...

Appendix H, Other Comments Received

From:	Kate Emrich
To:	Emily Barrett
Cc:	Justin; David Paull
Subject:	Climate Pollution Reduction Grant
Date:	Friday, January 5, 2024 4:54:45 PM
Attachments:	Georgia CPRG.pdf

Hi Emily,

I hope you had a wonderful holiday season! Thank you again for taking the time to connect with Justin, David, and me before the holiday break.

As mentioned in our meeting, we are working with various municipal and nonprofit organizations in Georgia to advocate for composting to be included in their PCAP(s) and a future implementation grant application. Attached is an example of what we've been working on in Georgia and what we think could work/happen in the Triangle and Climate Corridor. We also published a blog post today that outlines how we have been successful in partnerships similar to what we're working on for CPRG.

Let us know if you want to dig into this deeper, we would be happy to support. Hope you have a great weekend!

Worm regards,

—

Kate Emrich
(she/her)
Executive Assistant | CompostNow

Atlanta Regional Program for Scaled Access to Compost

In the US, wasted food causes 58% of the methane emissions from municipal solid waste landfills. Methane is a greenhouse gas that is 86 times more potent than carbon dioxide over a 20 year period. Methane emissions from landfilled food waste are increasing. All of this food waste can be diverted from landfills and composted with yard trimmings instead to create high quality finished compost. The finished compost created through composting in turn rebuilds local soils, increases the soil's water retention capacity, and increases the carbon storing capacity of the soil. In order to decrease greenhouse gas emissions and create healthier communities and food systems it is critical for local municipalities to invest in scaled composting infrastructure and programming. Currently in Metro Atlanta, composting infrastructure and programs are severely limited along with access to locally produced food waste compost, the highest quality and most environmentally beneficial compost. Food producers must often transport compost from nearby states at a premium, which is environmentally and economically unsustainable, especially for historically under-resourced BIPOC growers. Limited access to this material is due to challenges in siting and permitting compost facilities, as well as access to carbon feedstocks and funding.

To best capitalize on these funds and catalyze the reduction of greenhouse gas emissions in the Metro Atlanta region through composting, Atlanta Recycles, the Georgia Composting Council, CompostNow, and Food Well Alliance are working to gather a coalition of municipal and nonprofit partners to implement the Atlanta Regional Program for Scaled Access to Compost. Through this program, funds will be made available to municipal partners and organizations to be used for composting infrastructure, food waste hauling, community composting programs, compost education, and the return of finished compost.

Greenhouse Gas Reduction

The Atlanta Regional Program for Scaled Access to Compost will be a first-of-its-kind initiative with the goal of closing the loop on food waste and significantly decreasing greenhouse gas emissions in Metro Atlanta and the state of Georgia through the diversion of food waste from landfills and the creation and distribution of finished compost to local soils.

The program has not completed a greenhouse gas reduction analysis yet, but we intend to do so before the Implementation Grant deadline of April 1, 2024. The analysis of the greenhouse gas emissions reduction potential will be calculated by determining the amount of metric tons of food waste that could be collected,processed, and diverted from the landfill. Then calculating the estimated amount of methane avoided and the carbon dioxide equivalent through that diversion. The program will evaluate existing diversion activity via partners like CompostNow and determine what amount of funding would enable them to divert more and calculate what the impact would be from those scaled up activities.

Program Details

The Atlanta Regional Program for Scaled Access to Compost will be accomplished through a coalition of municipalities in the region applying to the EPA's CPRG Implementation Grant. This program will establish the necessary scaled infrastructure across the region to meaningfully compost thousands of tons of food waste annually and return finished compost to local growers and soils. Atlanta Recycles will lead the efforts to coordinate the coalition of municipalities and serve as the program administrator with support from the Georgia Composting Council, and

Food Well Alliance. This program will make funding available for composing equipment, operations, and programming through a fair and equitable regranting program. Funds will be available for activities including:

- compost facilities and manufacturing
- compost hauling equipment and operations
- food waste collection programs for households and businesses
- education and outreach
- return of finished compost to agricultural producers in the region

Atlanta Recycles will educate and collaborate with potential CPRG applicants (municipalities) that are interested in developing compost collection programs and assist in coordination with logistics to proposed composting facilities. Atlanta Recycles can assist with any local legislation that may be necessary for compost collection programs. Atlanta Recycles has existing relationships with major cities and counties in the region that may be interested in applying for CPRG grants (including, Cobb County, Dekalb County, City of Atlanta, etc.) Collaboration and coordination will result in more diversion from the landfills, decreased GHG's and broader representation in the region. Atlanta Recycles has the knowledge, history and expertise of its steering committee members to lead this effort.

Program Partners

Atlanta Recycles, the Georgia Composting Council, CompostNow, and Food Well Alliance are working to gather a coalition of interested municipalities and identify a lead applicant. The potential municipal partners include:

- Meriwether County
- Alpharetta
- DeKalb County
- Cobb County
- The City of Atlanta
- The City of East Point
- Douglas County
- City of Jonesboro
- City of Griffin
- Fayette County

Other partners include:

- Georgia Recycling Coalition
- SWANA – Ga Chapter
- Keep Georgia Beautiful
- Cox CSR
- CHaRM

From: Jordan Solomon
To: Emily Barrett
Cc: Alexander Wadud [alexander@ecostrat.com]; Aryn Garswood; Alan Peranson
Subject: Re: Support for CPRG Planning
Date: Wednesday, January 31, 2024 11:02:51 AM
Attachments: 2183b523ef3f5a0b73161a5ac83d85c3aa571590

Hi Emily:

Good to speak with you just now.

As discussed, I think BDO Zone ratings can really help North Carolina utilize its excess biomass resources as engines for both economic development and GHG reduction and be a powerful part of your PCAP.

They fit squarely into the CPRG as a powerful and proven initiative to impact clean energy "market transformation to accelerate the deployment of GHG emission reduction technologies"

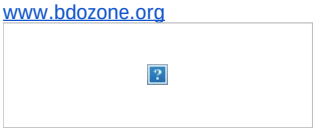
Alex, can you please send Emily some letters from bioenergy companies around the country that are building biofuel plants in BDO Zones now? Include the one from USA Bioenergy which is raising $1.5 billion for a biofuels plant right now.Thanks!

Also, Emily, if you can give us 30 minutes more of your time, we can show you a new mapping tool of useable biomass and infrastructure assets in your state, the number of new biomanufacturing plants (ground/aviation biofuel, renewable chemicals, biogas, and bioproducts) it can support, along with projected economic and carbon reduction impact over 5 and 10 years for your state. This data can go directly into your PCAP, if you think it's useful.

Alex, can you please send Emily some times for a potential meeting? Emily, if you would like to meet, just choose one and Alex will set it up :)

J

Jordan Solomon
President and CEO
ECOSTRAT Inc.
T 416.968.8884 ext 222
C 647.297.4590
www.ecostrat.com
www.bdozone.org



On Wed, Jan 31, 2024 at 8:37 AM Jordan Solomon <Jordan.Solomon@ecostrat.com> wrote:

> Hi Emily:
>
> I am reaching out because you are involved in the Climate Pollution Reduction Grant (CPRG) planning and we have unique data resources and analytical tools that can significantly help in your climate, energy and sustainability planning and implementation.
>
> I am the Chairman of the Bioeconomy Development Opportunity (BDO) Zone Initiative (www.bdozone.org). We have quantified and mapped available biomass resources in your state, and overlaid it with infrastructure assets to show areas that are “biomanufacturing ready”.
>
> We would like to show you a rating system that has been used to accelerate bio-based development and decarbonize in other states. This approach can be an important part of your planning and carbon reduction development process (see the attached video for testimonials from ec. dev. organizations in other states).
>
> We would like to schedule a call to brief you on the data and tools so you can decide if it can support your Priority Climate Action Plan (PCAP).
>
> Please let me know if you can free up 30 minutes this week and we can coordinate times.
>
> J

Jordan Solomon
President and CEO
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T 416.968.8884 ext 222
C 647.297.4590
www.ecostrat.com
www.bdozone.org

N.C. County Waste Disposal Report FY 2021-2022

Chatham	Calculated Total:	Population:	Tons/Person:
	110,599.94	77,420	1.43

Calculated Amount of waste disposed by county = [MSW Landfills + CD Landfills] + [Waste Exported out of county to recycling facility or transfer station] - [Waste imported into county to a recycling facility or transfer station]

Landfilled Waste

Solid waste landfilled in the county's name:

Total: 84,900.47

Waste	Total
MSW	84,120.04
CD	780.43

+

Exported Waste

Solid waste sent outside the county to transfer station or recycling facility and subsequently landfilled:

Total: 25,699.47

Waste	Total
MSW	25,699.47

−

Imported Waste

Solid waste received in the county at transfer station or recycling facility and subsequently landfilled:

Total: 0.00

Facilities Listing County as Source of Waste

Facility Name	Tons Received / Tons Transferred
0105-CDLF-1998 Cobles C&D Landfill	387.08 / 0.00
1912-TP-2022 Triad Transfer Station	18,115.40 / 16,422.72
3212-TRANSFER-2014 Durham, City of Transfer Station	2,677.32 / 2,659.59
3214T-TRANSFER-2001 Stone Park Court Transfer Station	7,671.75 / 7,563.72
3416T-TRANSFER- Overdale Road Transfer Station	31.77 / 31.77
4117-CDLF-2008 A-1 Sandrock C&D Landfill	180.94 / 0.00
4120T-TRANSFER- Greensboro, City of Transfer Station	1.08 / 1.08
5304T-TRANSFER-1993 Waste Man. - Lee Co. Transfer Station	9,309.87 / 9,309.87
5305-TRANSFER-2013 Sanford Transfer Station	6,120.15 / 6,120.15
6204-MSWLF-1995 Uwharrie Env. Reg. Landfill	2,714.02 / 0.00
7606-CDLF-2021 Wall Recycling CDLF	129.97 / 0.00
7607-MSWLF-2015 Great Oak Landfill	78,539.37 / 0.00
8202-MSWLF-2000 Sampson County Disposal, LLC	2,866.65 / 0.00
9215T-TRANSFER-1994 Waste Management Of Raleigh/Durham Transfer Station	104.70 / 13.29
9228-CDLF-2001 Red Rock Disposal C&D Landfill	82.44 / 0.00

N.C. County Waste Disposal Report FY 2021-2022

Durham	Calculated Total:	Population:	Tons/Person:
	367,218.78	327,957	1.12

Calculated Amount of waste disposed by county = [MSW Landfills + CD Landfills] + [Waste Exported out of county to recycling facility or transfer station] - [Waste imported into county to a recycling facility or transfer station]

Landfilled Waste

Solid waste landfilled in the county's name:

Total: 464,774.80

Waste	Total
MSW	365,556.24
CD	99,218.56

+

Exported Waste

Solid waste sent outside the county to transfer station or recycling facility and subsequently landfilled:

Total: 4,788.29

Waste	Total
MSW	4,788.29

−

Imported Waste

Solid waste received in the county at transfer station or recycling facility and subsequently landfilled:

Total: 102,344.32

Waste	Total
MSW	102,344.32

Facilities Listing County as Source of Waste

Facility Name	Tons Received / Tons Transferred
1304-MSWLF-1992 BFI-Charlotte Mtr Speedway Landfill V	69.69 / 0.00
3212-TRANSFER-2014 Durham, City of Transfer Station	145,919.41 / 144,952.94
3214T-TRANSFER-2001 Stone Park Court Transfer Station	134,485.61 / 132,591.91
3901-MSWLF-2012 Oxford Subtitle D MSWLF	4.50 / 0.00
4117-CDLF-2008 A-1 Sandrock C&D Landfill	0.00 / 0.00
7304-MSWLF-1997 Upper Piedmont Regional Landfill	22,464.12 / 0.00
7607-MSWLF-2015 Great Oak Landfill	21.03 / 0.00
8202-CDLF-1996 Sampson County Disposal, LLC	1.90 / 0.00
8202-MSWLF-2000 Sampson County Disposal, LLC	342,996.90 / 0.00
9215T-TRANSFER-1994 Waste Management Of Raleigh/Durham Transfer Station	19,385.32 / 2,460.93
9228-CDLF-2001 Red Rock Disposal C&D Landfill	99,173.53 / 0.00
9231-CDLF-2012 Brownfield Road C&D Landfill	43.13 / 0.00
9242-TRANSFER-2020 Wall Recycling - Garner Road	2,517.13 / 2,327.36

N.C. County Waste Disposal Report FY 2021-2022

Franklin	Calculated Total:	Population:	Tons/Person:
	73,791.57	71,220	1.04

Calculated Amount of waste disposed by county = [MSW Landfills + CD Landfills] + [Waste Exported out of county to recycling facility or transfer station] - [Waste imported into county to a recycling facility or transfer station]

Landfilled Waste

Solid waste landfilled in the county's name:

Total: 69,886.45

Waste	Total
MSW	51,255.29
CD	18,631.16

+

Exported Waste

Solid waste sent outside the county to transfer station or recycling facility and subsequently landfilled:

Total: 3,938.36

Waste	Total
MSW	3,571.13
CD	367.23

−

Imported Waste

Solid waste received in the county at transfer station or recycling facility and subsequently landfilled:

Total: 33.24

Waste	Total
MSW	33.24

Facilities Listing County as Source of Waste

Facility Name	Tons Received / Tons Transferred
3503-TRANSFER- Franklin County Transfer Station	49,551.68 / 50,252.87
3901-MSWLF-2012 Oxford Subtitle D MSWLF	772.90 / 0.00
7304-MSWLF-1997 Upper Piedmont Regional Landfill	46,551.19 / 0.00
8202-MSWLF-2000 Sampson County Disposal, LLC	3,931.20 / 0.00
9102T-TRANSFER-1997 Vance County Transfer Station	3,394.90 / 3,394.90
9215T-TRANSFER-1994 Waste Management Of Raleigh/Durham Transfer Station	71.09 / 9.02
9228-CDLF-2001 Red Rock Disposal C&D Landfill	440.22 / 0.00
9231-CDLF-2012 Brownfield Road C&D Landfill	18,190.94 / 0.00
9234-TRANSFER-2012 Wake Transfer Station	367.23 / 367.23
9242-TRANSFER-2020 Wall Recycling - Garner Road	180.84 / 167.21

N.C. County Waste Disposal Report FY 2021-2022

Granville	Calculated Total:	Population:	Tons/Person:
	50,929.24	61,150	0.83

Calculated Amount of waste disposed by county = [MSW Landfills + CD Landfills] + [Waste Exported out of county to recycling facility or transfer station] - [Waste imported into county to a recycling facility or transfer station]

Landfilled Waste

Solid waste landfilled in the county's name:

Total: 40,421.76

Waste	Total
MSW	40,396.09
CD	25.67

+

Exported Waste

Solid waste sent outside the county to transfer station or recycling facility and subsequently landfilled:

Total: 10,507.48

Waste	Total
MSW	10,507.48

−

Imported Waste

Solid waste received in the county at transfer station or recycling facility and subsequently landfilled:

Total: 0.00

Facilities Listing County as Source of Waste

Facility Name	Tons Received / Tons Transferred
3212-TRANSFER-2014 Durham, City of Transfer Station	4,309.69 / 4,281.15
3214T-TRANSFER-2001 Stone Park Court Transfer Station	123.28 / 121.54
3901-MSWLF-2012 Oxford Subtitle D MSWLF	32,210.56 / 0.00
7304-MSWLF-1997 Upper Piedmont Regional Landfill	8,184.97 / 0.00
8202-MSWLF-2000 Sampson County Disposal, LLC	0.56 / 0.00
9102T-TRANSFER-1997 Vance County Transfer Station	6,104.79 / 6,104.79
9228-CDLF-2001 Red Rock Disposal C&D Landfill	25.67 / 0.00

N.C. County Waste Disposal Report FY 2021-2022

Johnston	Calculated Total:	Population:	Tons/Person:
	177,005.67	226,661	0.78

Calculated Amount of waste disposed by county = [MSW Landfills + CD Landfills] + [Waste Exported out of county to recycling facility or transfer station] - [Waste imported into county to a recycling facility or transfer station]

Landfilled Waste

Solid waste landfilled in the county's name:

Total: 157,644.55

Waste	Total
MSW	157,538.77
CD	105.78

+

Exported Waste

Solid waste sent outside the county to transfer station or recycling facility and subsequently landfilled:

Total: 19,361.12

Waste	Total
MSW	19,361.12

−

Imported Waste

Solid waste received in the county at transfer station or recycling facility and subsequently landfilled:

Total: 0.00

Facilities Listing County as Source of Waste

Facility Name	Tons Received / Tons Transferred
2609-TRANSFER- Fayetteville, City of Transfer Station	2,742.03 / 2,742.03
5103-MSWLF- Johnston County MSW Landfill	148,916.60 / 0.00
5304T-TRANSFER-1993 Waste Man. - Lee Co. Transfer Station	18.15 / 18.15
5305-TRANSFER-2013 Sanford Transfer Station	14.16 / 14.16
6204-MSWLF-1995 Uwharrie Env. Reg. Landfill	450.91 / 0.00
7607-MSWLF-2015 Great Oak Landfill	89.77 / 0.00
8202-MSWLF-2000 Sampson County Disposal, LLC	8,081.49 / 0.00
9215T-TRANSFER-1994 Waste Management Of Raleigh/Durham Transfer Station	3,230.28 / 410.08
9228-CDLF-2001 Red Rock Disposal C&D Landfill	55.06 / 0.00
9231-CDLF-2012 Brownfield Road C&D Landfill	50.72 / 0.00
9242-TRANSFER-2020 Wall Recycling - Garner Road	139.06 / 128.58
9808T-TRANSFER-2000 Black Creek Road Transfer Station	16,276.22 / 16,048.12

N.C. County Waste Disposal Report FY 2021-2022

Orange	Calculated Total:	Population:	Tons/Person:
	75,139.99	148,197	0.51

Calculated Amount of waste disposed by county = [MSW Landfills + CD Landfills] + [Waste Exported out of county to recycling facility or transfer station] - [Waste imported into county to a recycling facility or transfer station]

Landfilled Waste

Solid waste landfilled in the county's name:

Total: 24,743.85

Waste	Total
MSW	189.26
CD	24,554.59

+

Exported Waste

Solid waste sent outside the county to transfer station or recycling facility and subsequently landfilled:

Total: 50,396.14

Waste	Total
MSW	50,396.14

−

Imported Waste

Solid waste received in the county at transfer station or recycling facility and subsequently landfilled:

Total: 0.00

Facilities Listing County as Source of Waste

Facility Name	Tons Received / Tons Transferred
0105-CDLF-1998 Cobles C&D Landfill	169.53 / 0.00
3212-TRANSFER-2014 Durham, City of Transfer Station	5,547.83 / 5,511.08
3214T-TRANSFER-2001 Stone Park Court Transfer Station	42,313.07 / 41,717.26
4118T-TRANSFER- Bishop Road Transfer Station	2,822.00 / 2,365.11
6204-MSWLF-1995 Uwharrie Env. Reg. Landfill	1.82 / 0.00
6804-CDLF-2005 Orange County CDLF	22,799.17 / 0.00
7304-MSWLF-1997 Upper Piedmont Regional Landfill	6.55 / 0.00
7607-MSWLF-2015 Great Oak Landfill	106.39 / 0.00
8202-MSWLF-2000 Sampson County Disposal, LLC	74.50 / 0.00
9215T-TRANSFER-1994 Waste Management Of Raleigh/Durham Transfer Station	6,322.98 / 802.69
9228-CDLF-2001 Red Rock Disposal C&D Landfill	1,585.89 / 0.00

N.C. County Waste Disposal Report FY 2021-2022

Person	Calculated Total:	Population:	Tons/Person:
	50,553.68	39,486	1.28

Calculated Amount of waste disposed by county = [MSW Landfills + CD Landfills] + [Waste Exported out of county to recycling facility or transfer station] - [Waste imported into county to a recycling facility or transfer station]

Landfilled Waste

Solid waste landfilled in the county's name:

Total: 49,727.05

Waste	Total
MSW	49,725.05
CD	2.00

+

Exported Waste

Solid waste sent outside the county to transfer station or recycling facility and subsequently landfilled:

Total: 826.63

Waste	Total
MSW	826.63

−

Imported Waste

Solid waste received in the county at transfer station or recycling facility and subsequently landfilled:

Total: 0.00

Facilities Listing County as Source of Waste

Facility Name	Tons Received / Tons Transferred
4117-CDLF-2008 A-1 Sandrock C&D Landfill	2.00 / 0.00
7304-MSWLF-1997 Upper Piedmont Regional Landfill	49,721.70 / 0.00
7607-MSWLF-2015 Great Oak Landfill	3.35 / 0.00
U0107-TRANS- First Piedmont Corporation Ringgold Transfer Station	826.63 / 826.63

N.C. County Waste Disposal Report FY 2021-2022

Wake	Calculated Total:	Population:	Tons/Person:
	1,826,768.59	1,150,722	1.59

Calculated Amount of waste disposed by county = [MSW Landfills + CD Landfills] + [Waste Exported out of county to recycling facility or transfer station] - [Waste imported into county to a recycling facility or transfer station]

Landfilled Waste

Solid waste landfilled in the county's name:

Total: 1,796,744.63

Waste	Total
MSW	159.55
MSW	887,967.35
CD	908,617.73

+

Exported Waste

Solid waste sent outside the county to transfer station or recycling facility and subsequently landfilled:

Total: 37,751.31

Waste	Total
MSW	37,751.31

−

Imported Waste

Solid waste received in the county at transfer station or recycling facility and subsequently landfilled:

Total: 7,727.36

Waste	Total
MSW	7,360.13
CD	367.23

Facilities Listing County as Source of Waste

Facility Name	Tons Received / Tons Transferred
1304-MSWLF-1992 BFI-Charlotte Mtr Speedway Landfill V	0.74 / 0.00
3212-TRANSFER-2014 Durham, City of Transfer Station	9.46 / 9.40
3214T-TRANSFER-2001 Stone Park Court Transfer Station	38,231.22 / 37,692.88
3503-TRANSFER- Franklin County Transfer Station	32.78 / 33.24
5304T-TRANSFER-1993 Waste Man. - Lee Co. Transfer Station	15.79 / 15.79
6204-MSWLF-1995 Uwharrie Env. Reg. Landfill	12.46 / 0.00
7304-MSWLF-1997 Upper Piedmont Regional Landfill	117,756.92 / 0.00
7606-CDLF-2021 Wall Recycling CDLF	1.00 / 0.00
7607-MSWLF-2015 Great Oak Landfill	80,799.94 / 0.00
8202-CDLF-1996 Sampson County Disposal, LLC	0.20 / 0.00
8202-MSWLF-2000 Sampson County Disposal, LLC	144,326.13 / 0.00
9211T-TRANSFER-1990 Cary, Town of Transfer Station	1,621.89 / 1,621.89
9215T-TRANSFER-1994 Waste Management Of Raleigh/Durham Transfer Station	77,495.77 / 9,837.96
9217-TRANSFER-1994 WI Garner Transfer Station	39,403.54 / 39,403.54
9222-MSWLF-2008 Wake County South Wake MSWLF	545,071.16 / 0.00
9226-CDLF-2020 Shotwell Landfill, Inc	139,683.48 / 0.00

SLOPE: State and Local Planning for Energy

Control Panel

Scenario Planner

Build, view, and compare the impacts of different energy strategies for state and local planning using the Scenario Planner.
To get started, provide a location and select options in the Control Panel.

Scenario 1: Reference Case

County: Chatham
State: North Carolina
Metric: CO_2 Emissions
Electricity Supply: Reference Case
Electrification: Reference
Building Efficiency: Reference
Demand Flexibility: Reference

Data Download

A business-as-usual scenario based on existing state and federal energy policies in 2020

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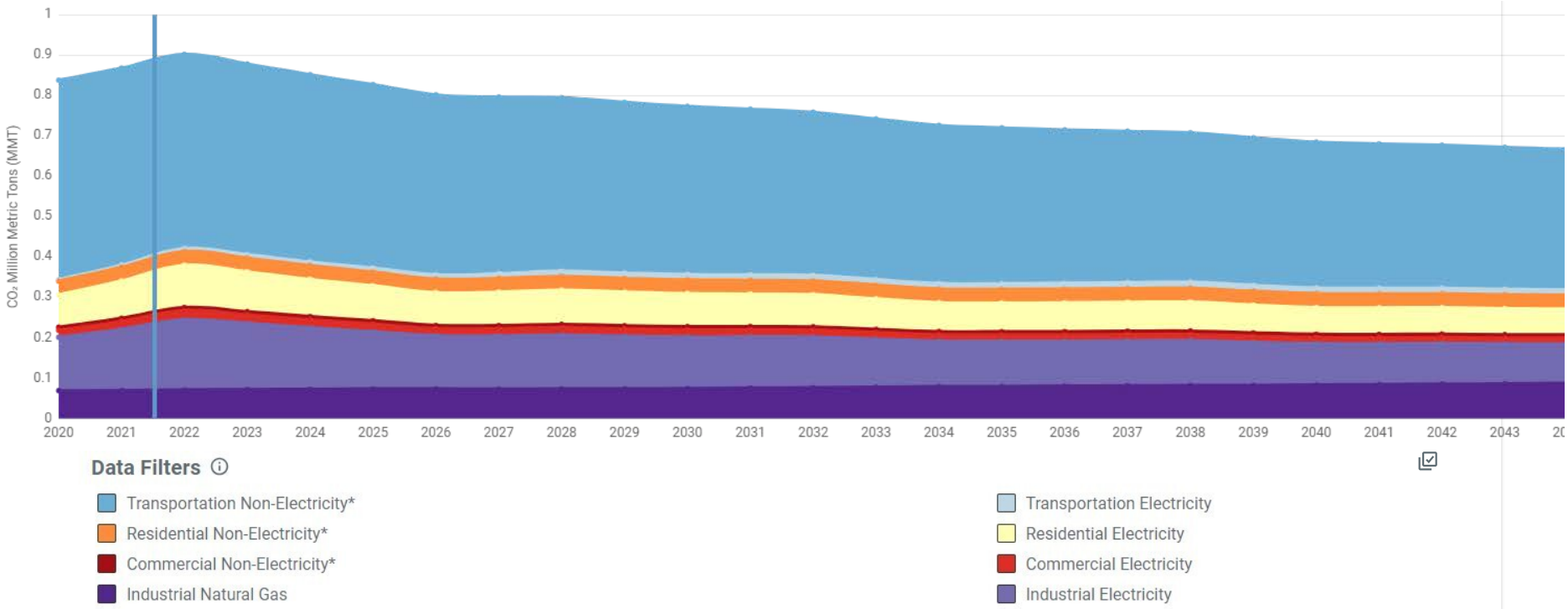
Scenario 1: Reference Case

CO_2 Emissions - Chatham, North Carolina



* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Scenario 1: Reference Case

CO_2 Emissions - Chatham, North Carolina

Details for Year 2022

	Residential	Commercial	Industrial	Transportation	Total
Electricity - CO_2 Million Metric Tons (MMT)	0.1047	0.02242	0.1741	0.007551	0.3087
Non-Electricity - CO_2 Million Metric Tons (MMT)	0.03408	0.007925	0.07085	0.4803	0.5931
Total - CO_2 Million Metric Tons (MMT)	0.1388	0.03034	0.2449	0.4878	0.9018

Planning Metrics

State-level data only

41.67%	2.400%	11.93%	9.972%	$0.000
Share of Space Heating Services Supplied by Electricity (%)	BEV and PHEV Share of Light-Duty Vehicles (%)	Share of Electricity Provided by Renewable Energy (%)	Reduction in Energy-Related CO2 Emissions from 2005 (%)	Net Change in System Cost from Reference Scenario (Billions 2020 $)

2020 Select Year 2050

Scenario 1: Reference Case

CO_2 Emissions - Chatham, North Carolina

This scenario evaluates the effects of business-as-usual projections for the evolution of electricity supply and energy demand sectors. The electricity generation mix evolves over time based on existing policies and default market and technology assumptions. End-use electrification, energy efficiency, and demand-side flexibility measures are assumed to grow modestly over time, consistent with current adoption and participation rates. For more details, please see Scenario Planner methodology documentation.

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Scenario 1: Reference Case

County: Durham
State: North Carolina
Metric: CO_2 Emissions
Electricity Supply: Reference Case
Electrification: Reference
Building Efficiency: Reference
Demand Flexibility: Reference

Data Download

A business-as-usual scenario based on existing state and federal energy policies in 2020

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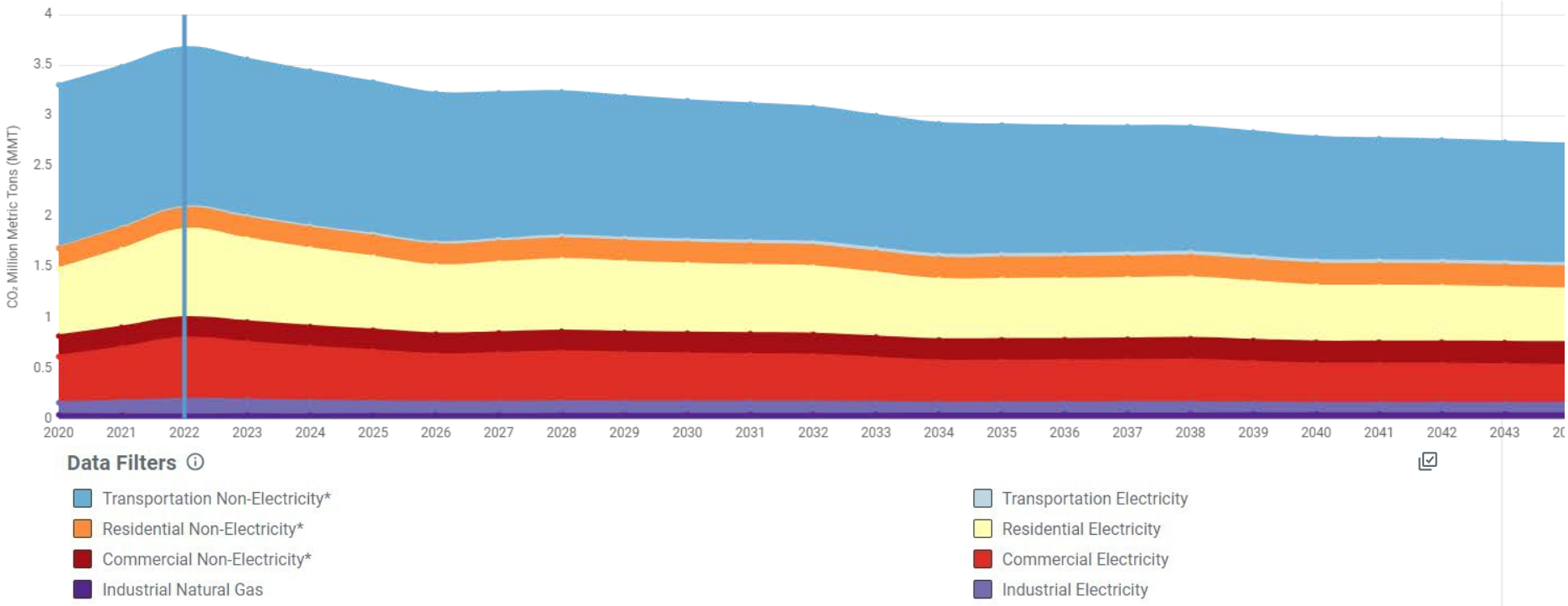
Scenario 1: Reference Case

CO_2 Emissions - Durham, North Carolina



* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Scenario 1: Reference Case

CO_2 Emissions - Durham, North Carolina

Details for Year 2022

	Residential	Commercial	Industrial	Transportation	Total
Electricity - CO_2 Million Metric Tons (MMT)	0.8728	0.6052	0.1529	0.01381	1.645
Non-Electricity - CO_2 Million Metric Tons (MMT)	0.2056	0.2034	0.03822	1.579	2.026
Total - CO_2 Million Metric Tons (MMT)	1.078	0.8085	0.1911	1.593	3.671

Planning Metrics

State-level data only

41.67%	2.400%	11.93%	9.972%	$0.000
Share of Space Heating Services Supplied by Electricity (%)	BEV and PHEV Share of Light-Duty Vehicles (%)	Share of Electricity Provided by Renewable Energy (%)	Reduction in Energy-Related CO2 Emissions from 2005 (%)	Net Change in System Cost from Reference Scenario (Billions 2020 $)

2020 Select Year 2050

Scenario 1: Reference Case

CO_2 Emissions - Durham, North Carolina

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SLOPE: State and Local Planning for Energy

Control Panel

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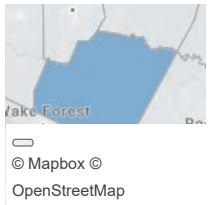
To get started, provide a location and select options in the Control Panel.

Scenario 1: Reference Case

County: Franklin
State: North Carolina
Metric: CO_2 Emissions
Electricity Supply: Reference Case
Electrification: Reference
Building Efficiency: Reference
Demand Flexibility: Reference



Data Download

A business-as-usual scenario based on existing state and federal energy policies in 2020

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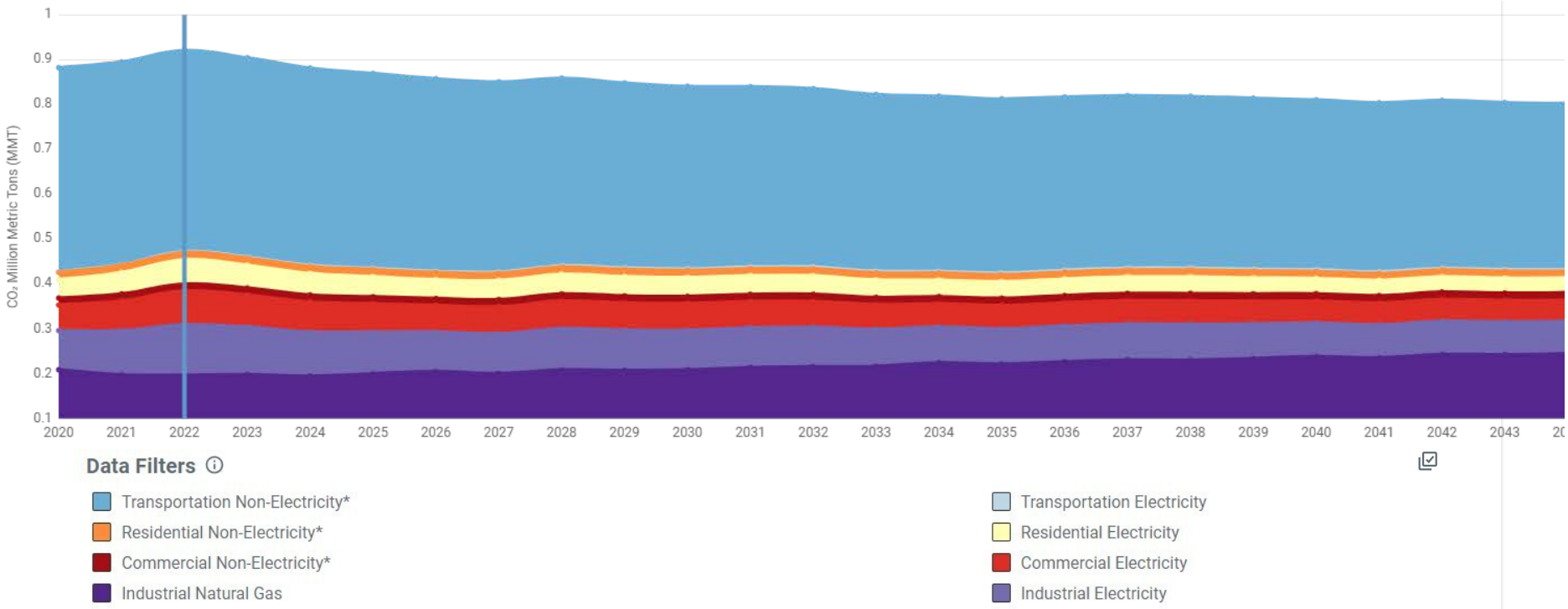
Scenario 1: Reference Case

CO_2 Emissions - Franklin, North Carolina



* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Scenario 1: Reference Case

CO_2 Emissions - Franklin, North Carolina

Details for Year 2022

	Residential	Commercial	Industrial	Transportation	Total
Electricity - CO_2 Million Metric Tons (MMT)	0.05428	0.07554	0.1121	0.001646	0.2436
Non-Electricity - CO_2 Million Metric Tons (MMT)	0.01614	0.01549	0.1970	0.4482	0.6768
Total - CO_2 Million Metric Tons (MMT)	0.07042	0.09103	0.3091	0.4499	0.9204

Planning Metrics

State-level data only

41.67%	2.400%	11.93%	9.972%	$0.000
Share of Space Heating Services Supplied by Electricity (%)	BEV and PHEV Share of Light-Duty Vehicles (%)	Share of Electricity Provided by Renewable Energy (%)	Reduction in Energy-Related CO2 Emissions from 2005 (%)	Net Change in System Cost from Reference Scenario (Billions 2020 $)

2020 Select Year 2050

Scenario 1: Reference Case

CO_2 Emissions - Franklin, North Carolina

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SLOPE: State and Local Planning for Energy

Control Panel

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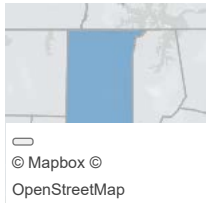
Build, view, and compare the impacts of different energy strategies for state and local planning using the Scenario Planner.
To get started, provide a location and select options in the Control Panel.

Scenario 1: Reference Case

County: Granville
State: North Carolina
Metric: CO_2 Emissions
Electricity Supply: Reference Case
Electrification: Reference
Building Efficiency: Reference
Demand Flexibility: Reference



Data Download

A business-as-usual scenario based on existing state and federal energy policies in 2020

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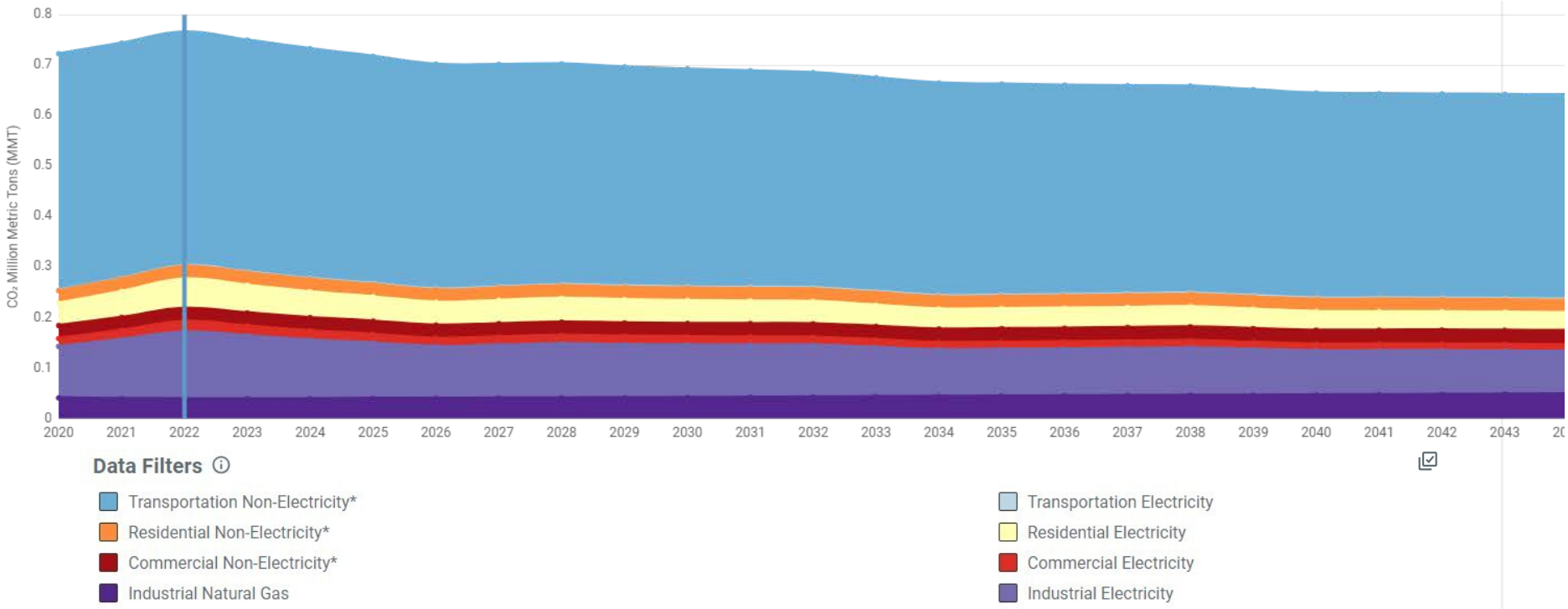
Scenario 1: Reference Case

CO_2 Emissions - Granville, North Carolina



* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Scenario 1: Reference Case

CO_2 Emissions - Granville, North Carolina

Details for Year 2022

	Residential	Commercial	Industrial	Transportation	Total
Electricity - CO_2 Million Metric Tons (MMT)	0.05825	0.02067	0.1324	0.001260	0.2126
Non-Electricity - CO_2 Million Metric Tons (MMT)	0.02493	0.02582	0.03932	0.4632	0.5532
Total - CO_2 Million Metric Tons (MMT)	0.08318	0.04649	0.1717	0.4644	0.7658

Planning Metrics

State-level data only

41.67%	2.400%	11.93%	9.972%	$0.000
Share of Space Heating Services Supplied by Electricity (%)	BEV and PHEV Share of Light-Duty Vehicles (%)	Share of Electricity Provided by Renewable Energy (%)	Reduction in Energy-Related CO2 Emissions from 2005 (%)	Net Change in System Cost from Reference Scenario (Billions 2020 $)

2020 Select Year 2050

Scenario 1: Reference Case

CO_2 Emissions - Granville, North Carolina

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SLOPE: State and Local Planning for Energy

Control Panel

Scenario Planner

Build, view, and compare the impacts of different energy strategies for state and local planning using the Scenario Planner.
To get started, provide a location and select options in the Control Panel.

Scenario 1: Reference Case

County: Johnston
State: North Carolina
Metric: CO_2 Emissions
Electricity Supply: Reference Case
Electrification: Reference
Building Efficiency: Reference
Demand Flexibility: Reference

Data Download

A business-as-usual scenario based on existing state and federal energy policies in 2020

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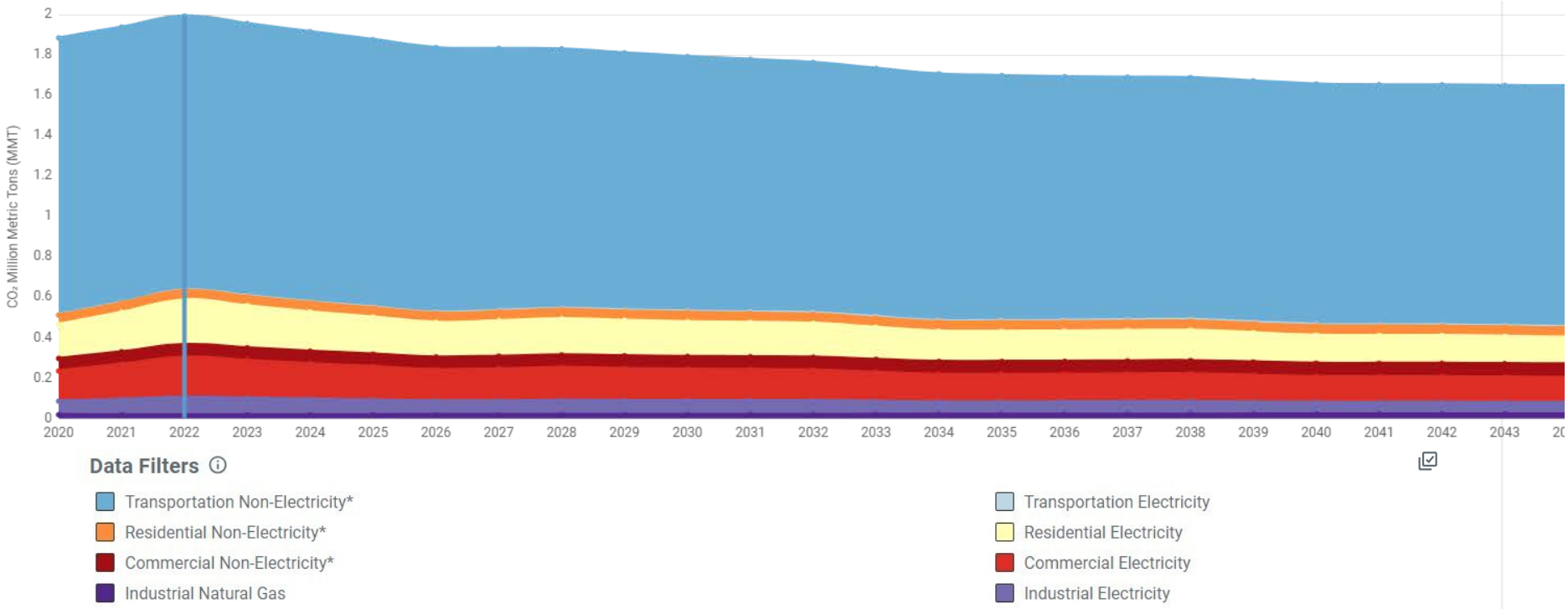
Scenario 1: Reference Case

CO_2 Emissions - Johnston, North Carolina



* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Scenario 1: Reference Case

CO_2 Emissions - Johnston, North Carolina

Details for Year 2022

	Residential	Commercial	Industrial	Transportation	Total
Electricity - CO_2 Million Metric Tons (MMT)	0.2218	0.1984	0.08713	0.003056	0.5104
Non-Electricity - CO_2 Million Metric Tons (MMT)	0.04591	0.06186	0.01883	1.357	1.484
Total - CO_2 Million Metric Tons (MMT)	0.2677	0.2602	0.1060	1.360	1.994

Planning Metrics

State-level data only

41.67%	2.400%	11.93%	9.972%	$0.000
Share of Space Heating Services Supplied by Electricity (%)	BEV and PHEV Share of Light-Duty Vehicles (%)	Share of Electricity Provided by Renewable Energy (%)	Reduction in Energy-Related CO2 Emissions from 2005 (%)	Net Change in System Cost from Reference Scenario (Billions 2020 $)

2020 Select Year 2050

Scenario 1: Reference Case

CO_2 Emissions - Johnston, North Carolina

This scenario evaluates the effects of business-as-usual projections for the evolution of electricity supply and energy demand sectors. The electricity generation mix evolves over time based on existing policies and default market and technology assumptions. End-use electrification, energy efficiency, and demand-side flexibility measures are assumed to grow modestly over time, consistent with current adoption and participation rates. For more details, please see Scenario Planner methodology documentation.

SLOPE: State and Local Planning for Energy

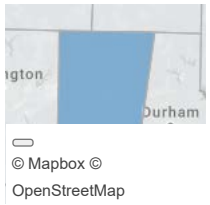
Control Panel

Scenario Planner

Build, view, and compare the impacts of different energy strategies for state and local planning using the Scenario Planner.
To get started, provide a location and select options in the Control Panel.

Scenario 1: Reference Case

County: Orange
State: North Carolina
Metric: CO_2 Emissions
Electricity Supply: Reference Case
Electrification: Reference
Building Efficiency: Reference
Demand Flexibility: Reference



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A business-as-usual scenario based on existing state and federal energy policies in 2020

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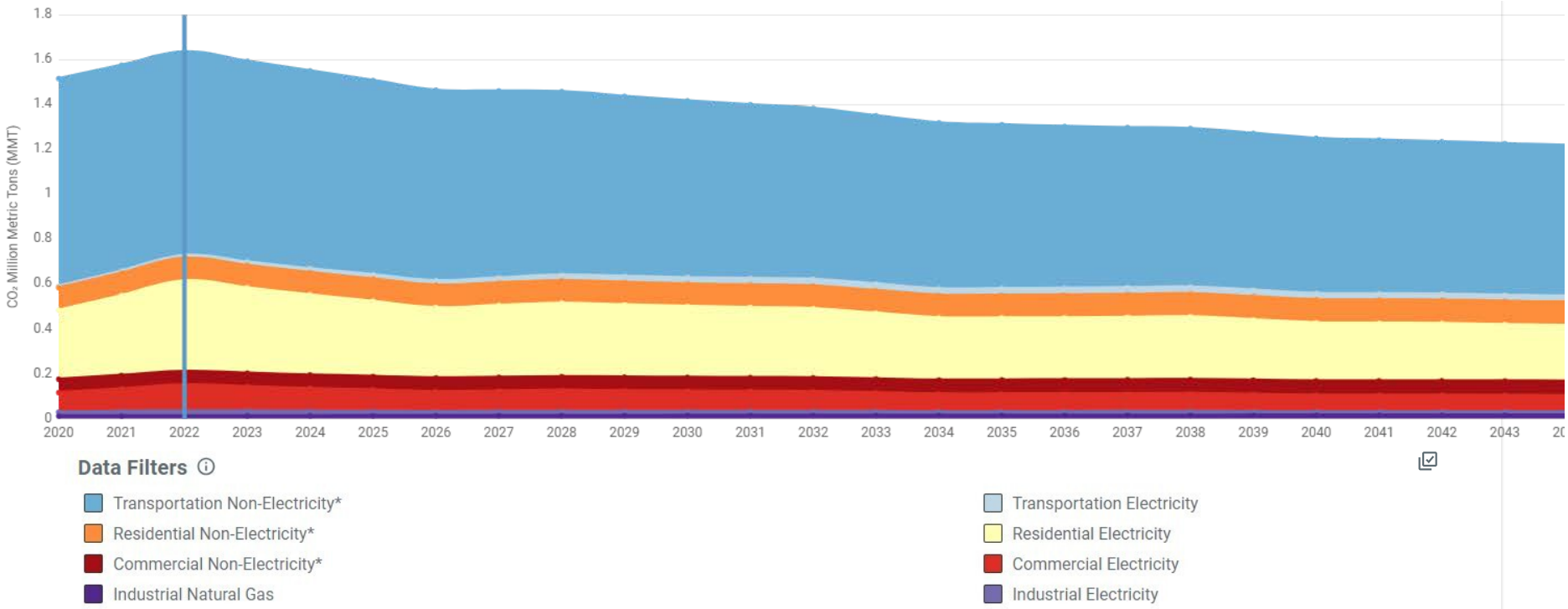
Scenario 1: Reference Case

CO_2 Emissions - Orange, North Carolina



* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Scenario 1: Reference Case

CO_2 Emissions - Orange, North Carolina

Details for Year 2022

	Residential	Commercial	Industrial	Transportation	Total
Electricity - CO_2 Million Metric Tons (MMT)	0.4041	0.1153	0.02290	0.01362	0.5559
Non-Electricity - CO_2 Million Metric Tons (MMT)	0.1001	0.05983	0.01192	0.9070	1.079
Total - CO_2 Million Metric Tons (MMT)	0.5042	0.1751	0.03482	0.9206	1.635

Planning Metrics

State-level data only

41.67%	2.400%	11.93%	9.972%	$0.000
Share of Space Heating Services Supplied by Electricity (%)	BEV and PHEV Share of Light-Duty Vehicles (%)	Share of Electricity Provided by Renewable Energy (%)	Reduction in Energy-Related CO2 Emissions from 2005 (%)	Net Change in System Cost from Reference Scenario (Billions 2020 $)

2020 Select Year 2050

Scenario 1: Reference Case

CO_2 Emissions - Orange, North Carolina

This scenario evaluates the effects of business-as-usual projections for the evolution of electricity supply and energy demand sectors. The electricity generation mix evolves over time based on existing policies and default market and technology assumptions. End-use electrification, energy efficiency, and demand-side flexibility measures are assumed to grow modestly over time, consistent with current adoption and participation rates. For more details, please see Scenario Planner methodology documentation.

SLOPE: State and Local Planning for Energy

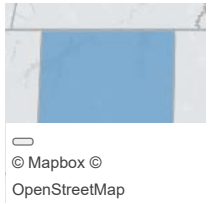
Control Panel

Scenario Planner

Build, view, and compare the impacts of different energy strategies for state and local planning using the Scenario Planner.
To get started, provide a location and select options in the Control Panel.

Scenario 1: Reference Case

County: Person
State: North Carolina
Metric: CO_2 Emissions
Electricity Supply: Reference Case
Electrification: Reference
Building Efficiency: Reference
Demand Flexibility: Reference



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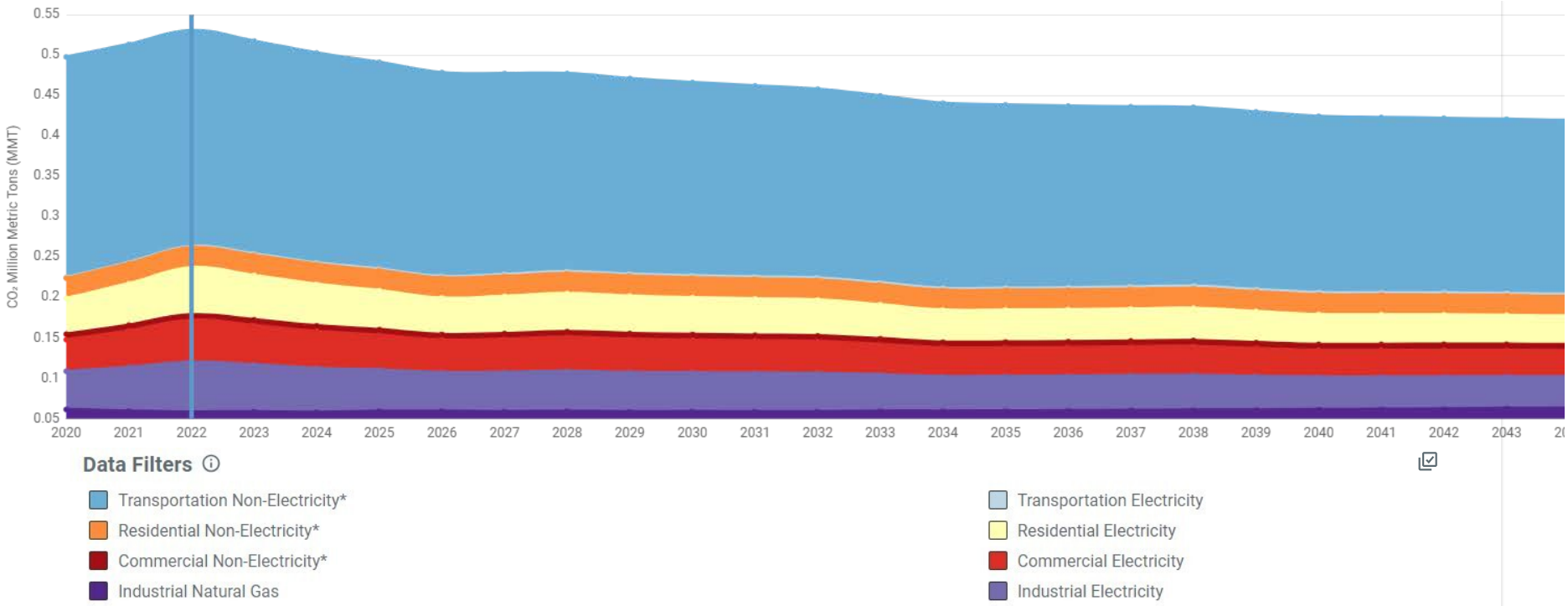
Scenario 1: Reference Case

CO_2 Emissions - Person, North Carolina



* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Scenario 1: Reference Case

CO_2 Emissions - Person, North Carolina

Details for Year 2022

	Residential	Commercial	Industrial	Transportation	Total
Electricity - CO_2 Million Metric Tons (MMT)	0.05825	0.05169	0.06175	0.001483	0.1732
Non-Electricity - CO_2 Million Metric Tons (MMT)	0.02493	0.006894	0.05846	0.2670	0.3573
Total - CO_2 Million Metric Tons (MMT)	0.08318	0.05859	0.1202	0.2685	0.5304

Planning Metrics

State-level data only

41.67%	2.400%	11.93%	9.972%	$0.000
Share of Space Heating Services Supplied by Electricity (%)	BEV and PHEV Share of Light-Duty Vehicles (%)	Share of Electricity Provided by Renewable Energy (%)	Reduction in Energy-Related CO2 Emissions from 2005 (%)	Net Change in System Cost from Reference Scenario (Billions 2020 $)

2020 Select Year 2050

Scenario 1: Reference Case

CO_2 Emissions - Person, North Carolina

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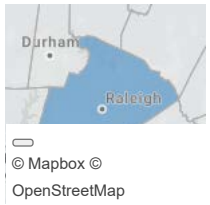
Scenario 1: Reference Case

County: Wake
State: North Carolina
Metric: CO_2 Emissions
Electricity Supply: Reference Case
Electrification: Reference
Building Efficiency: Reference
Demand Flexibility: Reference



Data Download

A business-as-usual scenario based on existing state and federal energy policies in 2020

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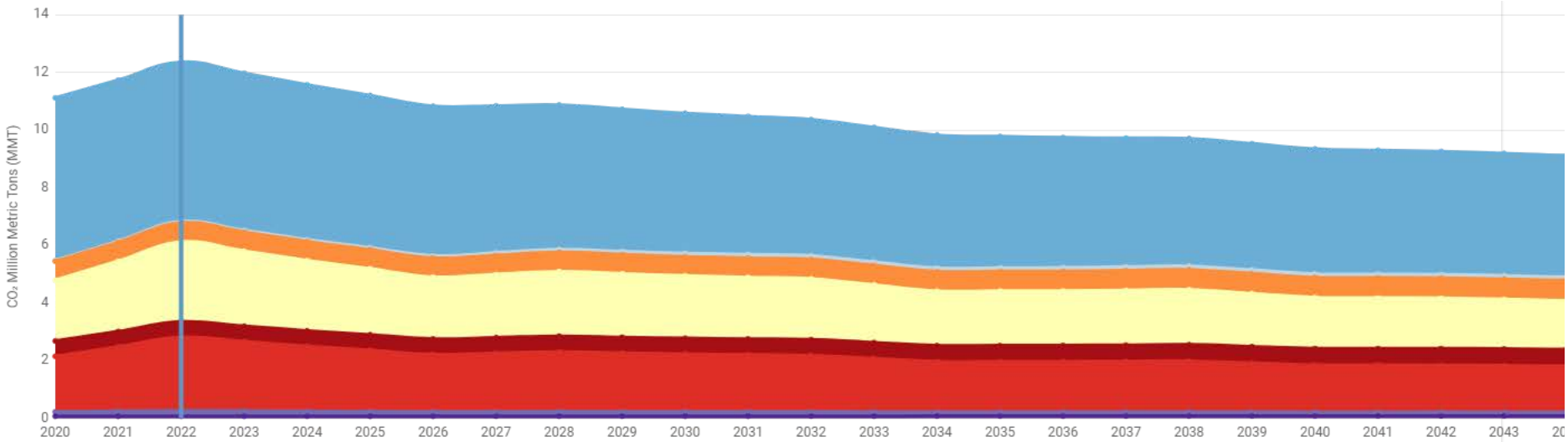
Scenario 1: Reference Case

CO_2 Emissions - Wake, North Carolina



Data Filters

- Transportation Non-Electricity*
- Residential Non-Electricity*
- Commercial Non-Electricity*
- Industrial Natural Gas
- Transportation Electricity
- Residential Electricity
- Commercial Electricity
- Industrial Electricity

* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Scenario 1: Reference Case

CO_2 Emissions - Wake, North Carolina

Details for Year 2022

	Residential	Commercial	Industrial	Transportation	Total
Electricity - CO_2 Million Metric Tons (MMT)	2.768	2.554	0.1965	0.04771	5.566
Non-Electricity - CO_2 Million Metric Tons (MMT)	0.6600	0.5335	0.07035	5.530	6.793
Total - CO_2 Million Metric Tons (MMT)	3.428	3.087	0.2669	5.577	12.36

Planning Metrics

State-level data only

41.67%	2.400%	11.93%	9.972%	$0.000
Share of Space Heating Services Supplied by Electricity (%)	BEV and PHEV Share of Light-Duty Vehicles (%)	Share of Electricity Provided by Renewable Energy (%)	Reduction in Energy-Related CO2 Emissions from 2005 (%)	Net Change in System Cost from Reference Scenario (Billions 2020 $)

2020 Select Year 2050

Scenario 1: Reference Case

CO_2 Emissions - Wake, North Carolina

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Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Chatham County, North Carolina

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Chatham County, North Carolina has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 569,814 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -1,037,212 t CO2e per year.

- Roughly 64% of Chatham County's total land base of 183,636 hectares (453,774 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 22.2 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -1,607,026 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Chatham County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Chatham county's GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-1,395,084	
Forest Disturbances		300,118
Non-Forest to Forest	-33,315	
Forest to Settlement		6,803
Forest to Grassland		90,301
Forest to other non-forest lands		4,241
Trees outside of forests	-178,628	168,351
Harvested Wood Products	0	
TOTAL	-1,607,026	569,814
Net GHG balance	**-1,037,212**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Chatham County’s total land base is approximately 183,636 hectares (453,774 acres), with nearly 8.9% Settlement (i.e. developed areas of varying intensity), around 63.6% forest, 21.8% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 1.2% cropland, 4.2% wetland and 0.2% other land.

Figure 1. Land cover in Chatham from the National Land Cover Database, 2019

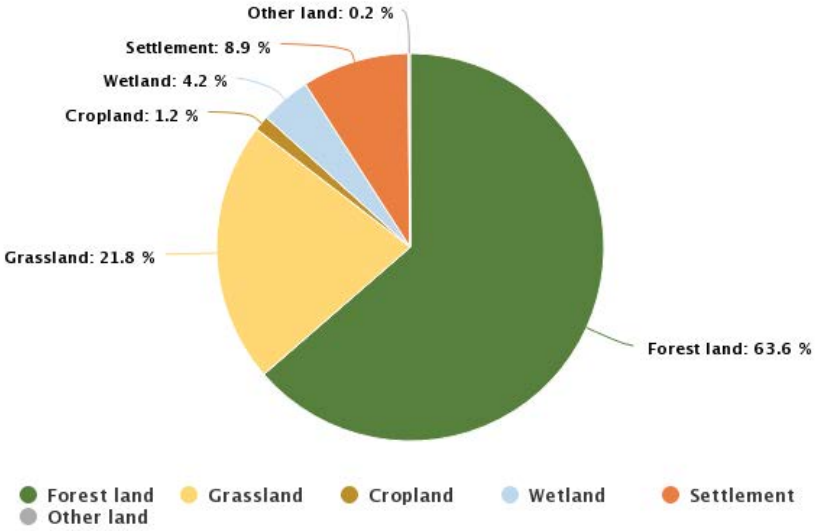
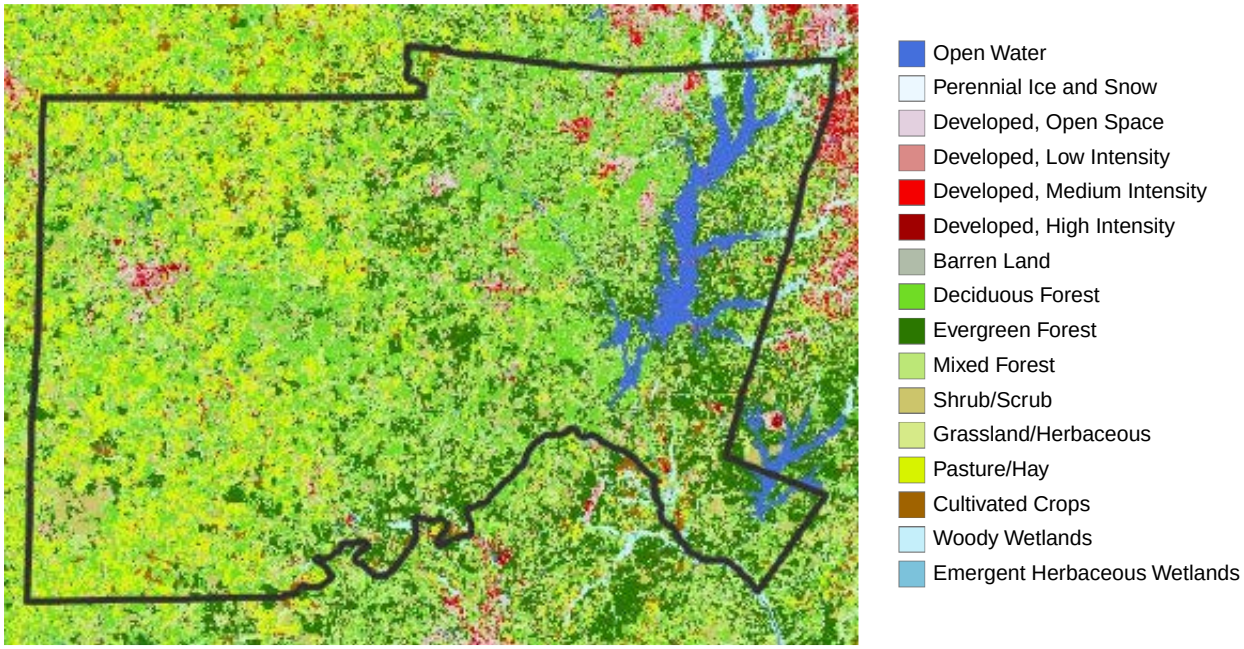


Figure 2. Land cover in Chatham from the National Land Cover Database, 2019



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 2,535 hectares (6,265 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 2,050 hectares (5,064 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

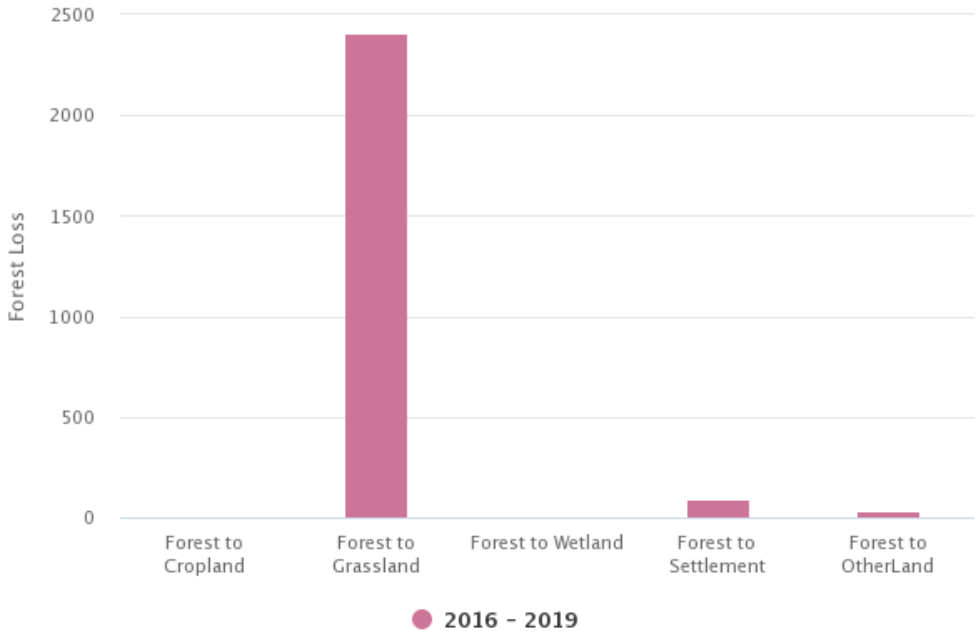
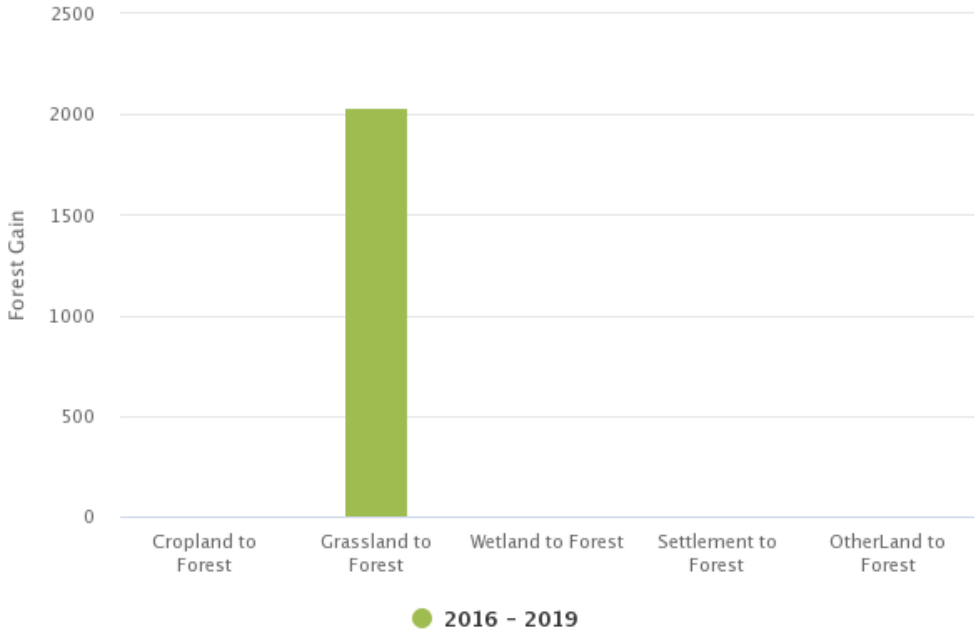


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from harvests/other disturbance was the most significant in Chatham County, affecting 5236.8 hectares (12940.4 acres), followed by fires, which affected 0 hectares (0.0 acres) and insects, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Chatham County had an average of 14,273 hectares (35,270 acres) of tree canopy outside forests. Between 2011 and 2016, 709 hectares per year of tree canopy were lost, for a total of 3,545 hectares (8,760 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Grassland class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

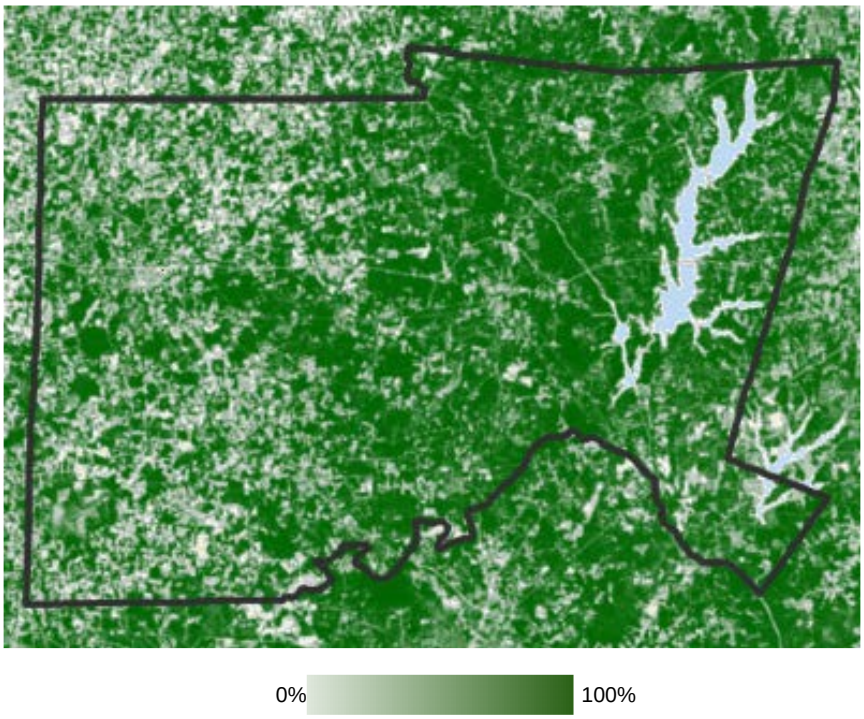


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Chatham County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

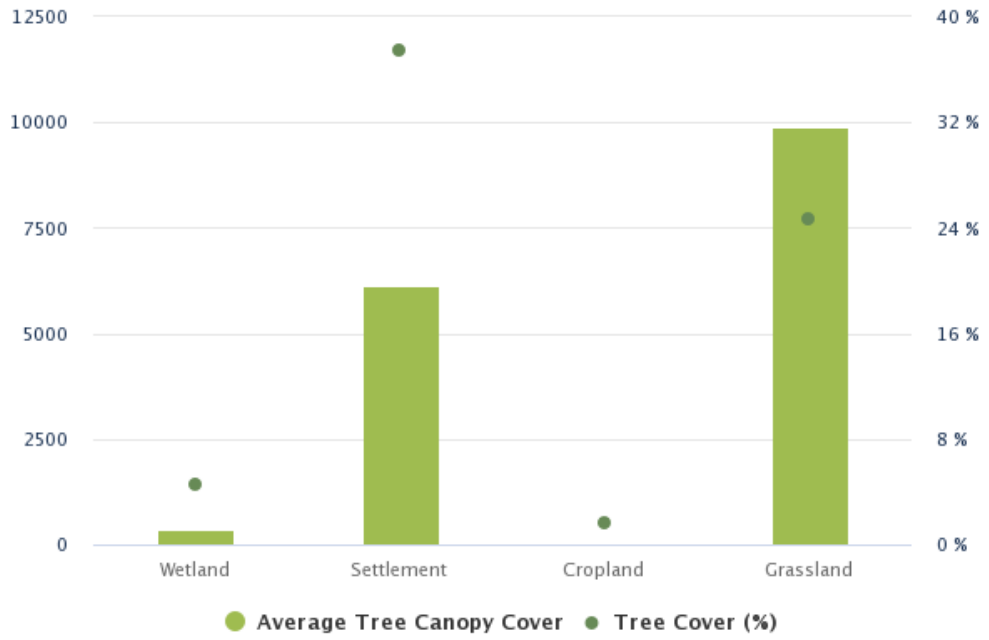
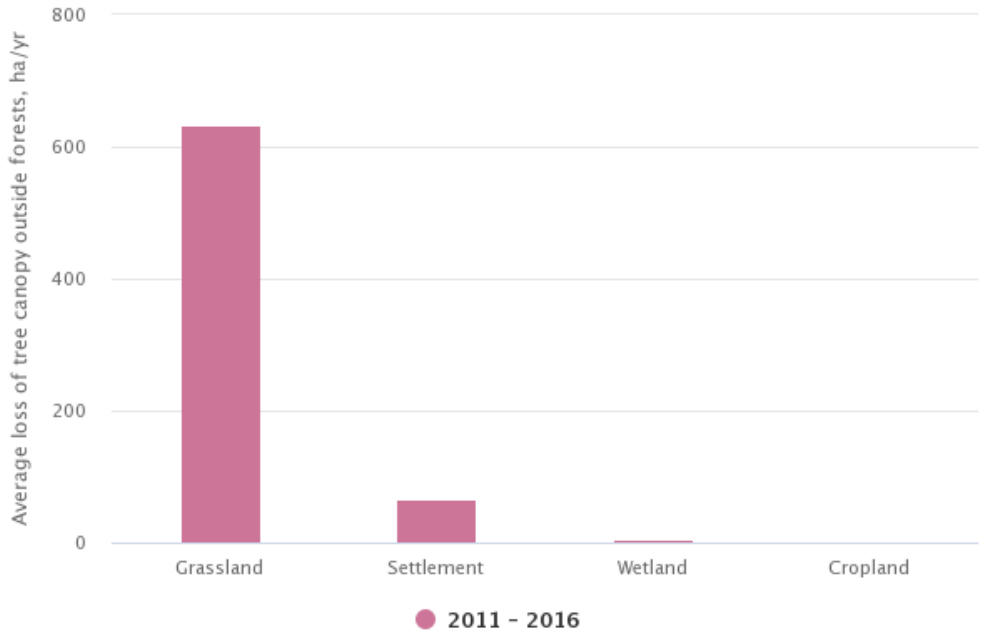


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Chatham County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	45,672	0	0.1	0.1	0.1	0.6	578	83	1	0.3	21	8	4	2	8	0	46,379
Evergreen Forest	0	34,673	0.1	0	0	0	1,061	109	0.8	0	11	8	8	2	12	0	35,885
Mixed Forest	0.3	0.4	31,908	0	0	0	544	31	0	0.1	12	6	4	3	14	0	32,522
Woody Wetlands	0	0	0	2,527	0	0	0.1	0	0	4	0	0	0	0	0	0	2,531
Cultivated Crops	0.1	0	0	0	2,289	2	0.1	0	0	0	0.1	0	0	0	3	0	2,294
Pasture/Hay	0.5	0	0	0.5	1	27,184	1	1	1	0	7	6	3	3	26	0	27,236
Grassland/Herbaceous	4	18	3	0	0	171	2,088	5,157	4	0.1	24	33	37	5	86	0	7,627
Shrub/Scrub	712	1,069	231	0	2	0.9	62	2,963	0.5	0	0.5	0.3	0.3	0	2	0	5,043
Open Water	0	1	0	0.5	0	0	2	0	7,345	185	0.5	0	0.4	0.4	5	0	7,540
Emergent Herbaceous Wetlands	0	0	0	11	0	0	0.6	0	0	172	0	0	0	0	0	0	183
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	11,403	34	65	6	0	0	11,509
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	3,079	11	7	0	0	3,097
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	1,257	1	0	0	1,259
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	328	0	0	328
Barren Land	0	0.2	0	0	0	0	4	10	31	0	0	0	0	0.2	160	0	206
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**46,388**	**35,762**	**32,142**	**2,539**	**2,292**	**27,358**	**4,340**	**8,355**	**7,383**	**361**	**11,479**	**3,175**	**1,391**	**356**	**317**	**0**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	114,782	0.1	2,408	6	88	34	**117,317**
Cropland	0.1	2,289	2	0	0.1	3	**2,294**
Grassland	2,037	3	37,628	6	119	115	**39,906**
Wetland	12	0	3	7,702	1	5	**7,723**
Settlement	0	0	0	0	16,192	0	**16,192**
Other Land	0.2	0	14	31	0.2	160	**206**
Total	**116,831**	**2,292**	**40,054**	**7,745**	**16,400**	**317**	**0**

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	0.91	
To Grassland	30.66	
To Settlement	63.18	
To Wetland	63.22	
To Other	91.98	
Reforestation (Non-Forest to Forest)		-4.43
Forest Remaining Forest		
Undisturbed		-3.47
Disturbed		
Fire	0	
Insect/Disease		
Harvest/Other	46.85	
Trees Outside Forest		
Tree canopy loss	64.70	
Canopy maintained/gained		-3.41

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Chatham County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Durham County, North Carolina

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Durham County, North Carolina has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 105,541 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -455,354 t CO2e per year.

- Roughly 49% of Durham County's total land base of 77,128 hectares (190,588 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 31 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -560,895 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Durham County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Durham county's GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-406,189	
Forest Disturbances		24,858
Non-Forest to Forest	-3,413	
Forest to Settlement		17,636
Forest to Grassland		12,707
Forest to other non-forest lands		3,530
Trees outside of forests	-151,292	46,810
Harvested Wood Products	0	
TOTAL	-560,895	105,541
Net GHG balance	**-455,354**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Durham County’s total land base is approximately 77,128 hectares (190,588 acres), with nearly 37.7% Settlement (i.e. developed areas of varying intensity), around 48.6% forest, 8.9% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 1% cropland, 3.7% wetland and 0.2% other land.

Figure 1. Land cover in Durham from the National Land Cover Database, 2019

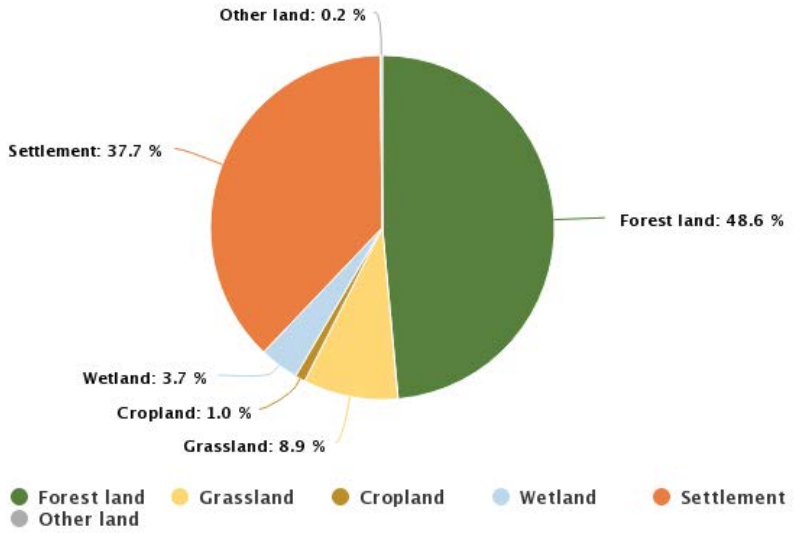
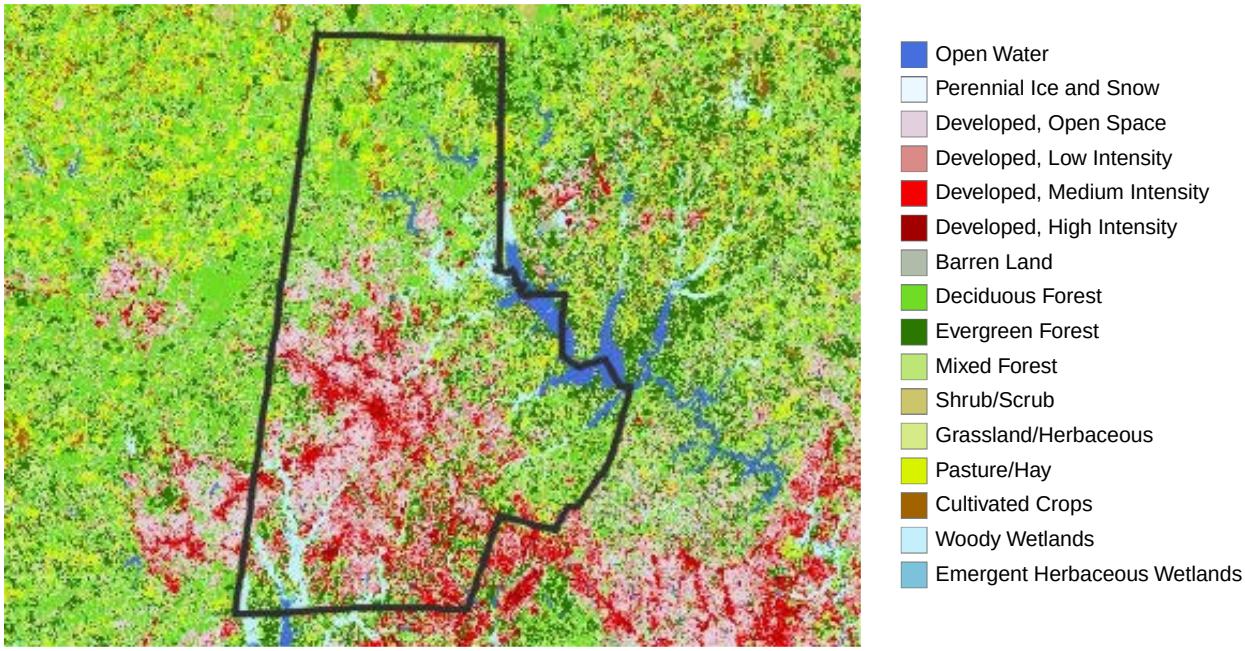


Figure 2. Land cover in Durham from the National Land Cover Database, 2019

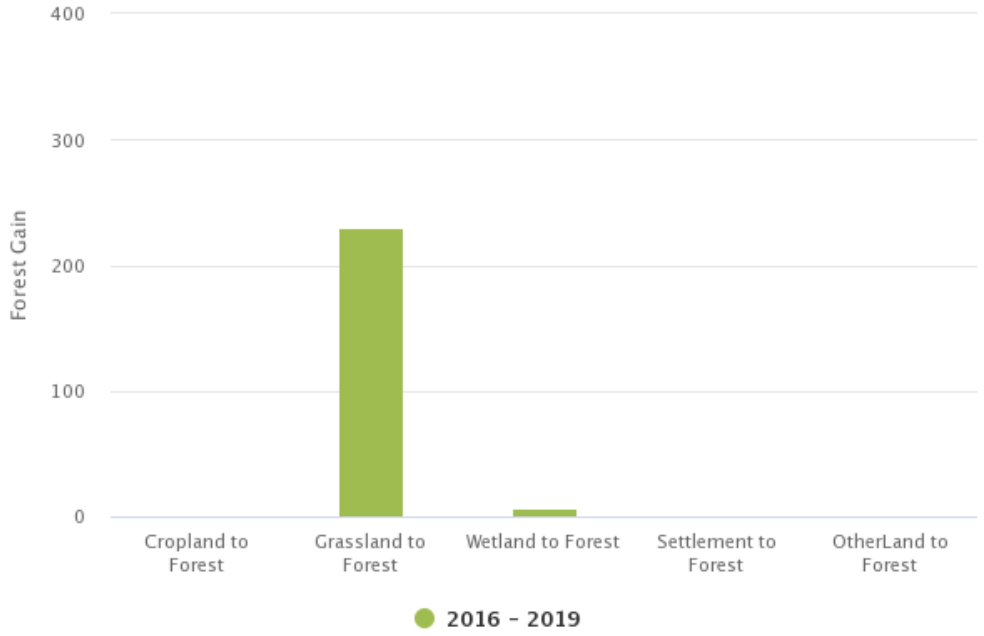


Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 649 hectares (1,603 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 237 hectares (585 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from harvests/other disturbance was the most significant in Durham County, affecting 450.5 hectares (1113.2 acres), followed by fires, which affected 0 hectares (0.0 acres) and insects, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Durham County had an average of 12,089 hectares (29,873 acres) of tree canopy outside forests. Between 2011 and 2016, 197 hectares per year of tree canopy were lost, for a total of 986 hectares (2,436 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Settlement class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

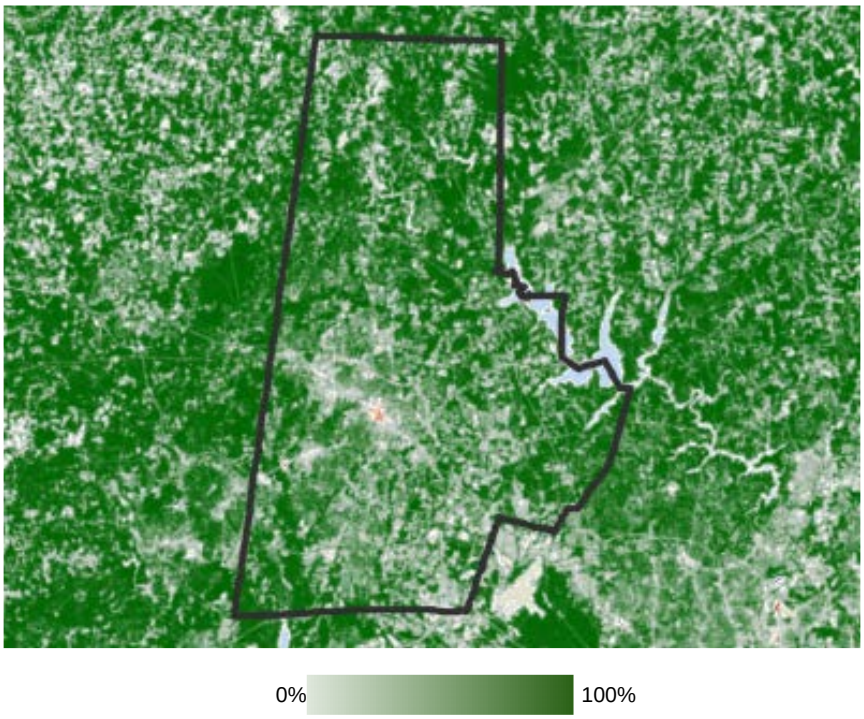


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Durham County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

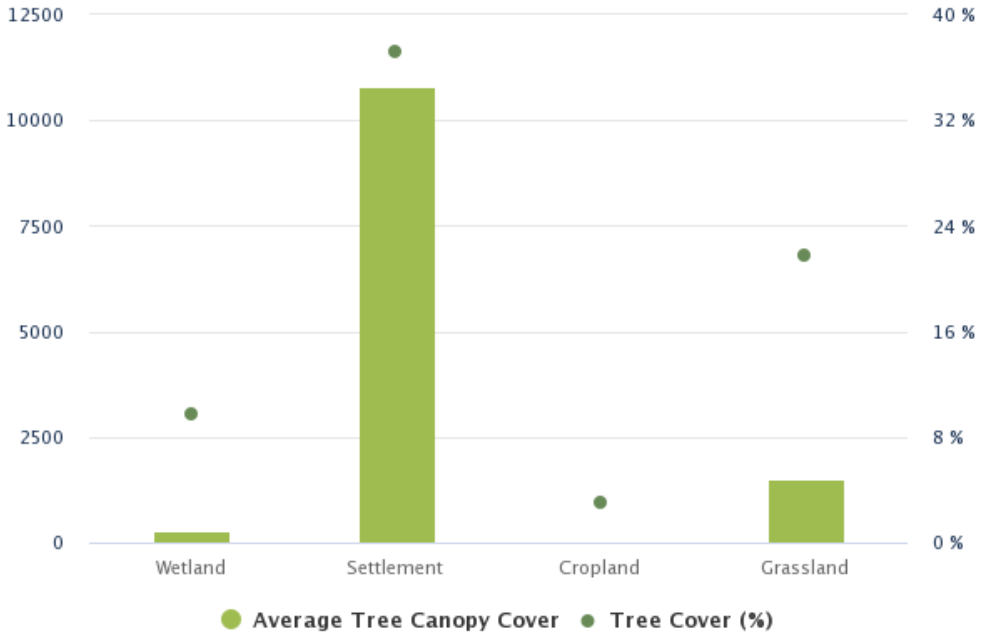
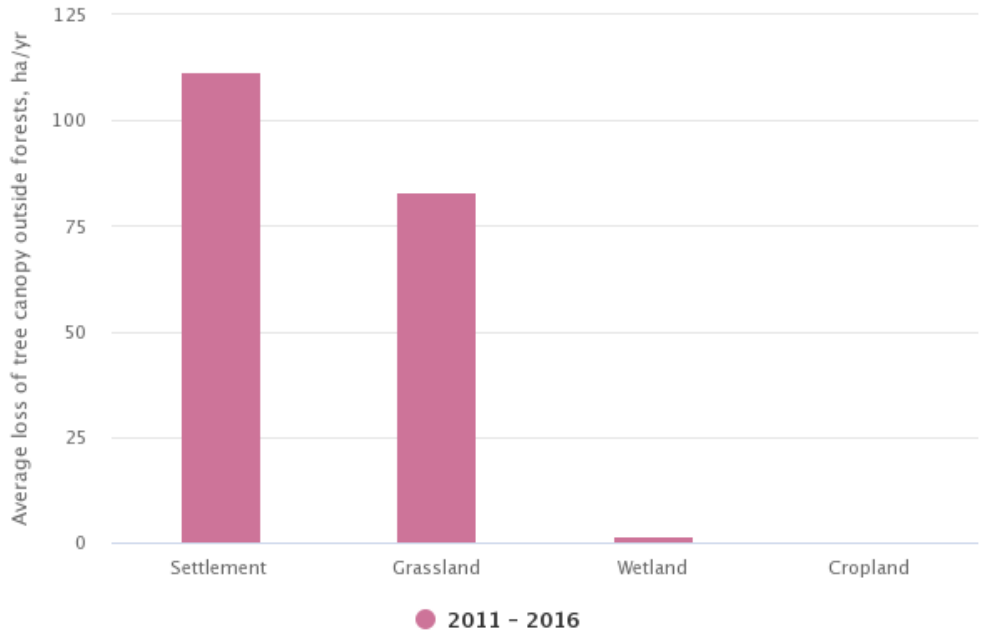


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Durham County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	13,932	0	0	0	0	0	91	14	0.2	0	18	13	14	7	8	0	14,096
Evergreen Forest	0	9,836	0	0	0	0	142	13	0	0	36	32	40	21	14	0	10,133
Mixed Forest	0	0	9,308	0	0	0	88	5	0.1	0	30	21	22	7	8	0	9,488
Woody Wetlands	0	0	0	4,134	0	0	0	0	0.3	5	0.8	0.3	0.2	0	0	0	4,141
Cultivated Crops	0	0	0	0	751	1	0	0	0	0	2	3	12	1	1	0	771
Pasture/Hay	0	0	0	0	0	4,875	0.2	0.2	0	0	10	11	14	2	16	0	4,929
Grassland/Herbaceous	3	4	2	0	0	16	772	380	1	0	37	50	108	20	10	0	1,402
Shrub/Scrub	112	82	27	0	0	0	20	446	0	0	2	2	7	3	0.7	0	703
Open Water	0	0	0	0	0	0	12	0	2,539	146	1	0.8	0.8	0.2	1	0	2,702
Emergent Herbaceous Wetlands	0	0	0	7	0	0	0	0	0	144	0.2	0.1	0.2	0	0	0	151
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	13,278	51	180	37	0	0	13,547
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	7,603	45	48	0	0	7,695
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	5,633	10	0	0	5,642
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	1,621	0	0	1,621
Barren Land	0	0	0	0	0	0	0.9	2	11	0	0	0.2	0.3	0.2	93	0	108
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**14,048**	**9,922**	**9,337**	**4,141**	**751**	**4,892**	**1,126**	**861**	**2,552**	**295**	**13,416**	**7,787**	**6,075**	**1,777**	**152**	**0**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	37,210	0	352	6	261	30	37,859
Cropland	0	751	1	0	18	1	771
Grassland	230	0	6,509	1	267	27	7,034
Wetland	7	0	12	2,828	4	1	2,853
Settlement	0	0	0	0	28,505	0	28,505
Other Land	0	0	3	11	0.7	93	108
Total	37,447	751	6,878	2,846	29,054	152	0

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	0.00	
To Grassland	29.48	
To Settlement	55.35	
To Wetland	65.55	
To Other	84.05	
Reforestation (Non-Forest to Forest)		-3.93
Forest Remaining Forest		
Undisturbed		-3.01
Disturbed		
Fire	0	
Insect/Disease		
Harvest/Other	45.10	
Trees Outside Forest		
Tree canopy loss	64.70	
Canopy maintained/gained		-3.41

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Durham County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Franklin County, North Carolina

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Franklin County, North Carolina has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 383,638 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -709,419 t CO2e per year.

- Roughly 58% of Franklin County's total land base of 128,097 hectares (316,534 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 18.9 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -1,093,057 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Franklin County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Franklin county's GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-948,809	
Forest Disturbances		158,991
Non-Forest to Forest	-22,908	
Forest to Settlement		6,151
Forest to Grassland		73,293
Forest to other non-forest lands		2,763
Trees outside of forests	-121,339	142,439
Harvested Wood Products	0	
TOTAL	-1,093,057	383,638
Net GHG balance	**-709,419**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Franklin County’s total land base is approximately 128,097 hectares (316,534 acres), with nearly 9.7% Settlement (i.e. developed areas of varying intensity), around 58.2% forest, 21.3% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 9.4% cropland, 1.3% wetland and 0.1% other land.

Figure 1. Land cover in Franklin from the National Land Cover Database, 2019

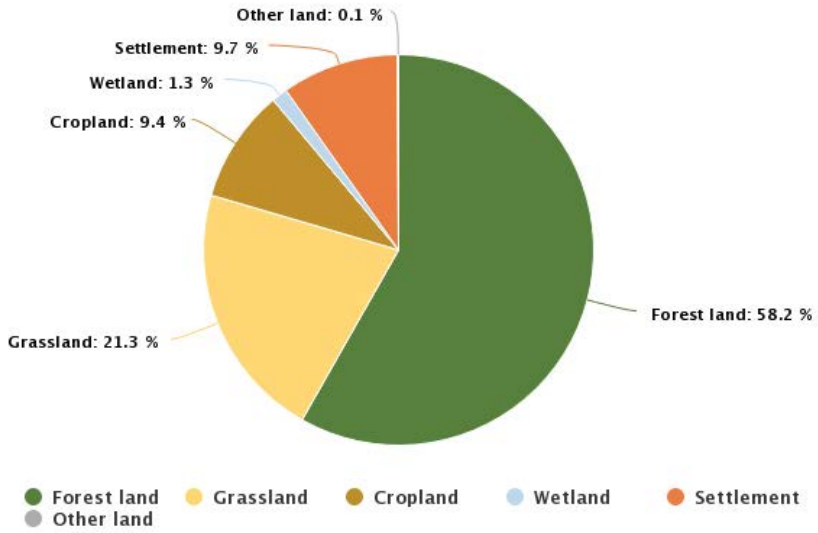
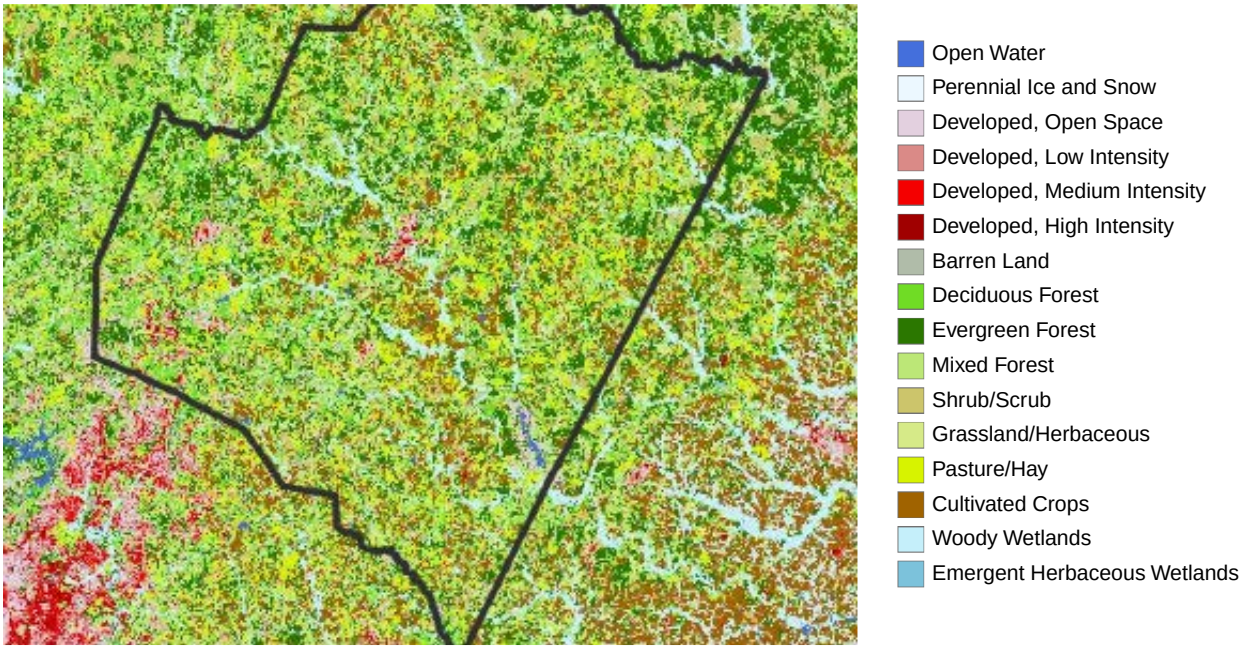


Figure 2. Land cover in Franklin from the National Land Cover Database, 2019



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 2,242 hectares (5,540 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 1,287 hectares (3,180 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

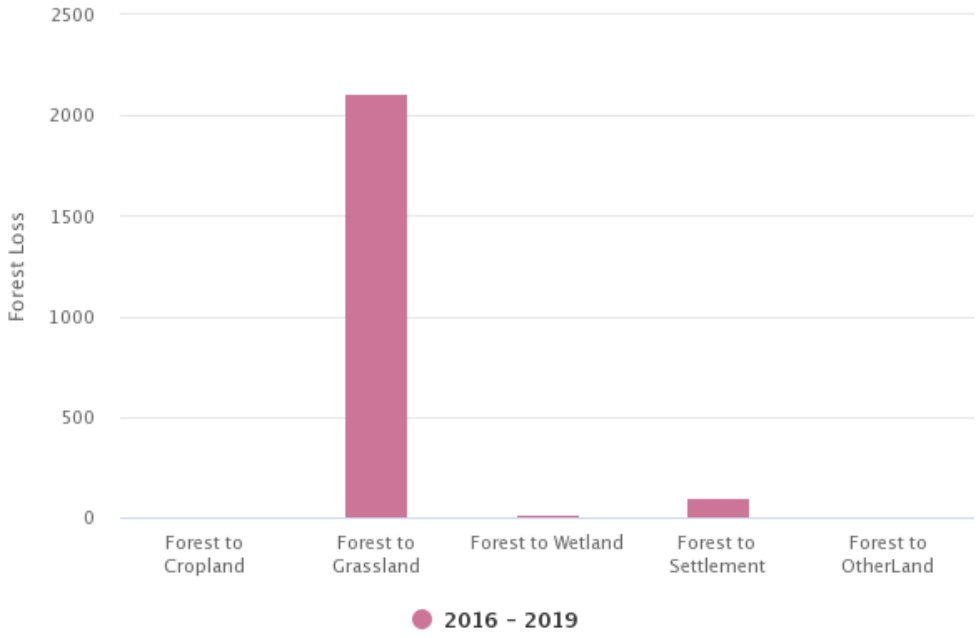
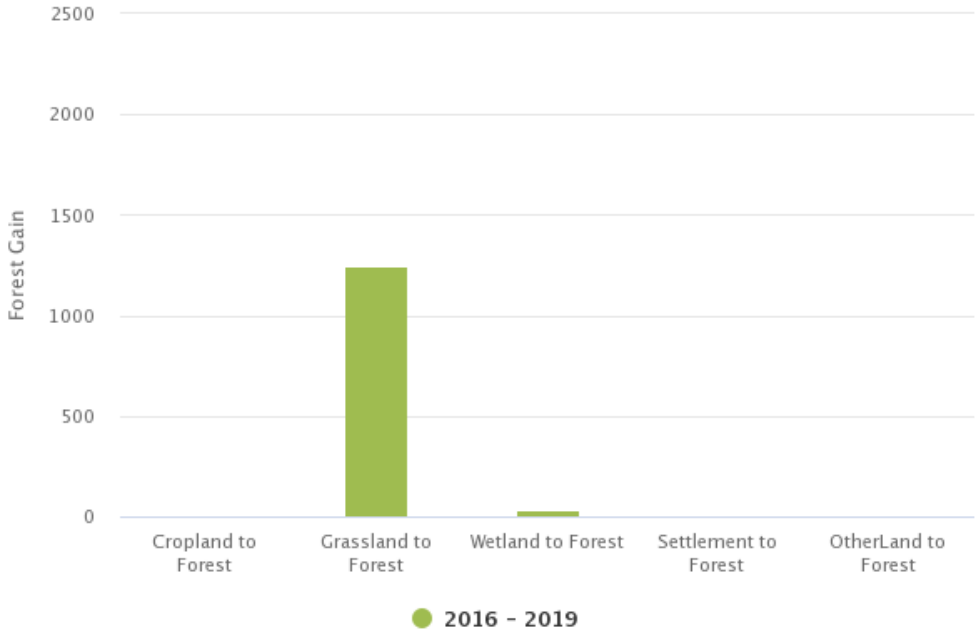


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from harvests/other disturbance was the most significant in Franklin County, affecting 2881.1 hectares (7119.3 acres), followed by fires, which affected 0 hectares (0.0 acres) and insects, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Franklin County had an average of 9,696 hectares (23,959 acres) of tree canopy outside forests. Between 2011 and 2016, 600 hectares per year of tree canopy were lost, for a total of 3,000 hectares (7,412 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Grassland class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

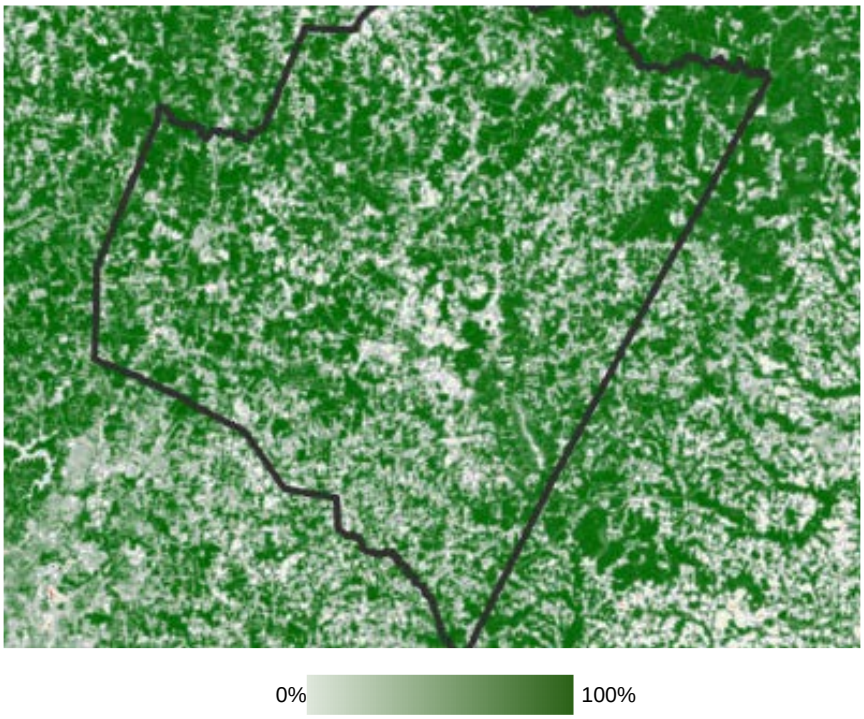


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Franklin County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

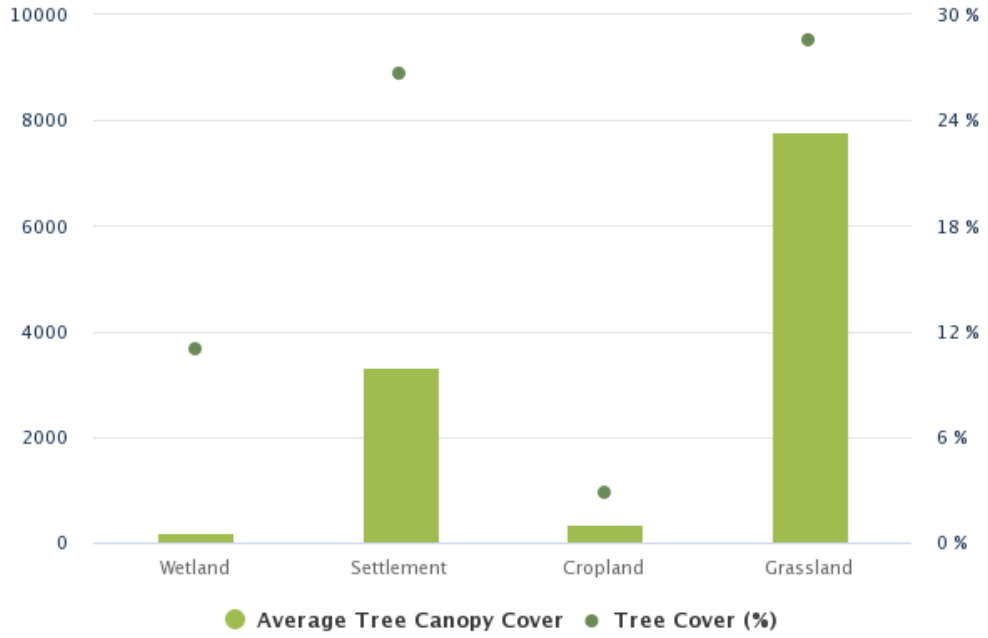
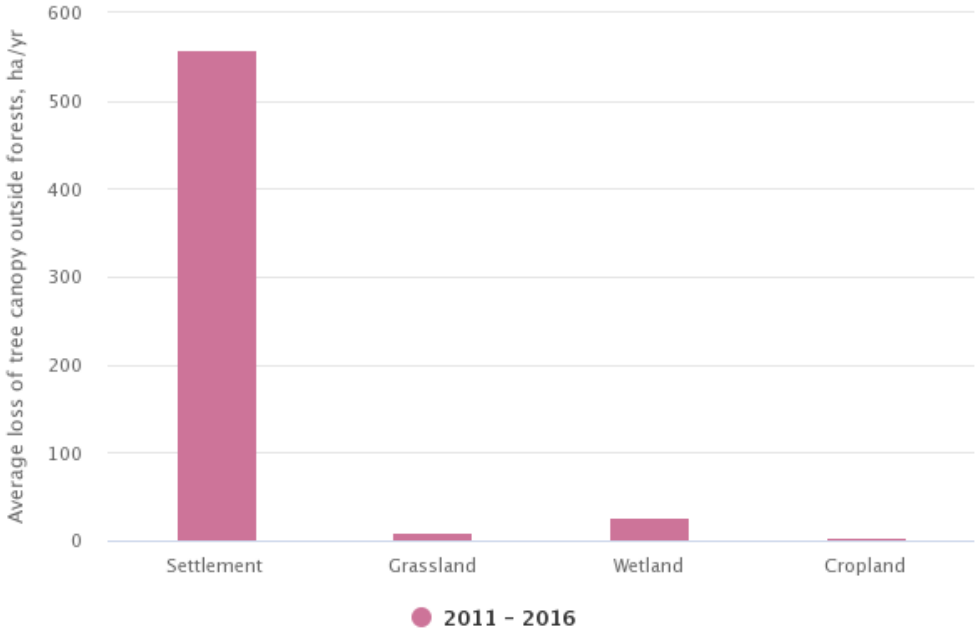


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Franklin County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	14,242	0	0.2	0	1	0	320	22	1	0	20	7	1	0.8	3	0	14,619
Evergreen Forest	0	26,694	0.1	0	0.6	0.5	1,106	20	0.4	0	18	11	7	3	5	0	27,864
Mixed Forest	0	0.2	24,949	0	1	0	631	9	1	0	21	7	4	0.9	4	0	25,629
Woody Wetlands	0	0	0	7,424	0	0	0.3	0	2	13	0.7	0	0	0	0	0	7,440
Cultivated Crops	0	2	0.1	0	11,986	13	0.1	0.1	0	0	10	3	3	1	0.2	0	12,018
Pasture/Hay	0	0.6	0.3	1	26	17,507	2	2	0.5	0	29	10	4	2	2	0	17,586
Grassland/Herbaceous	1	9	3	0	6	32	2,146	2,657	0.5	0	17	20	11	0.4	9	0	4,911
Shrub/Scrub	170	753	311	0	1	0	61	2,740	0	0	2	0.9	0.9	0	0.5	0	4,041
Open Water	0	0	0	0	0	0	0	0	1,435	17	0.4	0.1	0	0	0	0	1,453
Emergent Herbaceous Wetlands	0	0	0	35	0	0	0.6	0	0	201	0.1	0	0	0	0	0	237
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	8,281	22	30	2	0	0	8,335
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	3,039	4	3	0	0	3,046
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	670	0.6	0	0	670
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	183	0	0	183
Barren Land	0	0.6	0	0	0	0	3	2	0.3	0	0.1	0	0.1	0	58	0	65
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**14,414**	**27,459**	**25,263**	**7,461**	**12,022**	**17,553**	**4,269**	**5,452**	**1,441**	**231**	**8,400**	**3,120**	**735**	**196**	**82**	**0**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	73,310	3	2,108	17	102	12	**75,552**
Cropland	2	11,986	13	0	17	0.2	**12,018**
Grassland	1,249	33	25,146	1	97	12	**26,538**
Wetland	35	0	0.6	1,653	0.6	0	**1,690**
Settlement	0	0	0	0	12,234	0	**12,234**
Other Land	0.6	0	5	0.3	0.2	58	**65**
Total	**74,597**	**12,022**	**27,274**	**1,672**	**12,451**	**82**	**0**

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	50.58	
To Grassland	28.42	
To Settlement	49.40	
To Wetland	61.25	
To Other	90.39	
Reforestation (Non-Forest to Forest)		-4.85
Forest Remaining Forest		
Undisturbed		-3.67
Disturbed		
Fire	0	
Insect/Disease		
Harvest/Other	45.11	
Trees Outside Forest		
Tree canopy loss	64.70	
Canopy maintained/gained		-3.41

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Franklin County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Granville County, North Carolina

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Granville County, North Carolina has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 406,574 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -858,363 t CO2e per year.

- Roughly 67% of Granville County's total land base of 139,205 hectares (343,982 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 20.2 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -1,264,937 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Granville County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Granville county' s GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-1,127,890	
Forest Disturbances		200,524
Non-Forest to Forest	-24,676	
Forest to Settlement		3,677
Forest to Grassland		78,420
Forest to other non-forest lands		1,788
Trees outside of forests	-112,371	122,166
Harvested Wood Products	0	
TOTAL	-1,264,937	406,574
Net GHG balance	**-858,363**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Granville County’s total land base is approximately 139,205 hectares (343,982 acres), with nearly 8.6% Settlement (i.e. developed areas of varying intensity), around 66.7% forest, 19.4% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 3.8% cropland, 1.6% wetland and 0.1% other land.

Figure 1. Land cover in Granville from the National Land Cover Database, 2019

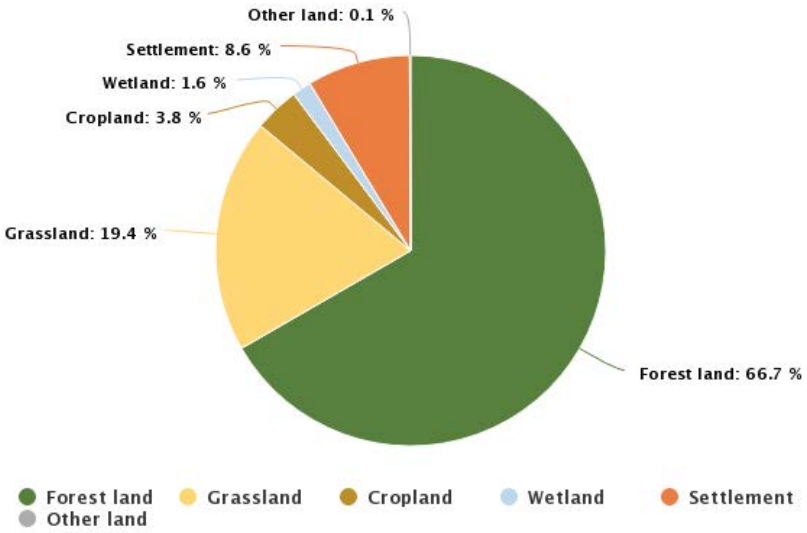
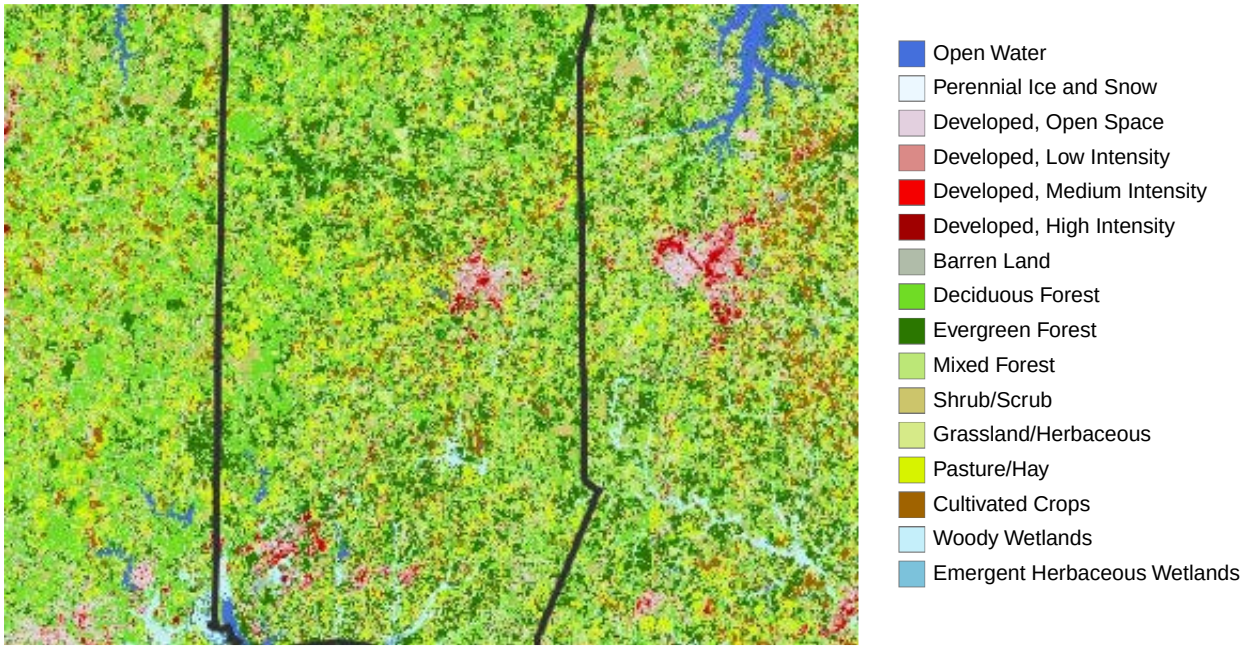


Figure 2. Land cover in Granville from the National Land Cover Database, 2019



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 2,029 hectares (5,014 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 1,733 hectares (4,283 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

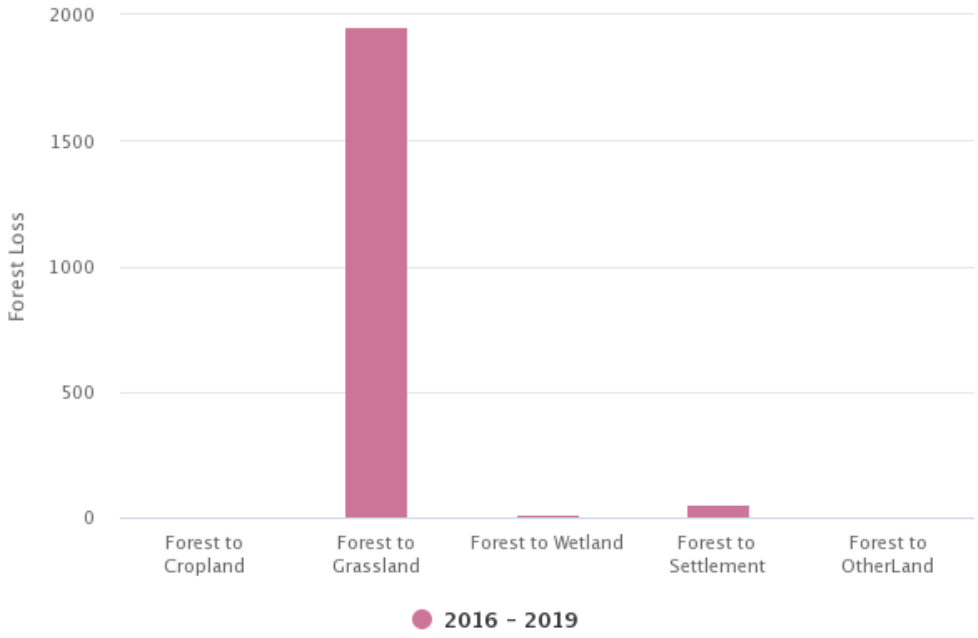
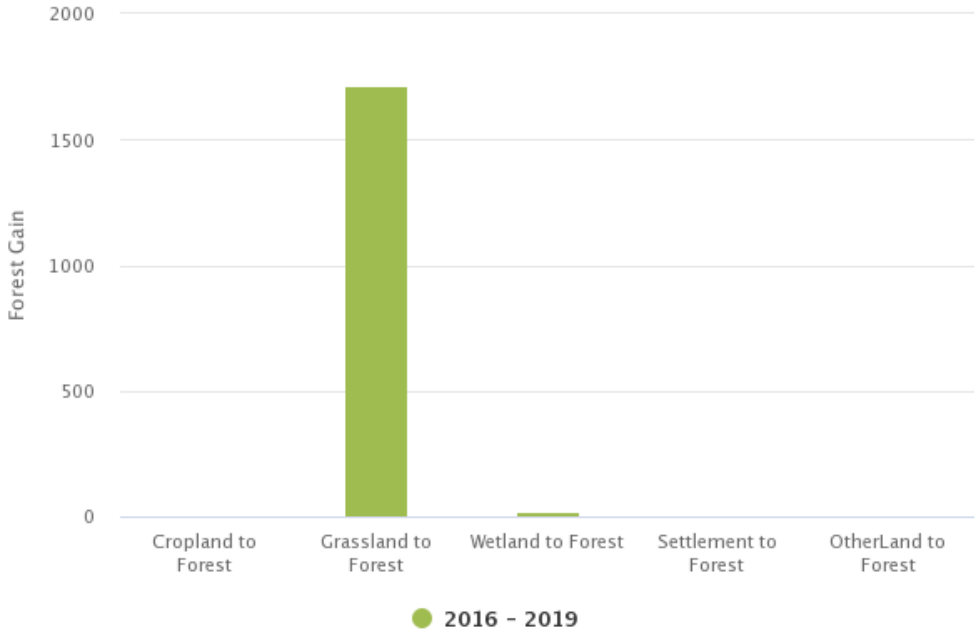


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from harvests/other disturbance was the most significant in Granville County, affecting 3773.7 hectares (9325.0 acres), followed by fires, which affected 0 hectares (0.0 acres) and insects, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Granville County had an average of 8,979 hectares (22,187 acres) of tree canopy outside forests. Between 2011 and 2016, 515 hectares per year of tree canopy were lost, for a total of 2,573 hectares (6,357 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Grassland class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

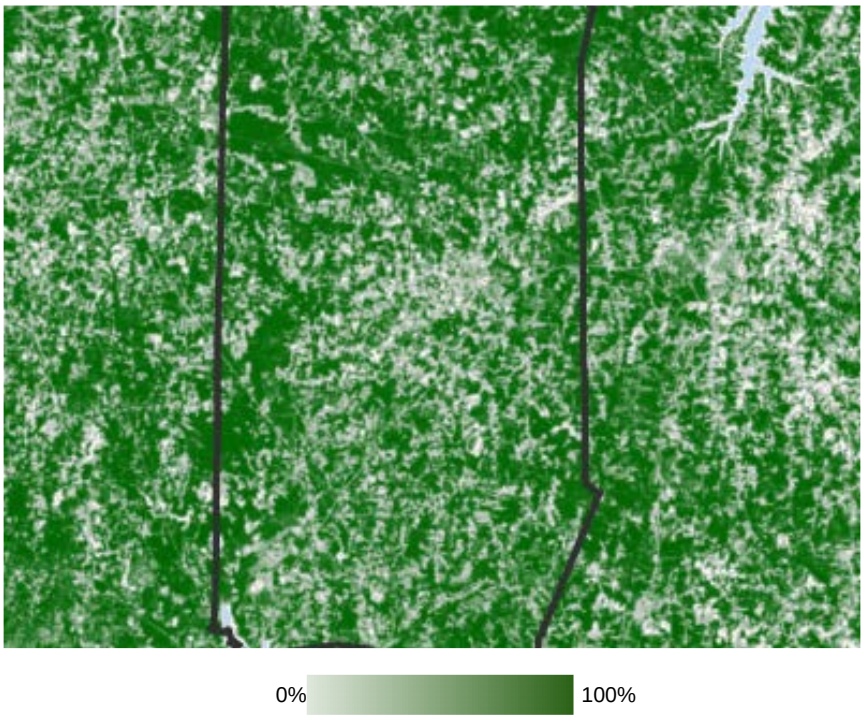


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Granville County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

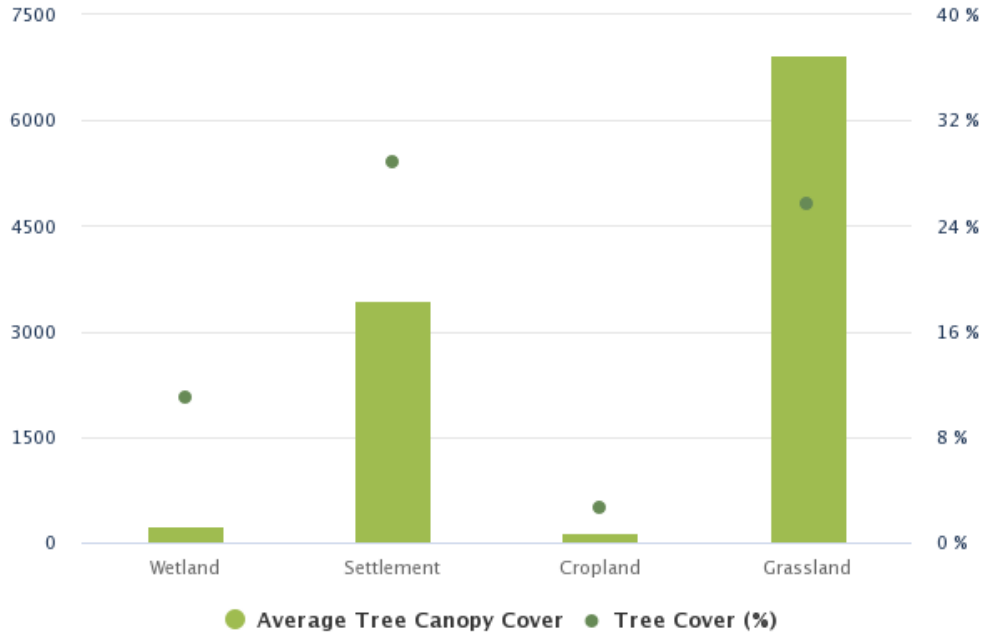
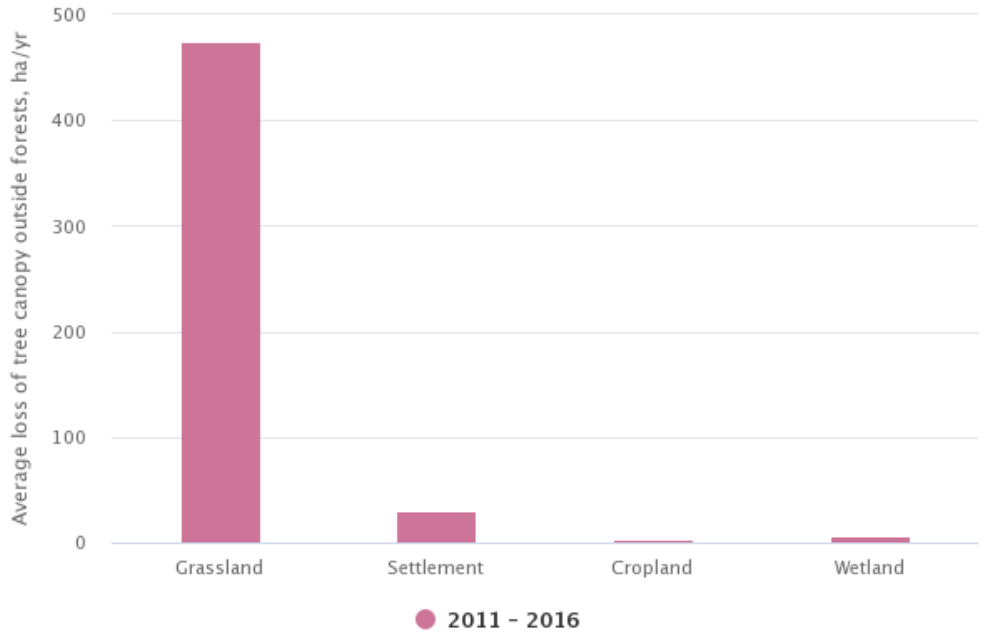


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Granville County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	29,453	0	0.2	0	2	0.2	393	27	0	0.3	11	2	0.6	0.1	3	0	29,892
Evergreen Forest	0	31,376	0.1	0	0.1	0.4	977	17	2	0	9	7	3	0.5	3	0	32,393
Mixed Forest	0.5	0	26,808	0	0.7	0	526	12	0.5	0	12	8	2	0.2	3	0	27,371
Woody Wetlands	0	0	0	3,461	0	0	0	0	2	8	0	0	0	0	0	0	3,472
Cultivated Crops	0.1	0.7	0	0	5,216	38	0.2	0	0	0	5	6	4	0.3	3	0	5,273
Pasture/Hay	0.7	0.5	0.1	0	4	17,609	2	0.2	0	0	17	3	2	0.6	1	0	17,640
Grassland/Herbaceous	7	20	4	0	3	42	2,141	3,182	1	0.1	10	9	0.4	0	16	0	5,437
Shrub/Scrub	790	659	233	0	0	0	43	1,935	0	0	2	0.3	0	0	1	0	3,662
Open Water	0.1	0.6	0	0	0	0	0.5	0	1,914	106	0.1	0.2	0	0	0	0	2,021
Emergent Herbaceous Wetlands	0	0	0	17	0	0	0.1	0	0.4	151	0	0.1	0	0	0	0	169
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	7,852	13	21	3	0	0	7,890
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	2,731	4	3	0	0	2,737
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	838	0.9	0	0	839
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	325	0	0	325
Barren Land	0	0.2	0	0	0	0	1	3	7	0	0.1	0.2	0.3	0.1	74	0	86
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**30,250**	**32,057**	**27,046**	**3,479**	**5,226**	**17,690**	**4,083**	**5,175**	**1,927**	**265**	**7,917**	**2,780**	**875**	**334**	**104**	**0**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	91,098	3	1,951	13	55	8	**93,127**
Cropland	0.8	5,216	39	0	15	3	**5,273**
Grassland	1,714	7	24,953	2	44	18	**26,739**
Wetland	18	0	0.6	2,171	0.4	0	**2,190**
Settlement	0	0	0	0	11,791	0	**11,791**
Other Land	0.2	0	4	7	0.7	74	**86**
Total	**92,831**	**5,226**	**26,947**	**2,192**	**11,906**	**104**	**0**

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	69.97	
To Grassland	32.86	
To Settlement	54.38	
To Wetland	48.16	
To Other	83.15	
Reforestation (Non-Forest to Forest)		-3.88
Forest Remaining Forest		
Undisturbed		-3.52
Disturbed		
Fire	0	
Insect/Disease		
Harvest/Other	43.44	
Trees Outside Forest		
Tree canopy loss	64.70	
Canopy maintained/gained		-3.41

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Granville County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Johnston County, North Carolina

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Johnston County, North Carolina has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 375,966 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -900,824 t CO2e per year.

- Roughly 47% of Johnston County's total land base of 206,082 hectares (509,239 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 10.3 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -1,276,790 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Johnston County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Johnston county' s GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-1,119,152	
Forest Disturbances		185,804
Non-Forest to Forest	-18,599	
Forest to Settlement		18,952
Forest to Grassland		45,093
Forest to other non-forest lands		51,225
Trees outside of forests	-139,039	74,894
Harvested Wood Products	0	
TOTAL	-1,276,790	375,966
Net GHG balance	**-900,824**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Johnston County’s total land base is approximately 206,082 hectares (509,239 acres), with nearly 14.1% Settlement (i.e. developed areas of varying intensity), around 46.7% forest, 11.1% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 26% cropland, 2% wetland and 0.1% other land.

Figure 1. Land cover in Johnston from the National Land Cover Database, 2019

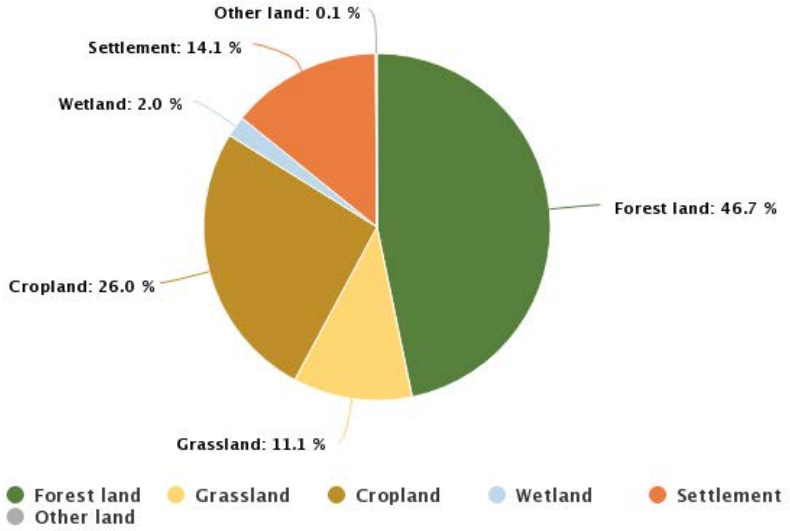
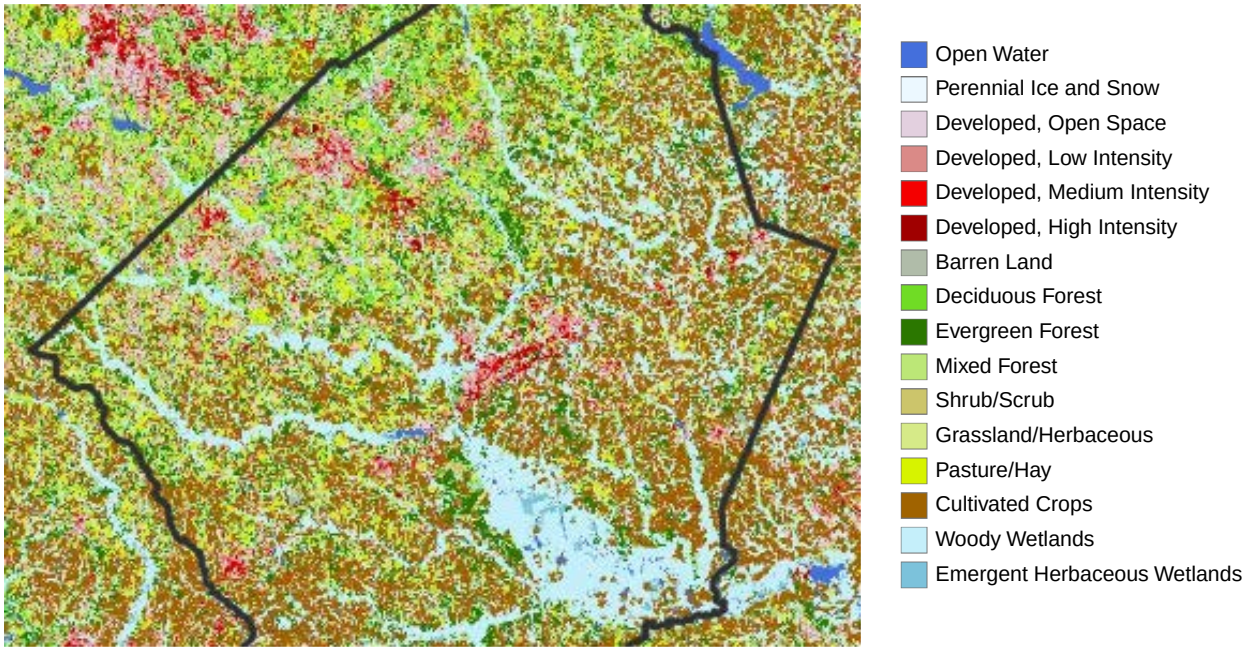


Figure 2. Land cover in Johnston from the National Land Cover Database, 2019



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 2,086 hectares (5,154 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 1,211 hectares (2,993 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

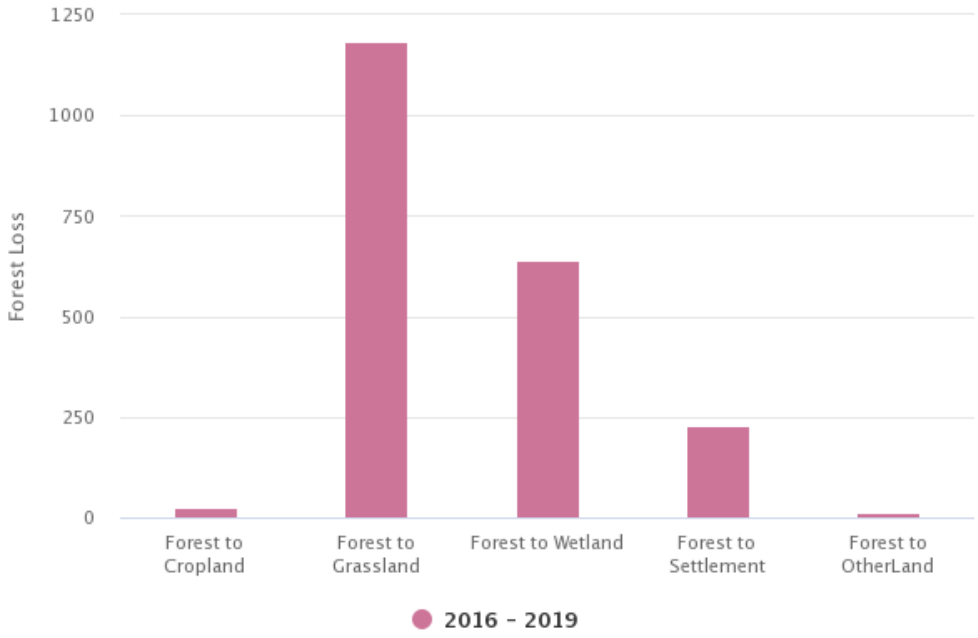
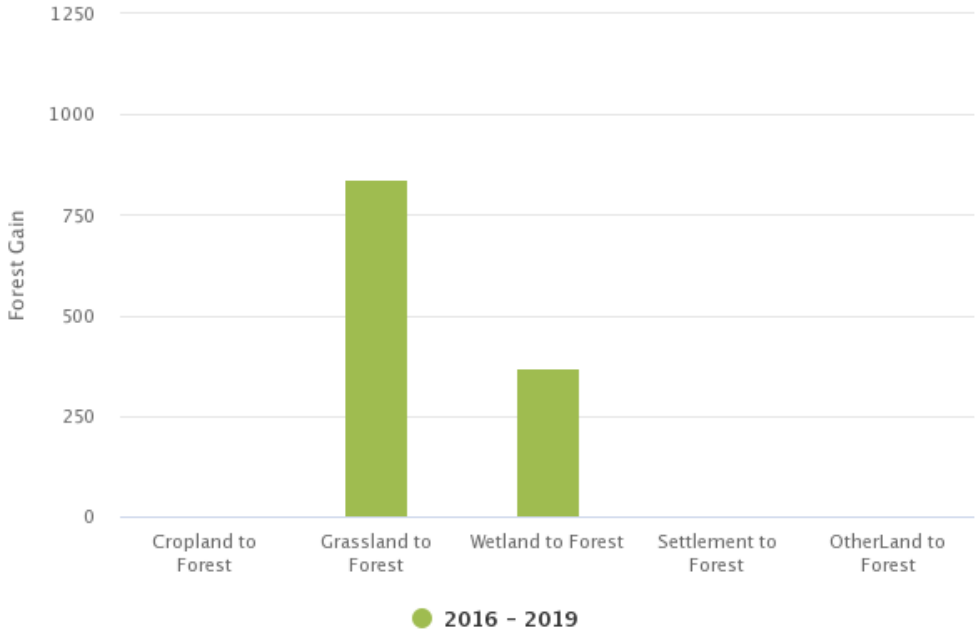


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from harvests/other disturbance was the most significant in Johnston County, affecting 3290.3 hectares (8130.5 acres), followed by fires, which affected 0 hectares (0.0 acres) and insects, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Johnston County had an average of 11,110 hectares (27,453 acres) of tree canopy outside forests. Between 2011 and 2016, 315 hectares per year of tree canopy were lost, for a total of 1,577 hectares (3,897 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Grassland class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

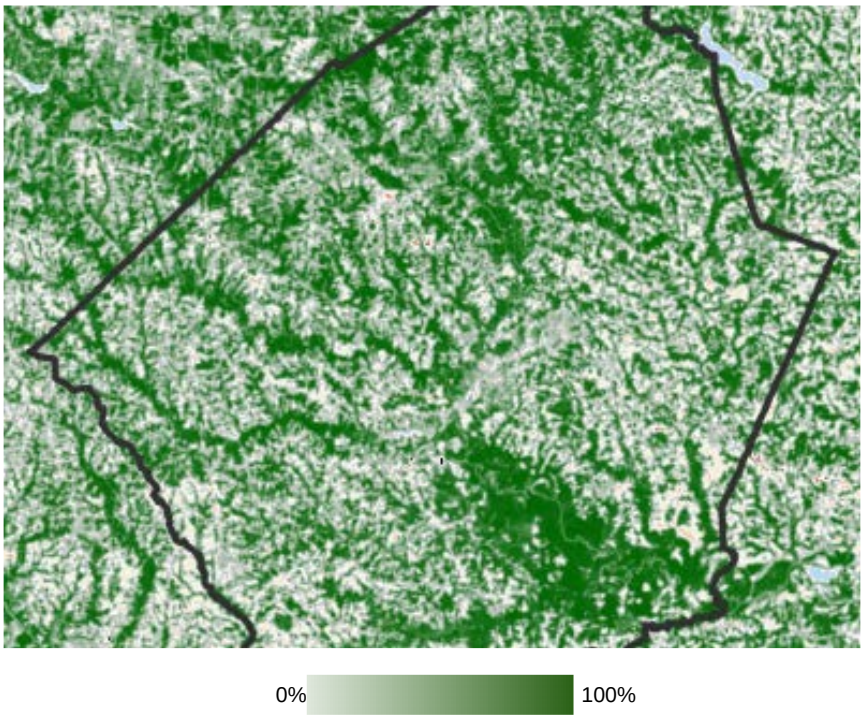


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Johnston County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

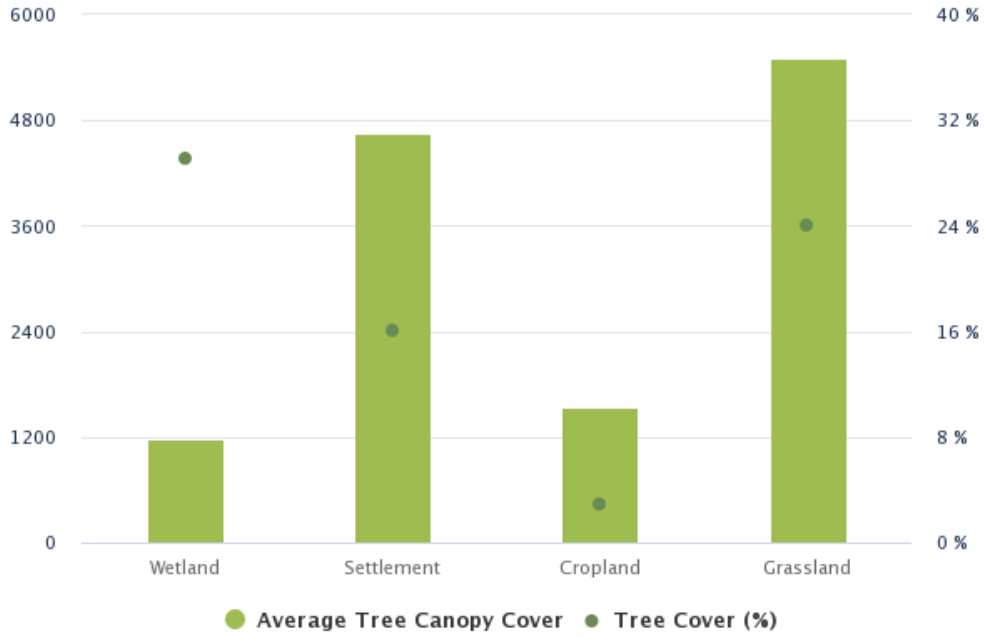
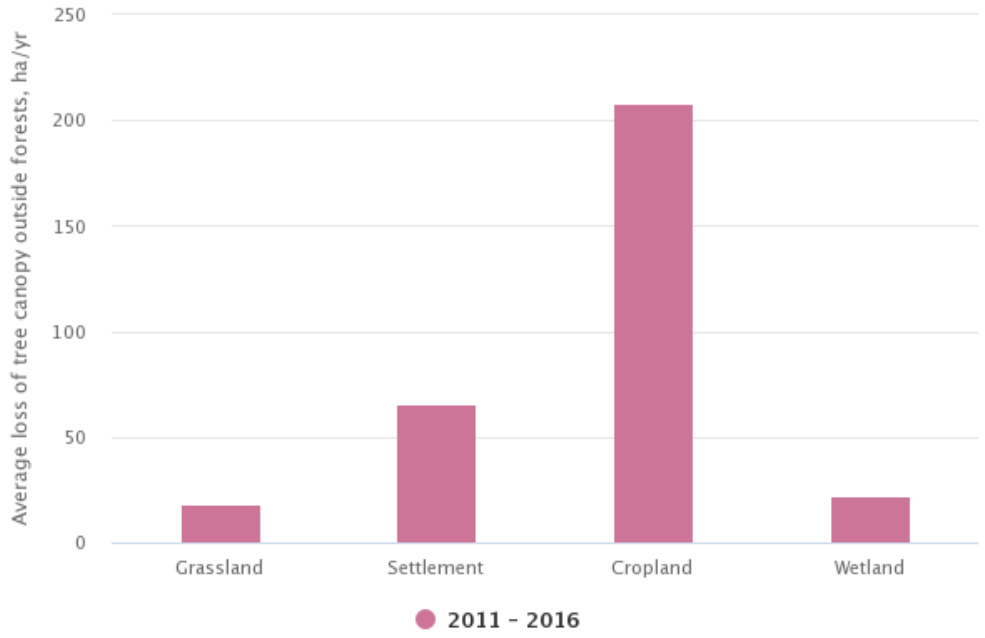


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Johnston County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	8,888	0	0	0	0.3	0	159	14	0	0	39	13	7	1	1	0	9,121
Evergreen Forest	0	23,346	0.1	0	2	0	652	21	0.5	0	39	27	10	3	5	0	24,105
Mixed Forest	0	0.2	18,017	0	0.2	0	326	12	0	0	36	19	7	0.8	4	0	18,422
Woody Wetlands	0	0	0	44,882	21	0	0.6	0	5	633	19	6	2	0.5	2	0	45,571
Cultivated Crops	0.5	1	0	1	53,437	12	0.3	0	8	0	81	50	34	23	5	0	53,652
Pasture/Hay	0.1	0.3	0.2	2	22	13,665	1	0.8	0	0.1	50	24	10	2	0.3	0	13,778
Grassland/Herbaceous	6	120	24	0.2	24	2	4,507	1,190	3	0	99	76	61	5	6	0	6,122
Shrub/Scrub	46	481	152	9	19	2	28	2,326	0	0	13	6	2	0.4	0.7	0	3,086
Open Water	0	0.1	0	0	0	0	0.5	0	2,229	146	2	0.2	0.5	0.1	5	0	2,383
Emergent Herbaceous Wetlands	0	0	0	368	9	0	0.6	0	4	1,023	3	2	2	0.1	0.6	0	1,412
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	14,814	77	178	9	0	0	15,079
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	9,367	24	13	0	0	9,404
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	2,866	3	0	0	2,869
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	841	0	0	841
Barren Land	0	0.1	0	0	0	0	4	1	7	0	1	1	2	0.8	224	0	242
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**8,939**	**23,949**	**18,193**	**45,263**	**53,535**	**13,681**	**5,678**	**3,565**	**2,257**	**1,802**	**15,194**	**9,668**	**3,206**	**903**	**253**	**0**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	95,133	24	1,184	639	228	12	**97,218**
Cropland	3	53,437	12	8	187	5	**53,652**
Grassland	840	66	21,722	3	348	7	**22,986**
Wetland	368	9	1	3,402	9	6	**3,795**
Settlement	0	0	0	0	28,193	0	**28,193**
Other Land	0.1	0	5	7	6	224	**242**
Total	**96,344**	**53,535**	**22,924**	**4,059**	**28,971**	**253**	**0**

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	57.01	
To Grassland	31.14	
To Settlement	67.93	
To Wetland	61.80	
To Other	91.28	
Reforestation (Non-Forest to Forest)		-4.19
Forest Remaining Forest		
Undisturbed		-3.32
Disturbed		
Fire	0	
Insect/Disease		
Harvest/Other	46.16	
Trees Outside Forest		
Tree canopy loss	64.70	
Canopy maintained/gained		-3.41

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Johnston County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Orange County, North Carolina

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Orange County, North Carolina has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 139,469 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -622,628 t CO2e per year.

- Roughly 61% of Orange County's total land base of 103,849 hectares (256,617 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 25 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -762,096 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Orange County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Orange county's GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-626,908	
Forest Disturbances		53,728
Non-Forest to Forest	-10,663	
Forest to Settlement		10,615
Forest to Grassland		27,096
Forest to other non-forest lands		841
Trees outside of forests	-124,525	47,190
Harvested Wood Products	0	
TOTAL	-762,096	139,469
Net GHG balance	**-622,628**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Orange County’s total land base is approximately 103,849 hectares (256,617 acres), with nearly 15.9% Settlement (i.e. developed areas of varying intensity), around 60.8% forest, 19.5% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 2.7% cropland, 1% wetland and 0.1% other land.

Figure 1. Land cover in Orange from the National Land Cover Database, 2019

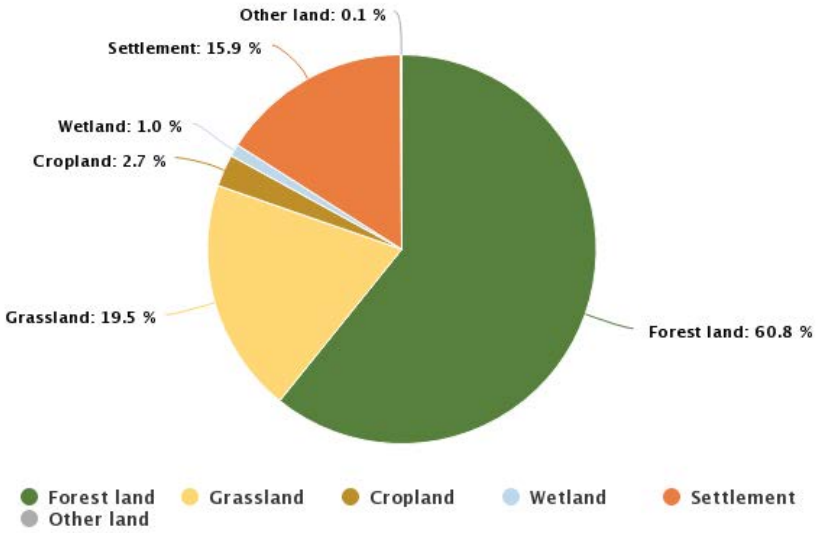
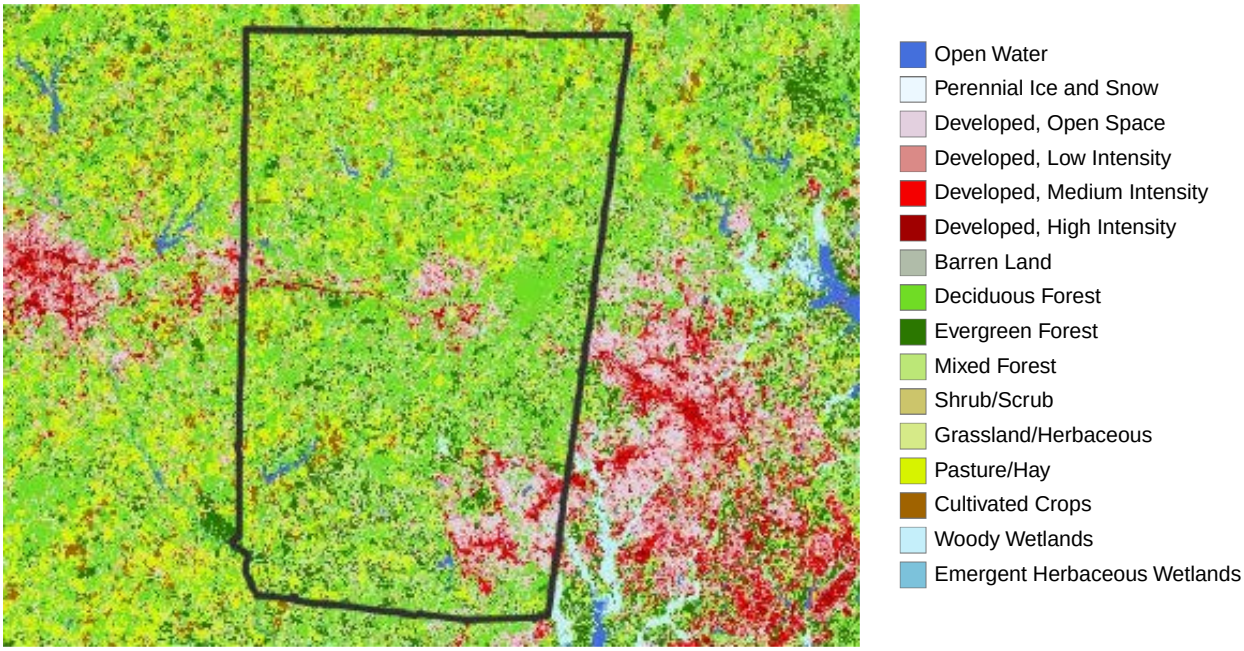


Figure 2. Land cover in Orange from the National Land Cover Database, 2019



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 830 hectares (2,051 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 824 hectares (2,036 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

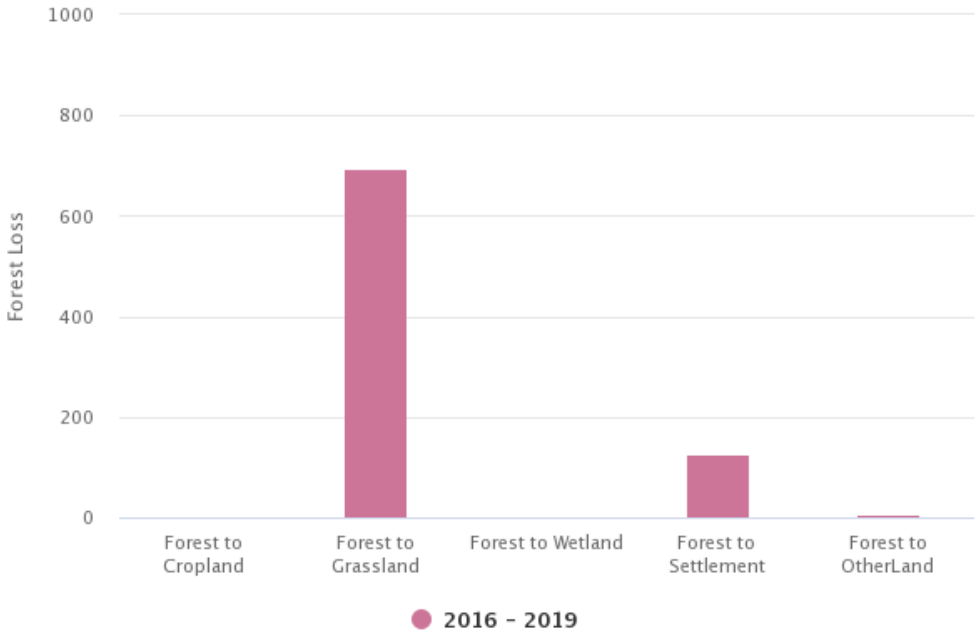
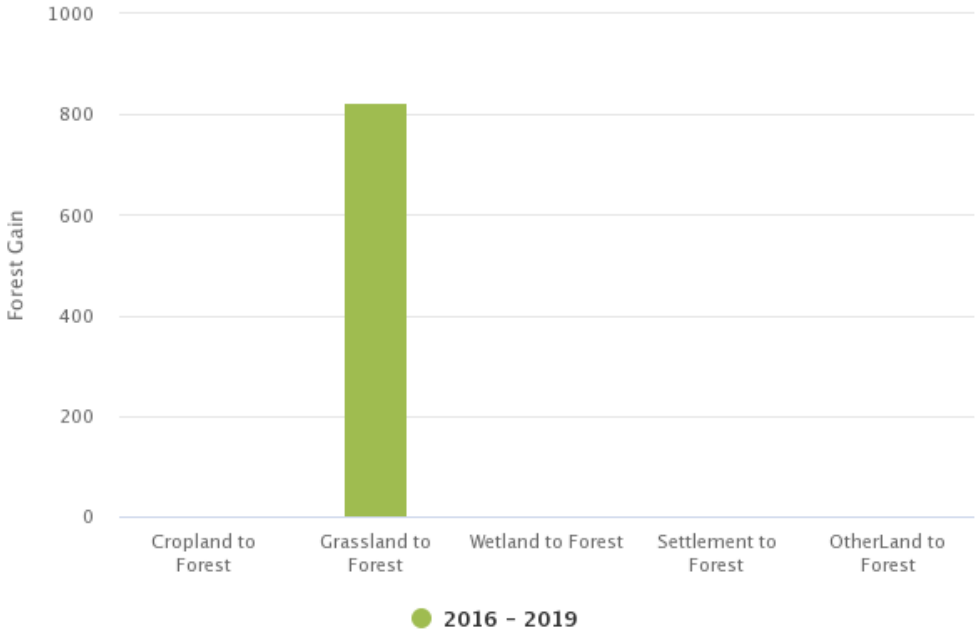


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from harvests/other disturbance was the most significant in Orange County, affecting 879.3 hectares (2172.8 acres), followed by fires, which affected 0 hectares (0.0 acres) and insects, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Orange County had an average of 9,950 hectares (24,587 acres) of tree canopy outside forests. Between 2011 and 2016, 199 hectares per year of tree canopy were lost, for a total of 994 hectares (2,456 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Grassland class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

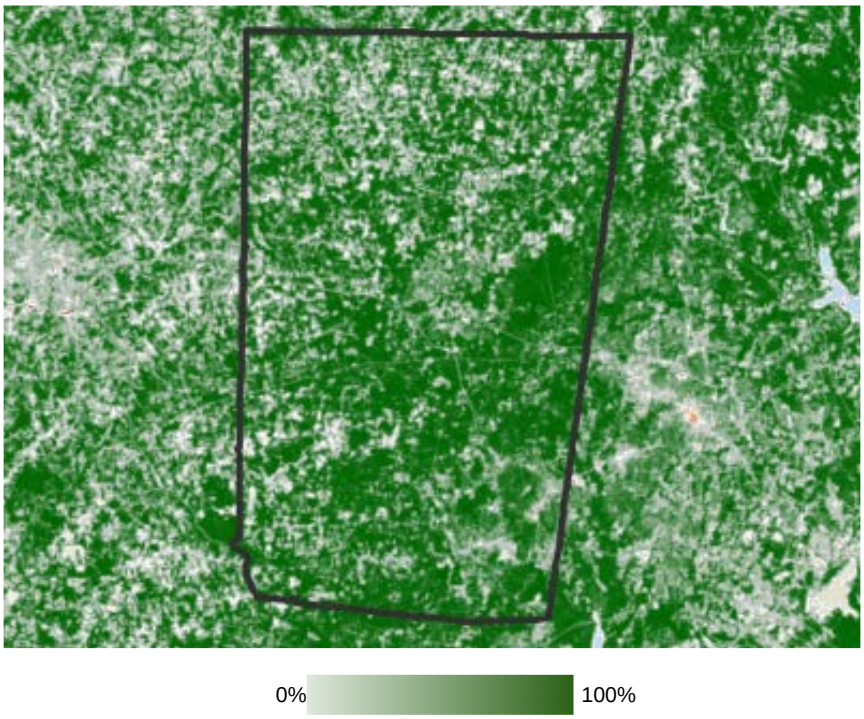


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Orange County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

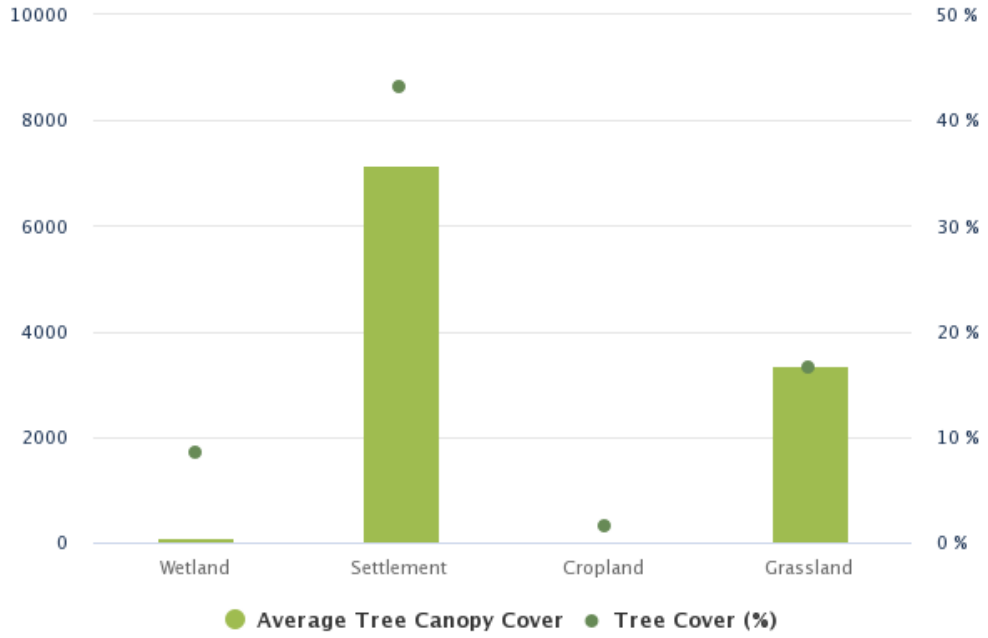
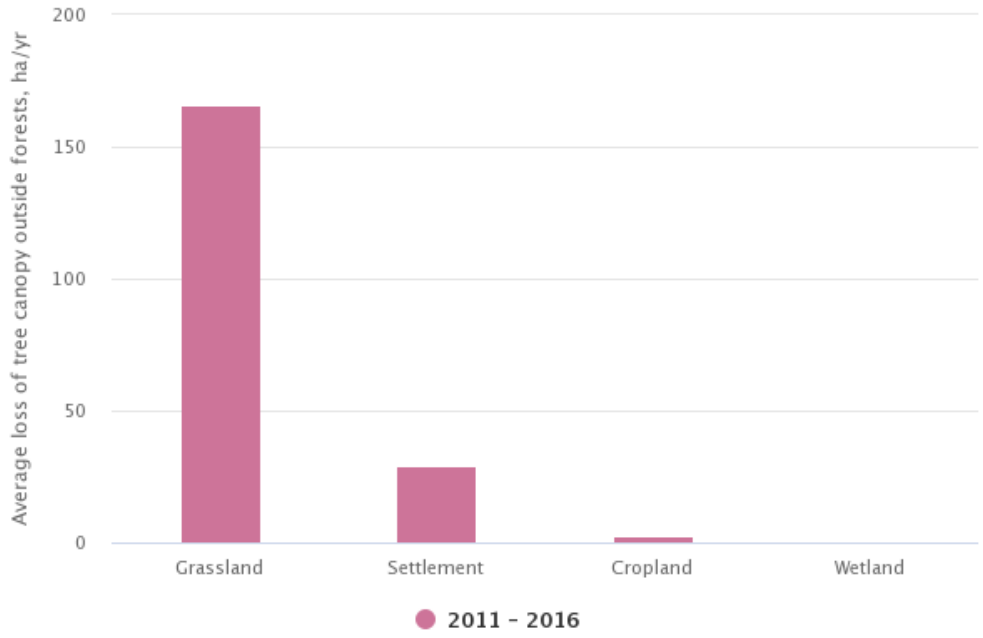


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Orange County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	37,768	0	0.1	0	0.7	0.6	331	29	0.9	0	58	11	8	3	3	0	38,213
Evergreen Forest	0	10,362	0.1	0	0	0.5	175	8	0.9	0	15	2	2	5	2	0	10,572
Mixed Forest	0.3	0	13,661	0	0	0.1	144	5	0.1	0	18	1	2	2	0.6	0	13,835
Woody Wetlands	0	0	0	537	0	0	0.1	0	0.6	2	0	0	0	0	0	0	539
Cultivated Crops	0.1	0	0	0	2,766	6	0	0	0	0	0.8	0.3	0.1	0	0.7	0	2,773
Pasture/Hay	2	0	0.1	0	5	16,957	0.3	0.7	0.1	0	46	8	6	0.7	8	0	17,032
Grassland/Herbaceous	8	0.5	0	0	0	18	589	1,060	1	0	9	11	10	1	5	0	1,713
Shrub/Scrub	533	145	135	0	0	0	33	887	0	0	2	0	0	0	0.9	0	1,736
Open Water	0.3	0	0	0.5	0	0	2	0	1,019	26	0.8	0.1	0.2	0.2	0.1	0	1,050
Emergent Herbaceous Wetlands	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	14
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	11,008	20	45	9	0	0	11,082
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	3,202	9	8	0	0	3,219
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	1,588	1	0	0	1,589
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	430	0	0	430
Barren Land	0	0	0	0	0	0	0.5	0.7	0	0	0	0	0.2	0.2	51	0	52
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**38,311**	**10,507**	**13,797**	**538**	**2,771**	**16,982**	**1,274**	**1,991**	**1,023**	**42**	**11,156**	**3,256**	**1,669**	**461**	**71**	**0**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	62,329	0.7	693	4	126	6	63,159
Cropland	0.1	2,766	6	0	1	0.7	2,773
Grassland	823	5	19,546	2	93	14	20,481
Wetland	0.8	0	2	1,060	1	0.1	1,064
Settlement	0	0	0	0	16,321	0	16,321
Other Land	0	0	1	0	0.4	51	52
Total	63,153	2,771	20,247	1,065	16,543	71	0

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	19.30	
To Grassland	31.96	
To Settlement	68.72	
To Wetland	53.75	
To Other	79.10	
Reforestation (Non-Forest to Forest)		-3.53
Forest Remaining Forest		
Undisturbed		-2.78
Disturbed		
Fire	0	
Insect/Disease		
Harvest/Other	49.95	
Trees Outside Forest		
Tree canopy loss	64.70	
Canopy maintained/gained		-3.41

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Orange County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Person County, North Carolina

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Person County, North Carolina has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 241,587 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -504,899 t CO2e per year.

- Roughly 59% of Person County's total land base of 104,701 hectares (258,721 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 18.5 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -746,486 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Person County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Person county's GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-623,913	
Forest Disturbances		90,678
Non-Forest to Forest	-25,777	
Forest to Settlement		917
Forest to Grassland		45,706
Forest to other non-forest lands		2,539
Trees outside of forests	-96,796	101,747
Harvested Wood Products	0	
TOTAL	-746,486	241,587
Net GHG balance	**-504,899**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Person County’s total land base is approximately 104,701 hectares (258,721 acres), with nearly 9.1% Settlement (i.e. developed areas of varying intensity), around 59% forest, 22.6% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 5.8% cropland, 3.4% wetland and 0.1% other land.

Figure 1. Land cover in Person from the National Land Cover Database, 2019

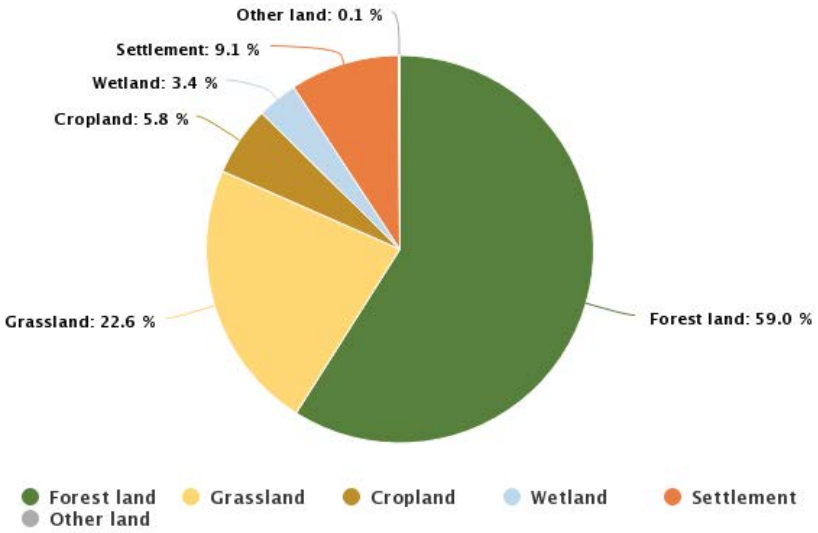
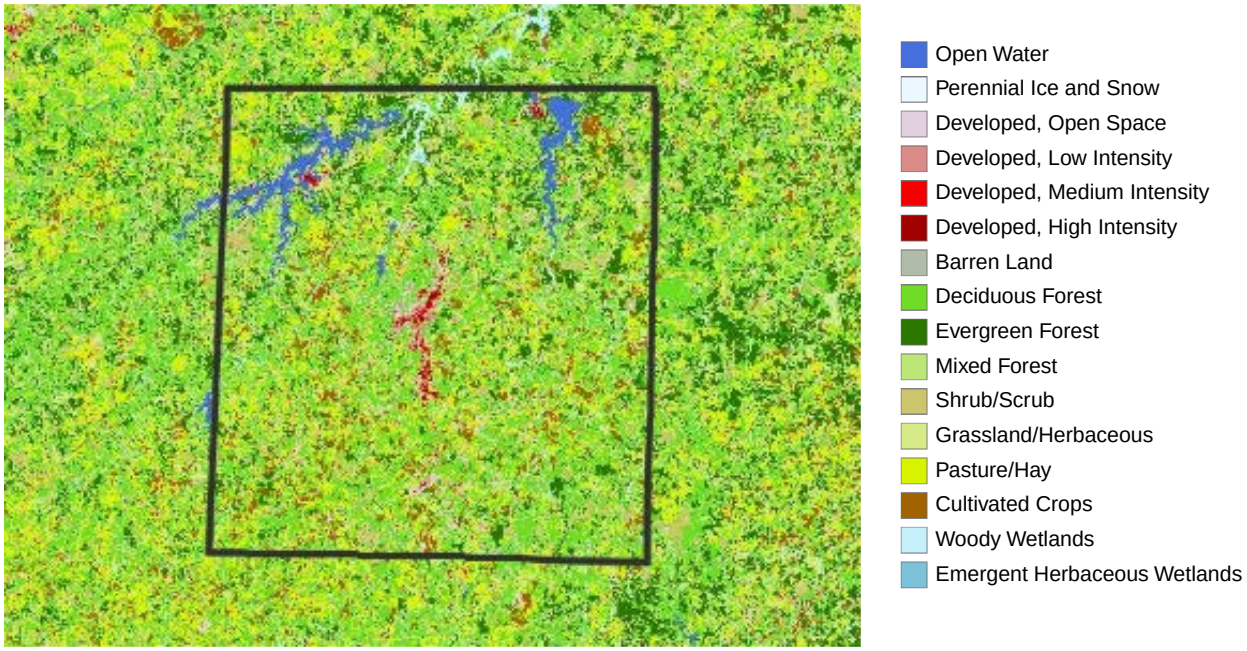


Figure 2. Land cover in Person from the National Land Cover Database, 2019



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 1,146 hectares (2,833 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 1,919 hectares (4,742 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

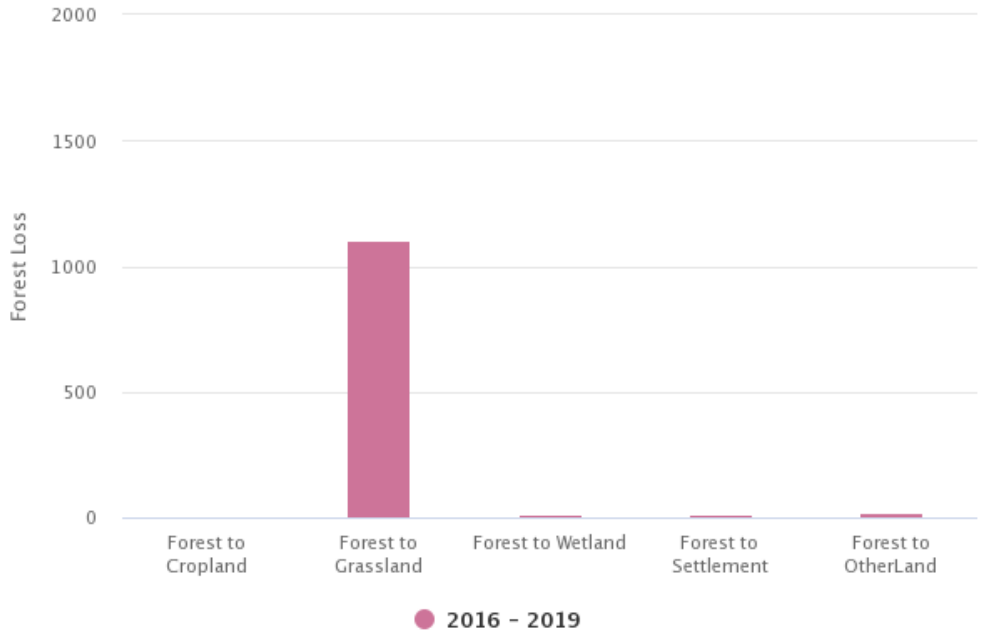
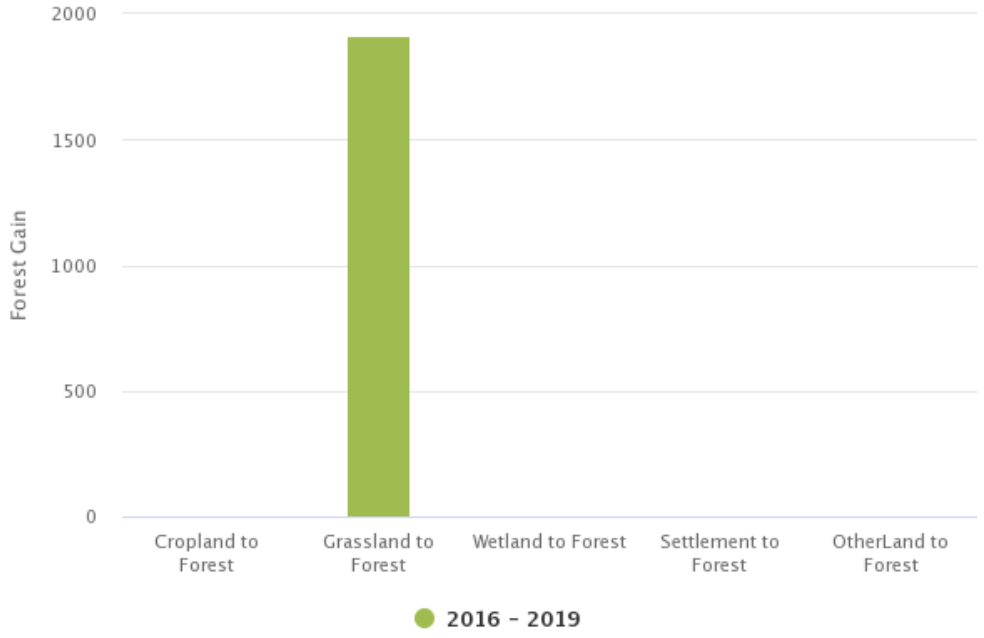


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from harvests/other disturbance was the most significant in Person County, affecting 1470.7 hectares (3634.2 acres), followed by insects, which affected 1.2 hectares (3.0 acres) and fires, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Person County had an average of 7,734 hectares (19,112 acres) of tree canopy outside forests. Between 2011 and 2016, 428 hectares per year of tree canopy were lost, for a total of 2,142 hectares (5,293 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Grassland class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

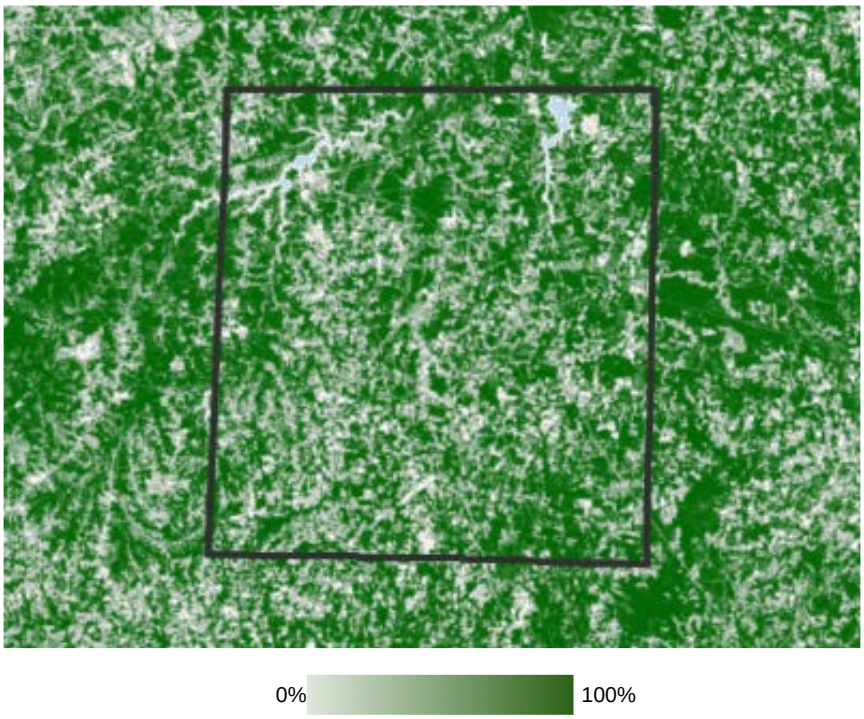


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Person County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

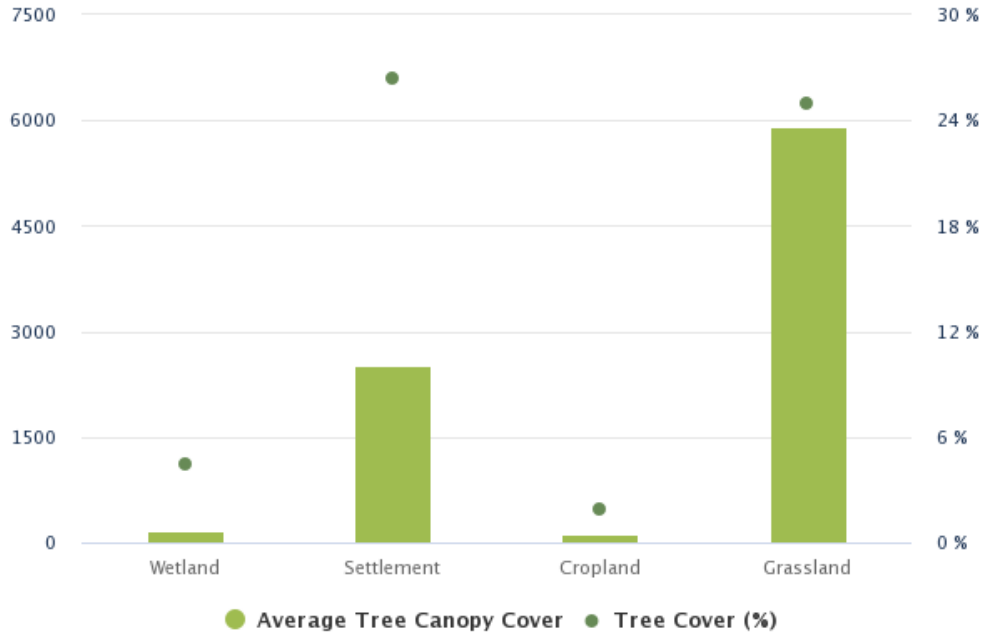
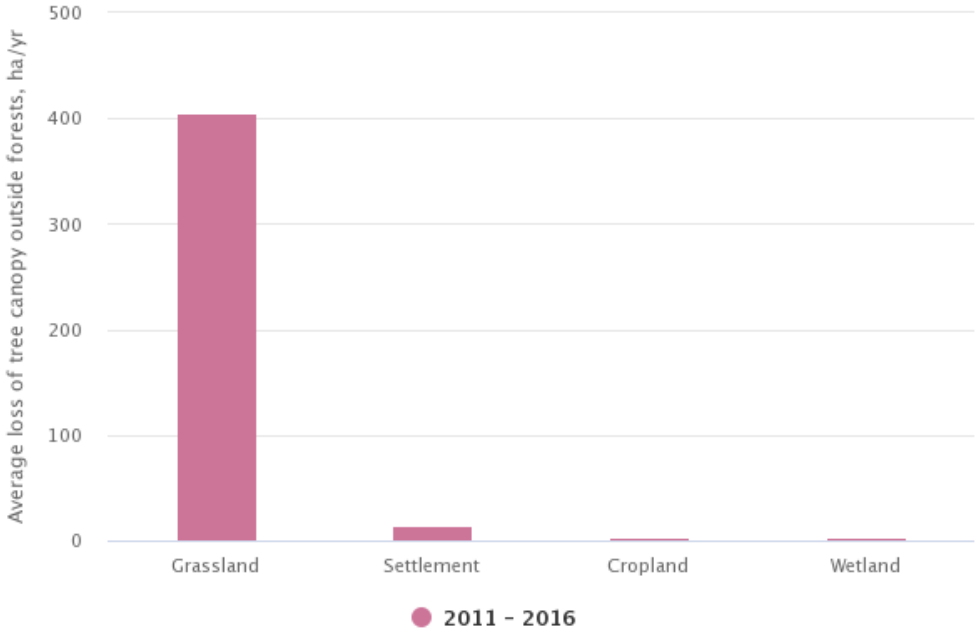


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Person County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	33,604	0	0	0	0	0	463	31	0.9	0	7	0.7	0.4	0.1	5	0	34,112
Evergreen Forest	0.1	11,671	0.1	0	0	0	361	11	4	0	0.7	0.3	0	0	9	0	12,058
Mixed Forest	0.7	0.1	13,256	0	0	0	231	8	2	0	1	0.1	0.5	0.5	4	0	13,504
Woody Wetlands	0	0	0	1,310	0	0	0.1	0	0	4	0	0	0	0	0	0	1,314
Cultivated Crops	0.5	0	0.1	0	6,033	4	0.1	0	0	0	0.7	0.1	0.1	0	0	0	6,038
Pasture/Hay	2	0.7	0.1	0	0	15,945	2	0.5	0.5	0	6	2	0.7	0	4	0	15,963
Grassland/Herbaceous	12	0.7	0.2	0	4	25	1,510	3,233	3	0	3	0.7	0.3	0.1	45	0	4,836
Shrub/Scrub	1,262	409	225	0	2	0	48	1,799	0.4	0	1	0	0	0	4	0	3,749
Open Water	0.1	0	0.5	0	0	0	1	0.1	3,456	34	0	0	0	0	7	0	3,498
Emergent Herbaceous Wetlands	0	0	0	7	0	0	0.4	0	0	47	0	0	0	0	0	0	54
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	6,571	18	30	3	0	0	6,622
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	1,992	7	6	0	0	2,005
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	606	1	0	0	607
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	302	0	0	302
Barren Land	0.2	0	0	0	0	0	0.5	0.8	0.6	0	0	0	0	0	36	0	38
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**34,881**	**12,081**	**13,482**	**1,317**	**6,039**	**15,973**	**2,616**	**5,084**	**3,468**	**85**	**6,590**	**2,014**	**645**	**313**	**114**	**0**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	59,841	0	1,106	11	11	18	60,988
Cropland	0.6	6,033	4	0	0.9	0	6,038
Grassland	1,910	6	22,561	4	14	53	24,548
Wetland	8	0	2	3,536	0	7	3,553
Settlement	0	0	0	0	9,536	0	9,536
Other Land	0.2	0	1	0.6	0	36	38
Total	61,760	6,039	23,673	3,552	9,562	114	0

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	0.00	
To Grassland	33.79	
To Settlement	66.64	
To Wetland	60.84	
To Other	76.91	
Reforestation (Non-Forest to Forest)		-3.66
Forest Remaining Forest		
Undisturbed		-2.91
Disturbed		
Fire	0	
Insect/Disease	2.02	
Harvest/Other	50.40	
Trees Outside Forest		
Tree canopy loss	64.70	
Canopy maintained/gained		-3.41

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Person County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Wake County, North Carolina

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Wake County, North Carolina has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 476,542 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -840,872 t CO2e per year.

- Roughly 40% of Wake County's total land base of 222,046 hectares (548,687 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 23.9 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -1,317,414 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Wake County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Wake county' s GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-909,580	
Forest Disturbances		144,613
Non-Forest to Forest	-19,143	
Forest to Settlement		105,427
Forest to Grassland		52,969
Forest to other non-forest lands		8,363
Trees outside of forests	-388,691	165,170
Harvested Wood Products	0	
TOTAL	-1,317,414	476,542
Net GHG balance	**-840,872**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Wake County’s total land base is approximately 222,046 hectares (548,687 acres), with nearly 42% Settlement (i.e. developed areas of varying intensity), around 40% forest, 9.9% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 4.6% cropland, 3.2% wetland and 0.3% other land.

Figure 1. Land cover in Wake from the National Land Cover Database, 2019

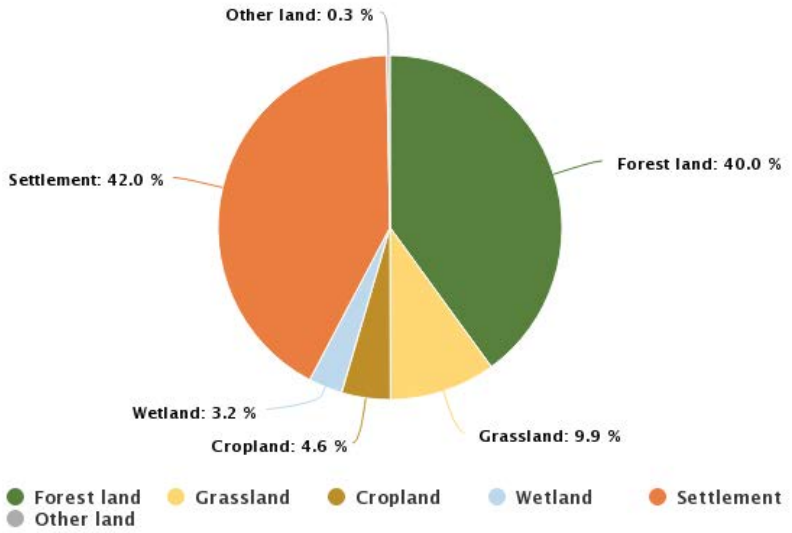
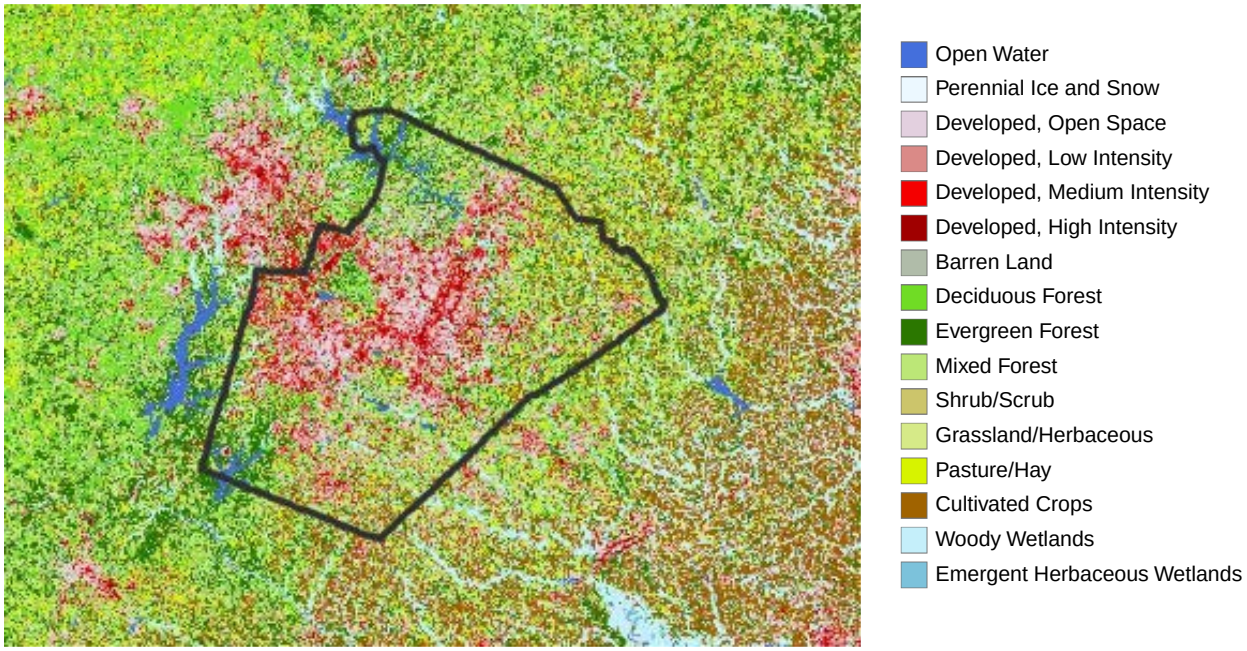


Figure 2. Land cover in Wake from the National Land Cover Database, 2019



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 3,015 hectares (7,449 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 1,132 hectares (2,798 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

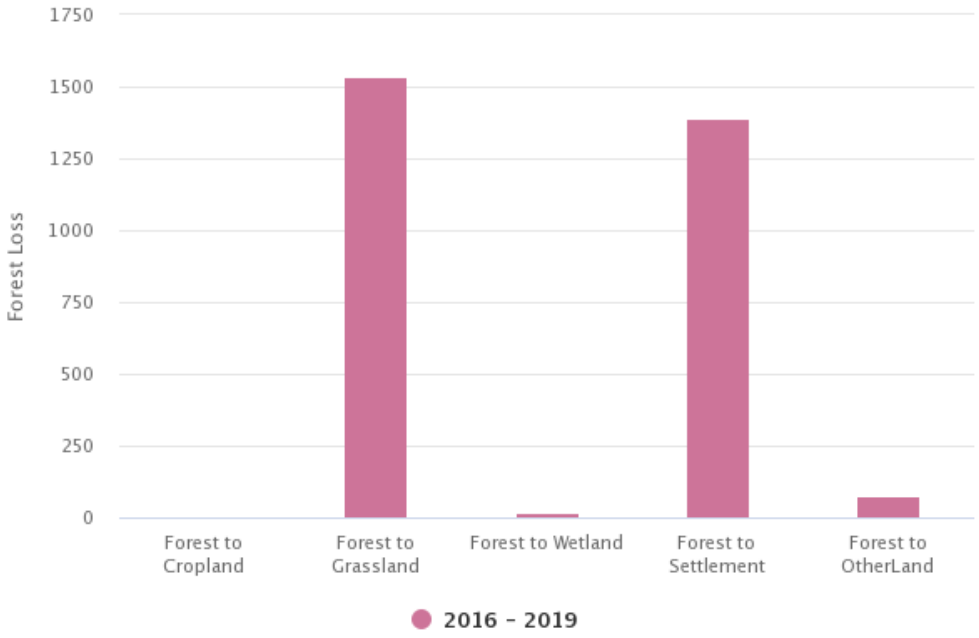
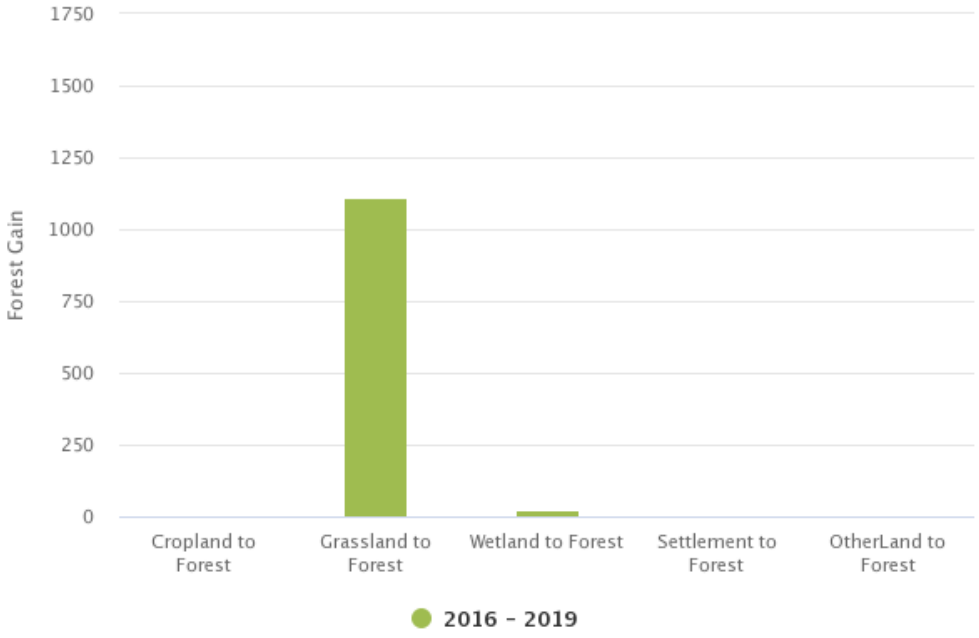


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from harvests/other disturbance was the most significant in Wake County, affecting 2319.7 hectares (5732.1 acres), followed by fires, which affected 0 hectares (0.0 acres) and insects, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Wake County had an average of 31,058 hectares (76,747 acres) of tree canopy outside forests. Between 2011 and 2016, 696 hectares per year of tree canopy were lost, for a total of 3,478 hectares (8,595 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Settlement class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

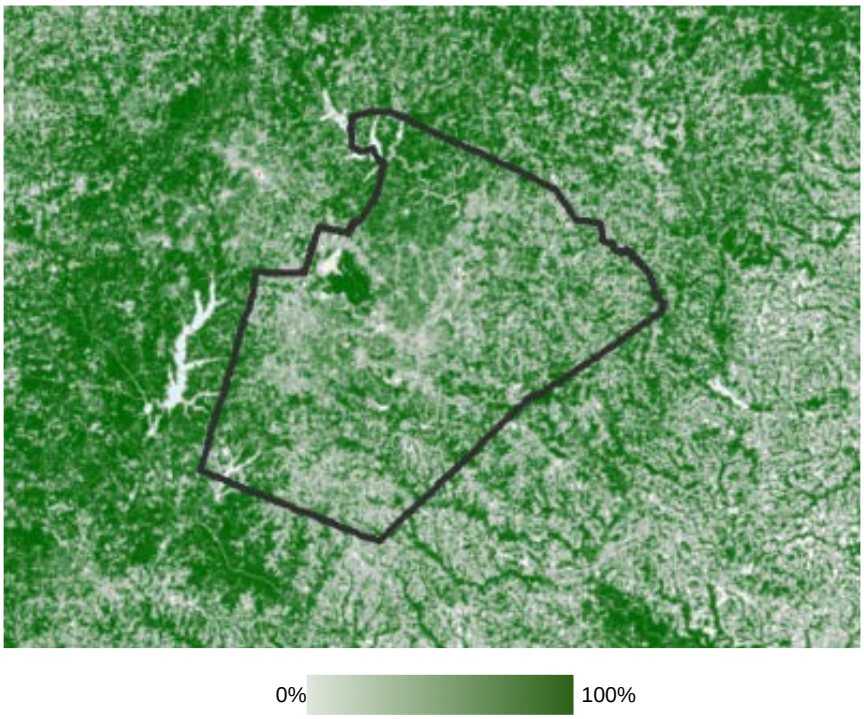


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Wake County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

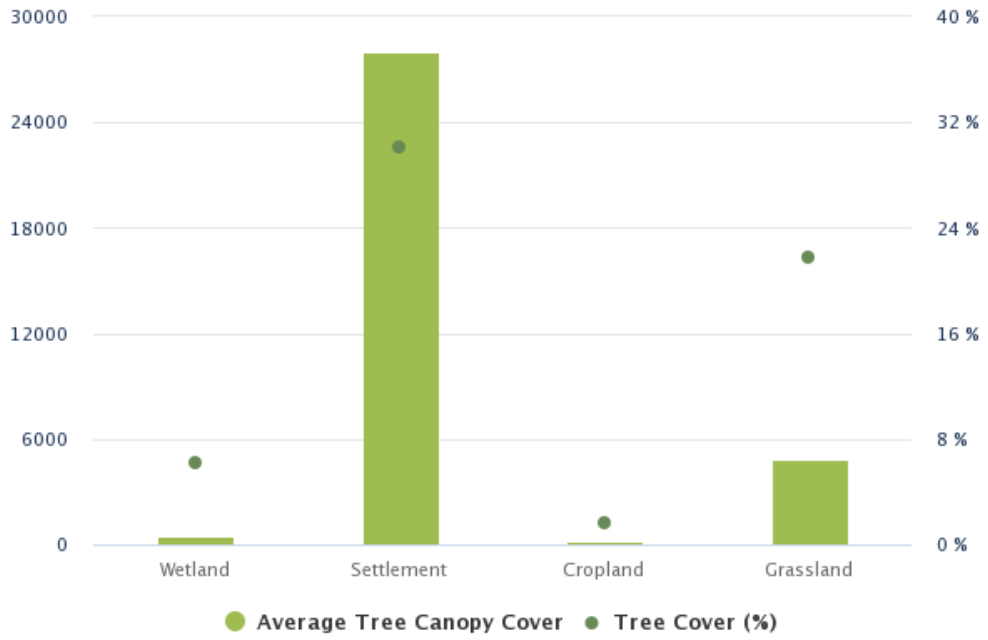
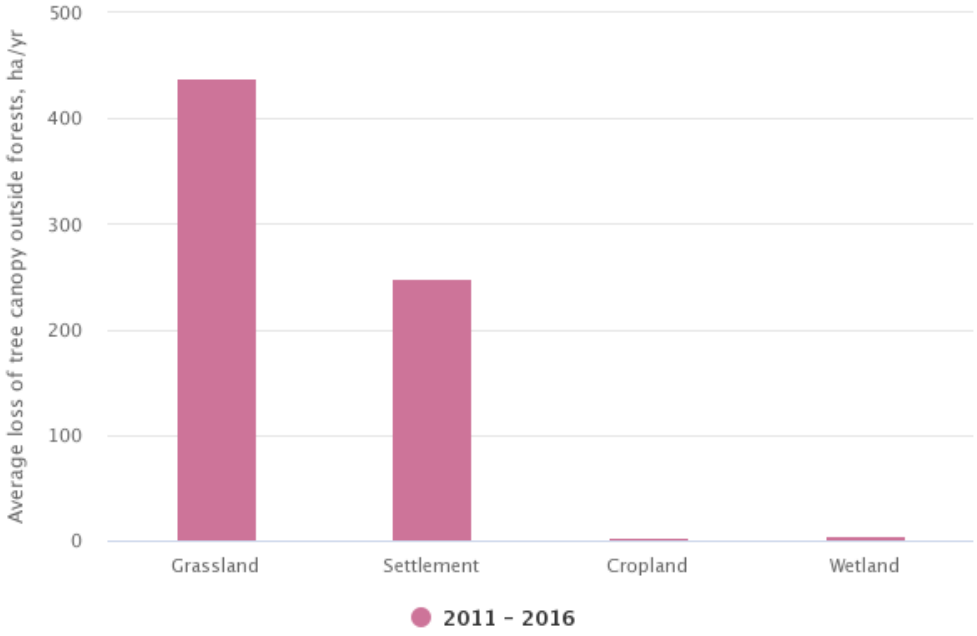


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Wake County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	19,912	0.1	0	0	0.1	0	300	34	0.4	0	109	88	68	23	20	0	20,555
Evergreen Forest	0	29,038	0	0	0	0.1	678	27	0.2	0	205	199	195	50	35	0	30,428
Mixed Forest	0	0.3	29,741	0.1	0	0	483	12	0	0	152	124	115	28	19	0	30,674
Woody Wetlands	0	0	0	8,994	0	0	0.4	0	0.3	19	19	7	4	0.4	0	0	9,043
Cultivated Crops	0	0.8	0	0	10,201	6	0.2	0	0	0	63	48	59	13	3	0	10,393
Pasture/Hay	0	3	0	0.1	5	14,294	2	0.7	0.1	0.1	110	90	89	27	6	0	14,626
Grassland/Herbaceous	5	29	6	0	3	15	3,774	1,167	2	0.1	149	212	280	48	41	0	5,731
Shrub/Scrub	135	826	104	0	0	0	39	1,240	0	0	10	7	7	4	2	0	2,375
Open Water	0	0.8	0	0.1	0	0	2	0	6,553	82	6	3	3	0.9	14	0	6,665
Emergent Herbaceous Wetlands	0	0	0	22	0	0	0.5	0	0	435	2	3	0.5	0	0	0	463
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	38,235	208	567	71	0	0	39,080
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	28,016	106	66	0	0	28,188
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	18,464	12	0	0	18,476
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	4,803	0	0	4,803
Barren Land	0	1	0	0	0	0	9	8	11	0	0.8	0.9	2	1	511	0	545
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**20,052**	**29,898**	**29,852**	**9,015**	**10,208**	**14,314**	**5,288**	**2,488**	**6,567**	**536**	**39,062**	**29,006**	**19,960**	**5,147**	**650**	**0**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	87,685	0.1	1,534	20	1,387	73	**90,699**
Cropland	0.8	10,201	6	0	183	3	**10,393**
Grassland	1,108	7	20,531	3	1,034	49	**22,732**
Wetland	22	0	3	7,071	19	14	**7,128**
Settlement	0	0	0	0	90,547	0	**90,547**
Other Land	1	0	17	11	5	511	**545**
Total	**88,817**	**10,208**	**22,091**	**7,104**	**93,174**	**650**	**0**

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	4.54	
To Grassland	28.22	
To Settlement	62.15	
To Wetland	64.52	
To Other	75.61	
Reforestation (Non-Forest to Forest)		-4.61
Forest Remaining Forest		
Undisturbed		-2.90
Disturbed		
Fire	0	
Insect/Disease		
Harvest/Other	50.96	
Trees Outside Forest		
Tree canopy loss	64.70	
Canopy maintained/gained		-3.41

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Wake County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.