Clean Air Mississippi Project
CAMP

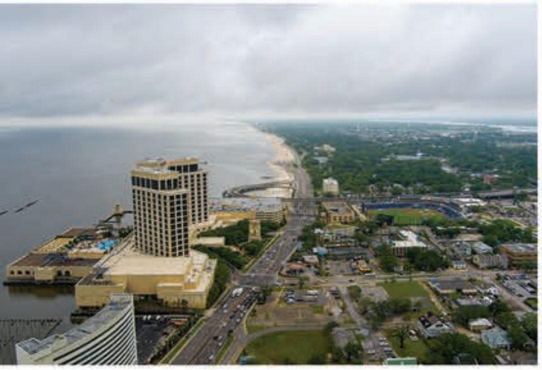
Mississippi Department of Environmental Quality

Priority Climate Action Plan









March 1, 2024

MISSISSIPPI DEPARTMENT OF
ENVIRONMENTAL QUALITY

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Abbreviations

AC	Alternating current
AEO	Annual Energy Outlook
BEV	Battery electric vehicles
BMP	Best management practice
BOD	Biochemical oxygen demand
BTU	British thermal units
CAMP	Clean Air Mississippi Project
CCAP	Comprehensive Climate Action Plan
CFC	Chlorofluorocarbons
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent
CPRG	Climate Pollution Reduction Grant
DC	Direct current
DOE	United States Department of Energy
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
EV	Electric vehicle
FFC	Fossil fuel combustion
FLIGHT	Facility Level Information on Greenhouse Gases Tool
GHG	Greenhouse gas
GHGRP	Greenhouse Gas Reporting Program
GLIMPSE	Global Change Analysis Model Long-term Interactive Multi-Pollutant Scenario Evaluator
GWP	Global warming potential
H_2	Hydrogen
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
HVAC	Heating, ventilation, and air conditioning
IIJA	Infrastructure Investment and Jobs Act
IPCC	Intergovernmental Panel on Climate Change

IRA	Inflation Reduction Act
kW	Kilowatt
kW_{AC}	Kilowatt alternating current
kWh	Kilowatt hour
LMOP	Landfill Methane Outreach Program
LULUCF	Land Use, Land-Use Change and Forestry
MBCI	Mississippi Band of Choctaw Indians
MDEQ	Mississippi Department of Environmental Quality
MER	Monthly Energy Reviews
MHDV	Medium- and heavy-duty vehicle
MMT	Million metric tons
MT	Metric tons
MW	Megawatt
MW_{AC}	Megawatt alternating current
MWh	Megawatt hour
N_2O	Nitrous oxide
NACAA	National Association of Clean Air Agencies
NEI	National Emissions Inventory
NF_3	Nitrogen trifluoride
NIR	National Inventory Report
O&M	Operation and maintenance
ODS	Ozone depleting substances
OEP	Office of Environmental Protection
PCAP	Priority Climate Action Plan
PFC	Perfluorocarbon
PM	Particulate matter
SF_6	Sulfur hexafluoride
SIT	State Inventory Tool
USDA	United States Department of Agriculture
TWh	Terawatt-hours
TVA	Tennessee Valley Authority
$watt_{AC}$	Watt alternating current

Executive Summary

The Climate Pollution Reduction Grant (CPRG) program, funded by the Inflation Reduction Act, is administered by the U.S. Environmental Protection Agency (EPA) to facilitate the development and implementation of climate action plans at state-, local-, tribal-, and territorial-government levels to reduce greenhouse gas (GHG) emissions and other air pollutants. The CPRG program includes: (1) a planning phase with grants to help jurisdictions identify key GHG sources, design corresponding reduction measures, and summarize these in a Priority Climate Action Plan (PCAP); and (2) an implementation phase with grants to help jurisdictions implement their proposed reduction measures. The State of Mississippi's objectives for this CPRG program, of which this PCAP report is the first step, are to develop, plan, and implement measures to reduce state-wide GHG emissions and other air pollutants.

Outreach to different communities, interest groups, and partners throughout the state is an important component of this work. This helps the state share its plans and evaluation process and also obtain feedback on future actions to meet statewide climate pollution goals. Given the limited development time for this PCAP, outreach was performed virtually through online meetings, a website, and using social media. Public outreach and engagement efforts were coordinated with those of the Mississippi Band of Choctaw Indians, who are concurrently developing a PCAP specifically for Tribal lands. For the State of Mississippi, outreach was led by the Mississippi Department of Environmental Quality and for the Tribe by their Office of Environmental Protection.

An initial estimate of GHG emissions for Mississippi was developed using a set of tools published by EPA, termed the State Inventory Tool (SIT). For the PCAP the estimates are developed using the default parameters, and these are expected to be updated and refined with more state-specific data in future phases. Because of the significance of the GHG inventory in planning future activities, it was also considered important to perform an independent evaluation of the GHG estimates for Mississippi. This additional evaluation was focused on the following sectors: electric power generation, transportation, industry, agriculture, and wastewater. Emissions for the year 2017 are used as the baseline year in this analysis, because this is a year for which alternative data sources for comparison were available. The total emissions for Mississippi are 74.5 million metric tons (MMT) of CO_2-equivalent (CO_2-e) and distributed among sectors as shown in Figure ES-1. Most of the emissions are in the form of CO_2 (83%), with the rest being methane (CH_4, 7.6%), nitrous oxide (N_2O, 6.6%) and other gases (2.7%). A notable observation from the inventory calculation is the finding that the extensive forested areas of Mississippi serve as a sink of magnitude comparable to GHG emissions from all other sectors. On a net basis, therefore, consideration of the forest carbon sink suggests that Mississippi's GHG emissions are zero or slightly negative. Even so, it should be understood that implementation of emissions reduction measures will contribute to minimizing both the harmful "nearfield" effects on low income, disadvantaged communities as well as broader regional ambitions for GHG reductions.

The independent review of GHG emissions for selected sectors revealed only minor differences and the SIT was considered appropriate for the present application. However, review indicates areas that could be the focus of further refinement in future phases of CPRG implementation.

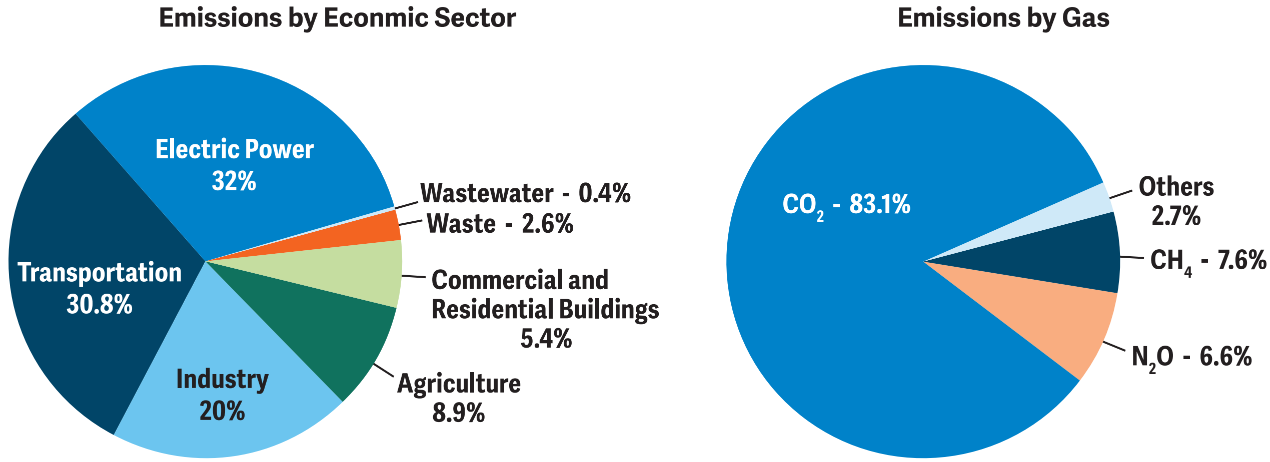

Figure ES-1. Mississippi GHG emissions by economic sector and by gas (based on carbon dioxide equivalent [CO_2-e]) in 2017

In support of the PCAP we first considered a potential list of 70 GHG reduction measures from the literature spanning each major emission sector. These potential measures included both policy- and regulatory-type actions as well as actions that needed new physical infrastructure or modifications to existing infrastructure. Based on preliminary feedback from stakeholders, a more limited set of 14 measures has been included for consideration in this PCAP, as follows:

- Residential and commercial distributed solar generation and storage
- Utility solar generation and storage
- Electricity transmission and distribution upgrades
- Cargo transportation to rail
- Vehicle transition
- School bus electrification
- Alternative fueling infrastructure
- Biofuel use for transportation or as an energy source
- Building energy efficiency improvements
- Refrigerant replacement
- Forest carbon management
- BMPs for agricultural land
- Landfill CH_4 capture
- Wastewater CH_4 capture

At this stage of the PCAP, the priority measures are defined in a “unit” form of a reasonable size, rather than as specific projects with a defined geographic footprint. For example, the costs and GHG benefits of solar photovoltaic generation as a source of renewable power are described on a per megawatt basis, with the actual amount of GHG reduction being scaled to the size of projects ultimately implemented. Other criteria, such as co-benefits to the environment, are described in terms of non-GHG atmospheric pollution avoided per megawatt of current generation. Also, criteria such as workforce impacts and benefits to low income and disadvantaged communities, are described in narrative form and can be refined once a specific project or group of projects are formulated.

The supporting information for each priority measure, both quantitative and narrative, allows eligible entities across Mississippi, including state, local, and regional governments and agencies, to develop applications in pursuit of grant funding from EPA or other federal sources. These applications may choose to focus on one or multiple measures. At the grant application stage, it is expected that a potential grantee will propose a specific program--defining size, geographic location or range, and specific activities, such as subsidies or other incentives, or actual creation of infrastructure, for example—that builds on the information presented in this document.

In addition to following up on implementation grants, this PCAP will serve as the foundation for Mississippi’s future plans for climate pollution reduction in developing the Comprehensive Climate Action Plan (CCAP). This longer-range planning will include further improvements to the PCAP inventory, including modifying and refining current and/or identifying additional, measures, as well as potentially developing monitoring and modeling programs to better quantify statewide emissions and report on long-term trends.

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1 Introduction

The Inflation Reduction Act's (IRA's) Climate Pollution Reduction Grant (CPRG) program presents a unique opportunity for the State of Mississippi to develop a set of plans for reducing greenhouse gas (GHG) emissions and other harmful air pollution and set in motion a plan for implementing those identified as key. The first part of the process is the preparation of this Priority Climate Action Plan (PCAP) to be followed by a Comprehensive Climate Action Plan (CCAP), as well as specific actions to reduce GHG emissions. In this plan, we provide an overview of the CPRG process; a general approach to quantify GHG emissions and our best understanding of GHG emissions in the state; the community outreach undertaken thus far and to be continued in future stages of the CPRG program; the effect of national-scale drivers in the IRA on emissions within Mississippi; and a set of priority emission reduction measures. These priority measures are evaluated as to their GHG and air pollution reduction benefits and costs, their potential to benefit low income and disadvantaged communities, and workforce needs and impacts related to their implementation. Key technical information in this document will also provide the foundation for a separate PCAP to be developed for the Mississippi Band of Choctaw Indians (MBCI).

1.1 Background of the EPA CPRG Program

The CPRG program, funded by the IRA, is administered by the U.S. Environmental Protection Agency (EPA) to facilitate the development and implementation of climate action plans at state-, local-, tribal-, and territorial-government levels to reduce GHG emissions and other air pollutants. The CPRG program includes: (1) a planning phase with grants to help jurisdictions identify key GHG sources, design corresponding reduction measures, and summarize these in a PCAP and CCAP; and (2) an implementation phase with grants to help jurisdictions implement their proposed reduction measures.

1.2 Objectives

The State of Mississippi's objectives for this CPRG program, of which the PCAP report is the first step, are to develop, plan, and implement measures to reduce state-wide GHG emissions and other air pollutants. In addition, the State intends to use this opportunity to enhance and revitalize economic and social development in the state, particularly for low income and disadvantaged communities. Reducing net GHG emissions--common sources of which include burning of fossil fuels for transportation and energy generation, industrial processes, deforestation, and agriculture practices (USGCRP 2023a) -- can require re-evaluation and, potentially, transformation of the associated economic sectors and activities. Thus, in addition to reducing emissions of GHG and other air pollutants, the measures developed as part of the CPRG program (and reflected in this planning document) can be formulated to stimulate and incentivize the creation of good-paying jobs and stimulate economic development, as well as to address and improve environmental justice and equity.

1.3 Overview of Planning Process

This document, the Mississippi PCAP, is the initial report on priority measures planned for the State of Mississippi to reduce GHG net emissions and other air pollutants. Following the March 1, 2024, submittal to EPA, implementation grant applications will be developed and submitted that seek to implement one or more of the priority actions. The implementation grants may be submitted by the agency leading this effort, the Mississippi Department of Environmental Quality (MDEQ), or by other state, local, regional agencies,or academic institutions that are best suited and have the capacity for leading a particular type of implementation action. A subsequent planning document, the Mississippi CCAP, will be prepared by mid-2025, expanding on the work in the PCAP with a more detailed assessment of emission sources and mitigation measures to provide a pathway to deliver cleaner air and lower energy costs for Mississippi. Technical information in this document, notably the inventory elements, will also provide the foundation for a separate PCAP to be developed for the MBCI. The MBCI PCAP will be an independent document and may focus on a different set of emission reduction measures that are of interest to the Tribe.

1.4 Report Overview

The remaining sections of the PCAP are organized as follows. Chapter 2 provides a description of the outreach activities undertaken to date. Feedback from the outreach has informed priority measures identified in this plan, and MDEQ will continue engagement and solicitation to support future phases of the planning. Chapter 3 provides an overview of the methodology adopted in this report to estimate Mississippi's GHG inventory and to evaluate the proposed reduction measures. Chapter 4 describes the GHG inventory by sector developed using EPA's State Inventory Tool (SIT) published in June 2023 (USEPA 2023a), as well as an independent evaluation of emissions from selected individual sectors. Chapter 5 provides an overview of changes that are anticipated following passage of the IRA. Many of these are national-scale changes in key sectors, such as electricity generation and transportation, that will also have a major impact on GHG production in Mississippi. Chapter 6 presents a summary and evaluation of 14 priority GHG reduction measures that can form the basis of specific programs and projects in the state. Chapter 7 outlines the next steps of planning and implementation Mississippi's climate pollution planning.

2 Community Outreach

Outreach to different communities, interest groups, and partners throughout the state is an important component of the PCAP, helping share the State's planning and evaluation process and solicitating and obtaining feedback and input. This section describes the outreach and education efforts implemented during PCAP development. Outreach was performed jointly with the MBCI, who are concurrently developing a PCAP that would apply to Tribal lands. For the State of Mississippi, outreach was led by MDEQ and for the Tribe by their Office of Environmental Protection (OEP).

2.1 Goals and Objectives

Outreach regarding the Mississippi PCAP project focused on two key tasks: information exchange and notification of outcomes. Goals and objectives defined within each of these tasks guided creation of graphic and other informational materials used to explain the PCAP initiative in everyday language and are specified below.

2.1.1 Information Exchange

GOAL: Make project-related information readily available in simple language via multiple media; provide branding elements and graphics that help to quickly identify the project and related concepts.

> **Objective:** To increase project understanding and recognition by using everyday language and eye-catching, informative graphic elements.

GOAL: Work alongside other coordinating Mississippi entities to reach out to and engage communities to gather information for PCAP development.

> **Objective:** To gather input from communities statewide to ensure that priority measures reflect the needs and priorities of Mississippians.

GOAL: Provide opportunities for Mississippi residents to collaborate early and often with project representatives before decisions are finalized to provide input on community-specific concerns and preferences.

> **Objective:** To improve the quality and sustainability of final outcomes by obtaining public input and using it to help guide plan development.

2.1.2 Notification of Outcomes

GOAL: Provide opportunities for public review and comment on the draft priority GHG reduction measures proposed for incorporation into the PCAP.

Objective: To receive public feedback before final plan decisions are made.

GOAL: Make final PCAP outcomes publicly available.

Objective: To close the communication loop and promote project transparency.

2.2 Branding

Project branding was developed to boost project recognition among the public and partners. The name *Clean Air Mississippi Project* (CAMP) was established, and a logo (Figure 2-1) developed using colors consistent with MDEQ's existing branding. The logo and CAMP name were used on all materials to help people readily identify the project and ultimately aid in linking to subsequent phases of CAMP information. In addition, a project-specific email address (camp@mdeq.ms.gov) was established for people to provide comments and ask questions.

Figure 2-1. CAMP Logo.

MDEQ entered into partnership with the Mississippi Band of Choctaw Indians, Office of Environmental Protection (MBCI/OEP) for their CPRG efforts. As part of tribal efforts toward GHG emissions reductions, many of the MDEQ community engagement and outreach materials, including the survey, are co-branded with the OEP logo.

2.2.1 Branded Informational Materials

The CAMP branding was used on all project materials produced to educate and engage the public about the process. Materials were designed to be suitable for both electronic and hard-copy dissemination, and were distributed by MDEQ, MBCI OEP, consulting team members, and other partners to reach a wide array of interested parties. Materials developed included:

- Graphic-driven overview flyer
- Frequently Asked Questions document
- Quick-response code for quick access to online project information
- Website for project materials and information
- Survey designed to learn more about concerns and how people receive information.

Additional details about the website and survey are included below.

2.2.2 Project Website

A project-specific website was prepared to supply accessible, easily-understood information on CAMP and associated surveys and public meetings, and to house related educational materials and ensure they are readily available to the public. This site was developed to resemble MDEQ's existing online presence to illustrate continuity but is a standalone site for ease in navigation and maintenance. Educational materials are posted to this site, as well as meeting information, a link to the project survey (see details in Section 2.2.3), and email sign-up for notifications. The website will continue to be updated as the planning process moves forward into the next phase.

Figure 2-2. CAMP Website Landing Page.

2.2.3 Survey

A project survey was developed to gather information about concerns and thoughts related to air quality issues and other environmental challenges. The survey was posted to the CAMP website after the first public meeting (held December 7, 2023; see additional details in Section 2.4.2), and email and social media notifications (see additional details in Section 2.3) were sent to focus attention on its availability.

As of February 25, 2024, 110 people had completed the survey. The greatest number of respondents were aged 30–49 followed by the 50–64 age group. About half of the respondents identified as white or Caucasian, and about a quarter identified as American Indian or Alaskan Native. Inputs on the climate change/air pollution effects of greatest concern, climate change impacts that are priorities for reduction, and activities for carbon reduction that respondents are likely to participate in are summarized in Figures 2-3 through 2-5, respectively. The majority of respondents indicated that they would be more likely to participate in carbon pollution reduction activities if there was a tax break or rebate involved, or if it saved money (Figure 2-6). Numerous activities that could lessen the impacts of climate change were supported by a majority of respondents, from planting trees to investing in solar and updating building standards (Figure 2-7). Respondents identified financial constraints as the primary barrier preventing them from adopting a more sustainable lifestyle (Figure 2-7).

Additional details about the responses are shown in the figures below. The survey remains open for continual input. The feedback received will help frame concerns raised by Mississippians and focus potential GHG reduction measures.

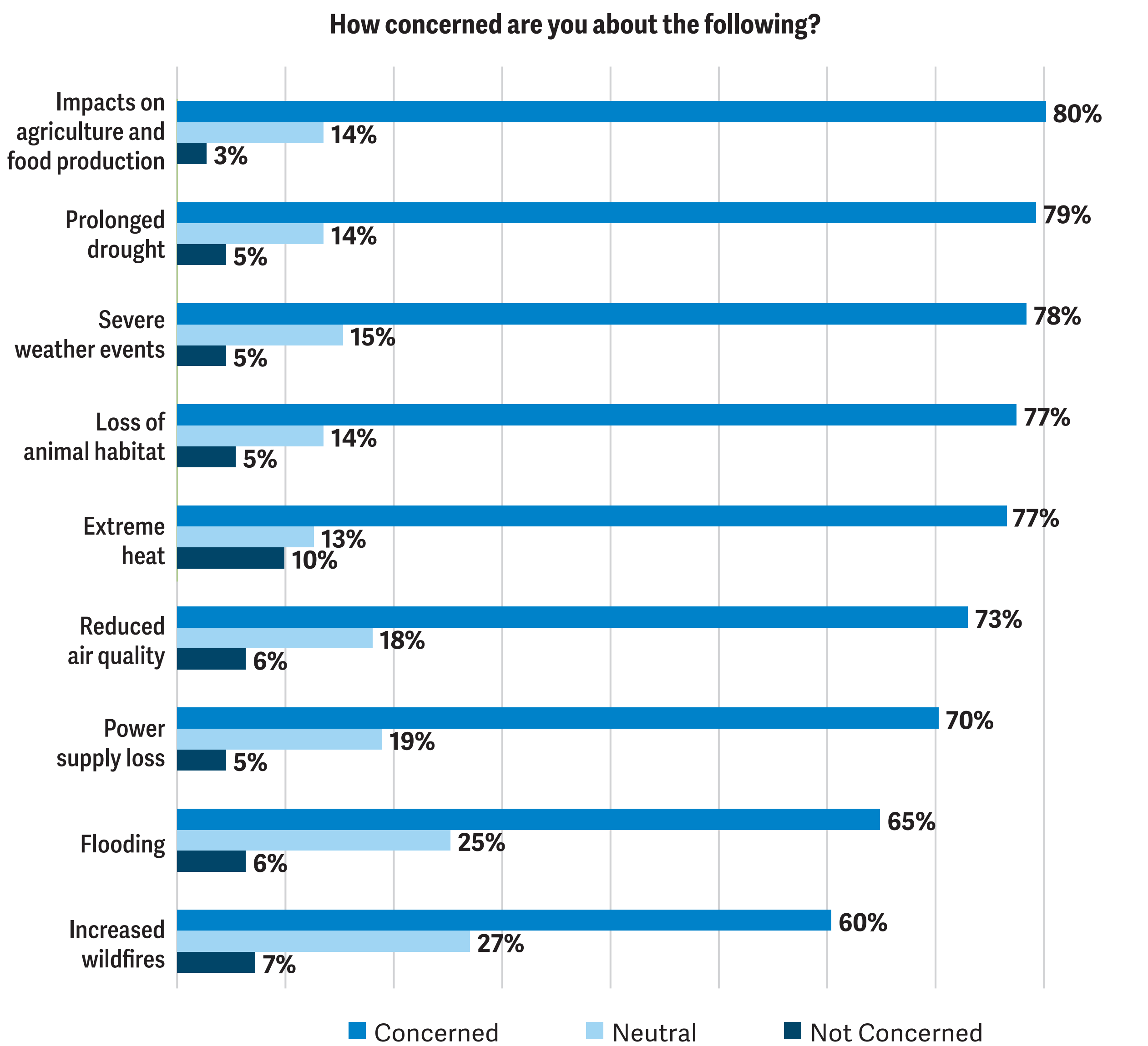

Figure 2-3. Summary of Responses to the Survey Question About Items of Concern.

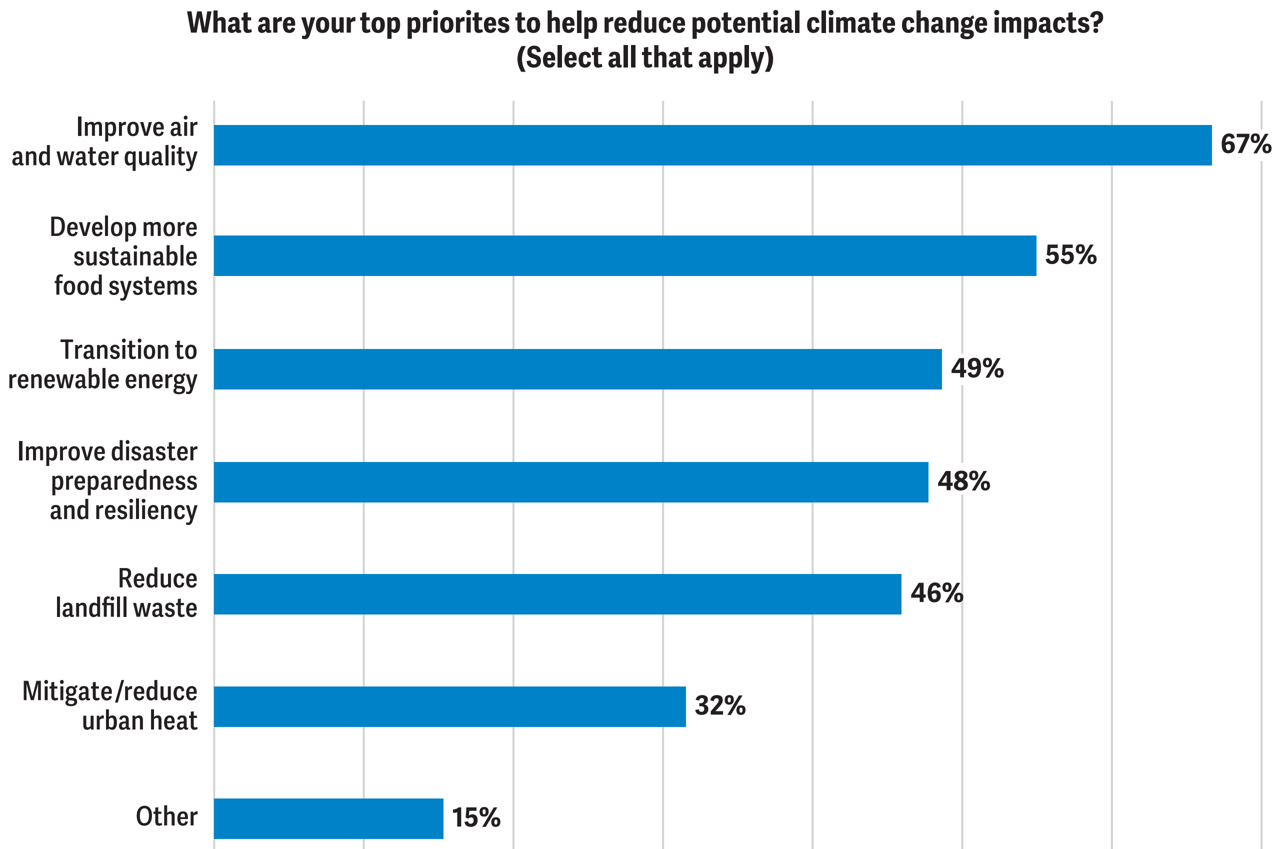

Figure 2-4. Summary of Responses to the Survey Question About Top Priorities to Reduce Potential Climate Change Impacts.

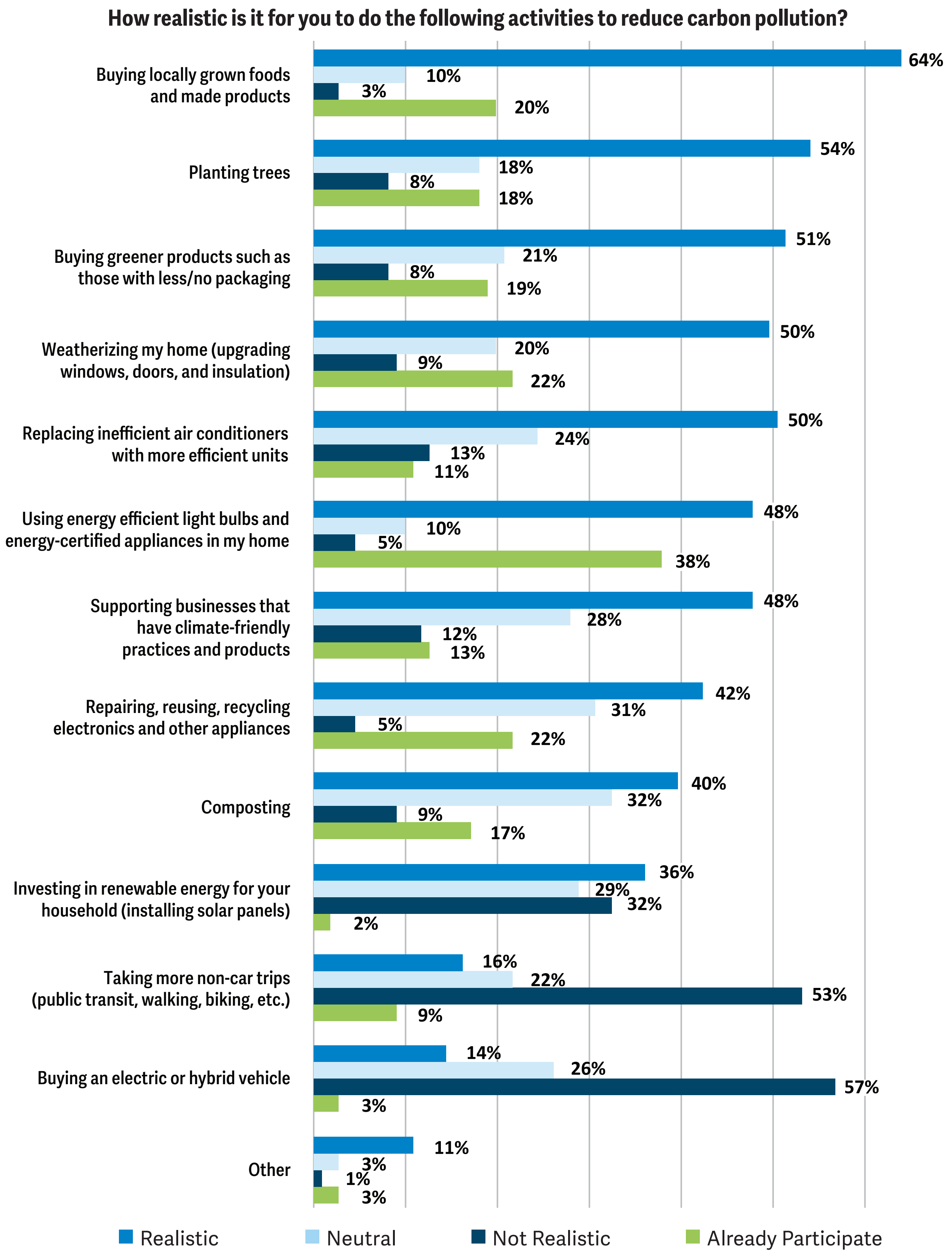

Figure 2-5. Summary of Responses to the Survey Question About Implementing Activities to Reduce Carbon Pollution.

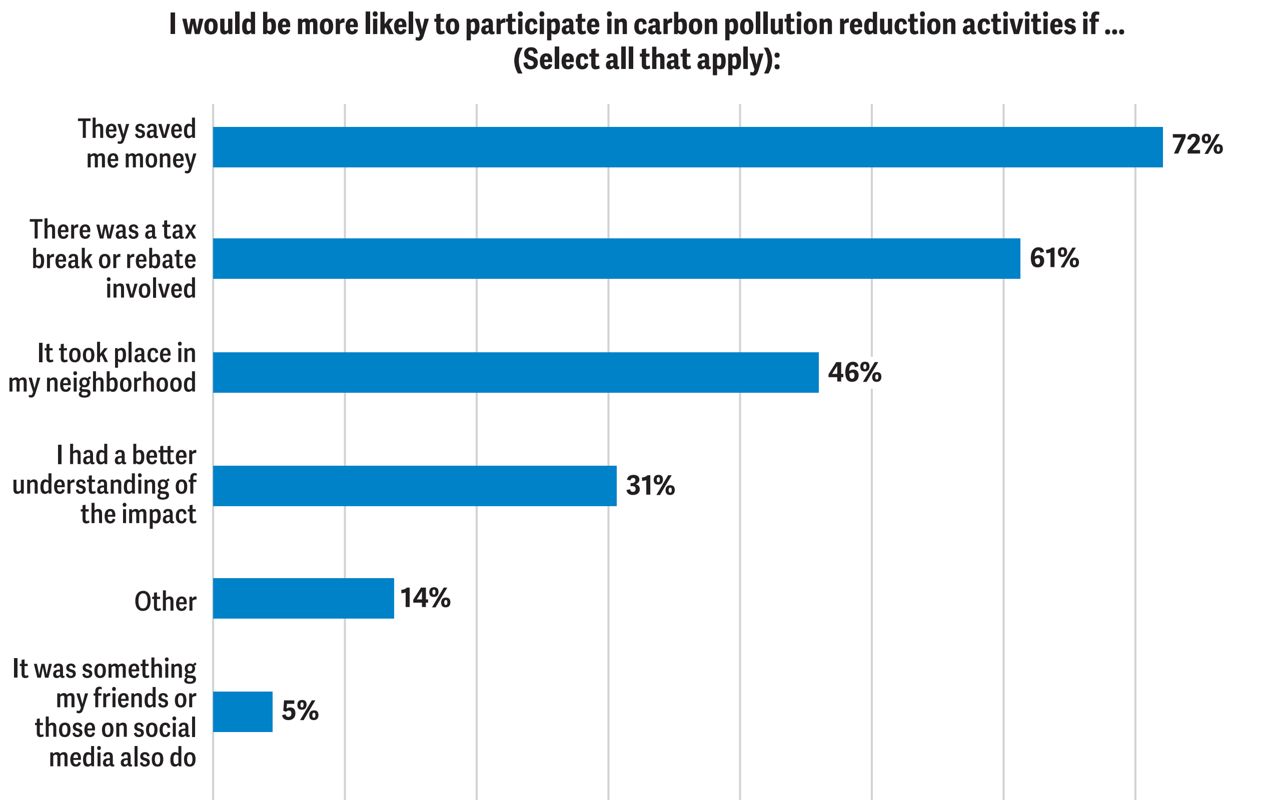

Figure 2-6. Summary of Responses to the Survey Question About Incentives to Participate in Carbon Pollution Reduction Activities.

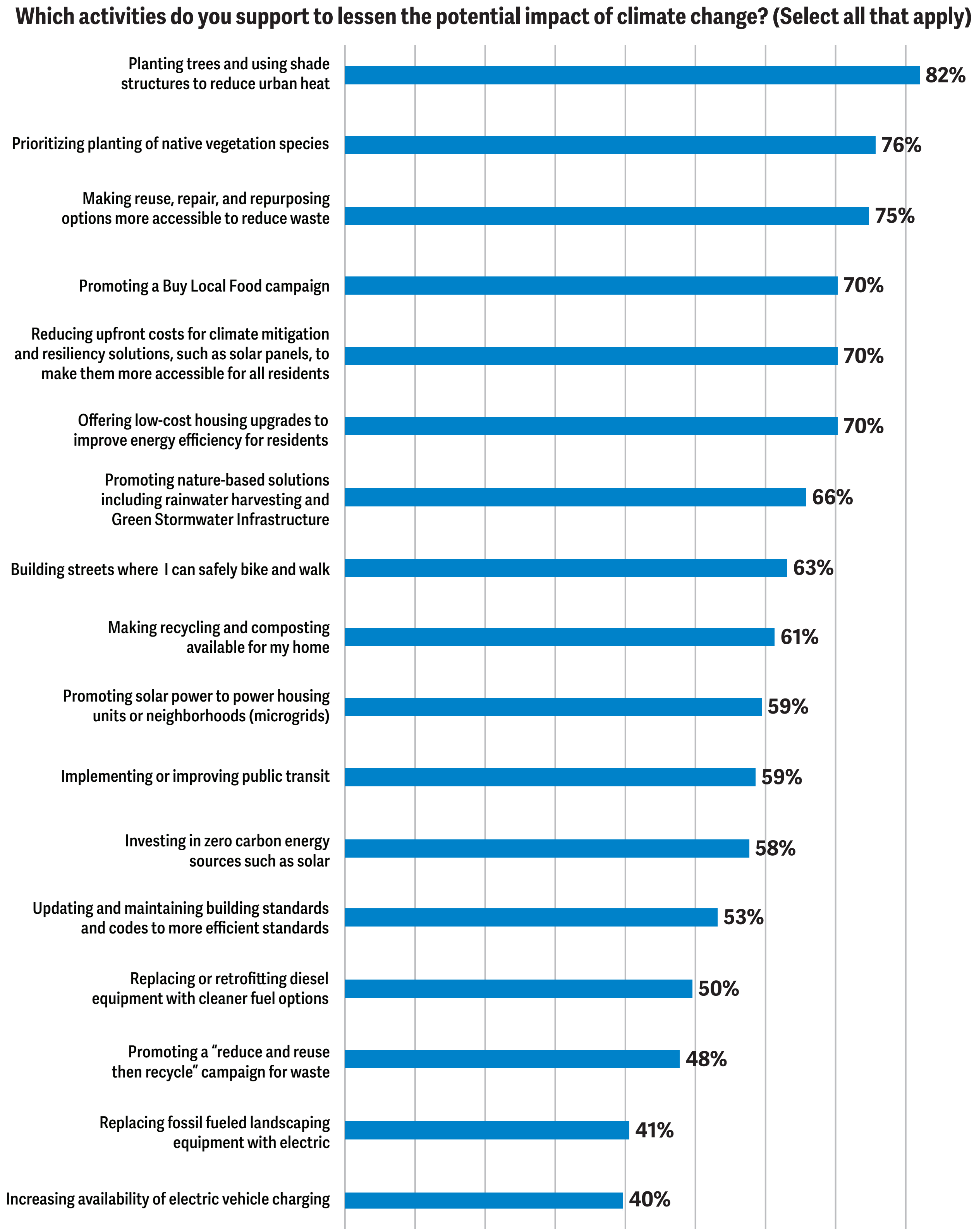

Figure 2-7. Summary of Responses to the Survey Question About Support for Activities to Lessen Potential Climate Change Impacts.

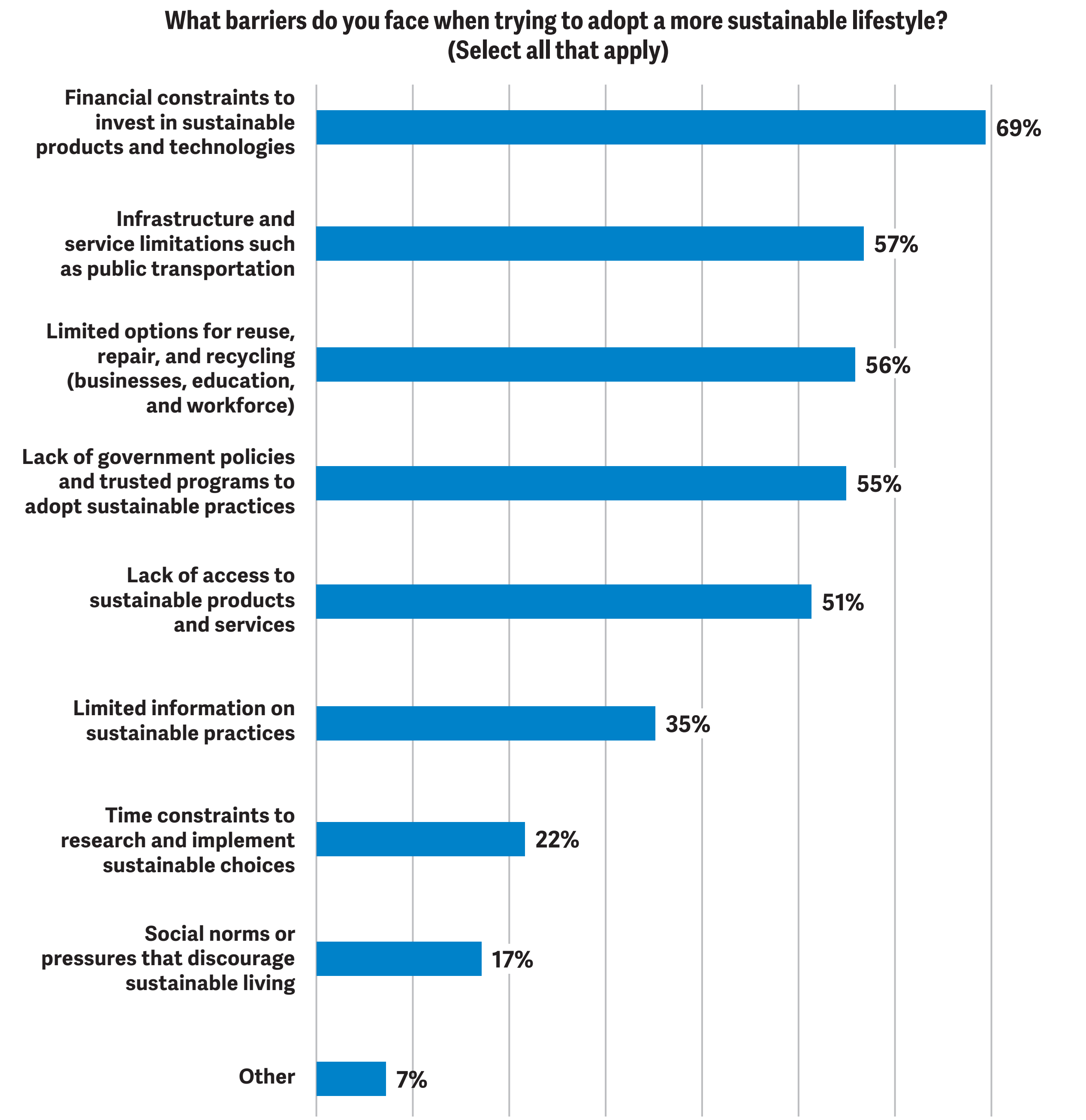

Figure 2-8. Summary of Responses to the Survey Question About Barriers to a More Sustainable Lifestyle.

2.3 Notifications

At key points throughout PCAP development, project notifications were provided via several methods to reach as many people throughout the state as possible.

2.3.1 Distribution Lists and Email Notifications

A project contact database was developed starting with MDEQ's existing database and adding known environmental justice (EJ) organizations, state agencies, local, state, and federal elected government officials, and other interested parties. This database will be updated throughout the project as people and organizations are identified or as requests are made through the project website. In addition, MDEQ shared project notifications with partner agencies who disseminated information through their contact lists.

Email notifications (Figure 2-9) were prepared using the CAMP branding and a color scheme consistent with MDEQ's branding. Messages were clear and concise so they could be understood by a wide audience. Multiple email notifications were sent ahead of each meeting (see additional details about meetings in Section 2.4) to inform people about the meeting and then remind them of the date and time. Email notifications were also sent when the survey was opened.

2.3.2 Social Media

In addition to the email notifications (Figure 2-10), messages were developed for posting on MDEQ's social media accounts including Facebook, Instagram, and X (formerly known as Twitter), and for sharing with partners (Figure 2-10). The social media posts were used to increase public awareness about the project and encourage participation in meetings and the survey. MDEQ's communications staff posted the notices across its social media platforms and shared the posts with other agencies for posting on their social media accounts. The project website includes links to MDEQ's social media to connect all project information.

Figure 2-9. Example Email Notification about the First Public Meeting.

Figure 2-10. Example Social Media Post for the Survey.

2.3.3 News Releases

For each public meeting, news releases were prepared to notify all Mississippians about the meeting and its associated opportunity for engagement. The news releases were placed on MDEQ letterhead with CAMP branding and disseminated via MDEQ's existing media channels.

2.4 Meetings

At key points in the development of this PCAP, meetings were held with interested people, agencies, and groups to discuss the initiative and gather ideas, suggestions, and other data to help guide plan development. A summary of each meeting is provided below.

2.4.1 Partners Meeting

On November 16, 2023, a virtual Zoom meeting was held during business hours with other state agencies and partners to provide background information on PCAP development and request input on the following items:

- What complementary activities do you have underway or planned?
- Is your agency interested in pursuing a grant?
- Do you have any data and/or literature to help support the planning effort?

During this meeting, representatives from the following five agencies participated:

- Mississippi Department of Agriculture and Commerce (MDAC)
- Mississippi Department of Marine Resources (MDMR)
- Mississippi Department of Transportation (MDOT)
- Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP)
- Mississippi Development Authority (MDA)

The partners discussed potential grant projects and other planning efforts underway.

2.4.2 First Public Meeting

On December 7, 2023, a virtual Zoom meeting was held in the evening that was open to all interested parties and individuals. The goals of the meeting were to provide background information on the Climate Pollution Reduction Planning Grant, CAMP, Climate Pollution Reduction Implementation Grant opportunities, and examples of GHG reduction measures, as well as inform participants about how they can get involved in the project and provide input.

There were 11 participants representing the general public, Mississippi Energy Developers, Mississippi State University, and Memphis-Shelby County. There was discussion about how research institutions fit within the planning process and how to complete the survey to provide input.

2.4.3 Second Public Meeting

A second virtual Zoom meeting was held on January 18, 2024, during business hours, which was open to all interested parties and individuals. The goals of the meeting were to provide background information on the Climate Pollution Reduction Planning Grant, CAMP, Climate Pollution Reduction Implementation Grant, and GHG reduction measures proposed for the PCAP, as well as to inform participants about how they can get involved in the project and provide input. There were 18 participants from the public and various organizations. There were no questions or comments raised during this meeting.

2.4.4 One-on-one Meetings

In addition to the meetings noted above, respective meetings were held with different stakeholders (industrial entities, state agencies, energy service providers, etc.) to help frame the priority reduction measures.

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3 Planning and Quantification Methodology

The methodology is based primarily on published information related to different economic sectors and individual GHG emission sources. As a first step, this information is used to develop an inventory of net GHG emissions from different economic sectors in Mississippi. The major sectors include electric power generation, transportation, industry, agriculture, commercial and residential buildings, waste management, wastewater, and natural and working lands. A sector may be a direct source of emissions, or an indirect source, where emissions occur as a consequence of electricity use. In the scientific literature on emissions, direct emissions are referred to as "Scope 1" emissions, and indirect emissions from energy use are referred to as "Scope 2" emissions. Emissions may also occur as a result of energy or goods being imported into a region. These are referred to as "Scope 3" emissions. This PCAP is primarily focused on Scope 1 and Scope 2 emissions within Mississippi.

3.1 Mississippi's GHG Inventory

The initial estimate of GHG emissions for Mississippi is based on the use of a set of sector-specific spreadsheet estimates, published in 2023 by EPA as part of the SIT. For the PCAP, the estimates are developed using the default parameters, and they are expected to be updated and refined with more state-specific data in future phases. The SIT estimates provide a starting point for understanding the magnitude and types of GHG emissions in the state, forming a baseline against which future actions to reduce GHG emissions can be compared. Because of the significance of the GHG inventory in planning future activities, it was also considered important to perform an independent evaluation of the GHG estimates for Mississippi using other related tools and emission databases (i.e., double-checking the reasonableness of the estimates obtained from the SIT). This additional evaluation focused on electric power generation, transportation, industry, agriculture, and wastewater. The SIT inventory estimates and the independent evaluation are presented in Chapter 4.

3.2 Identification and Evaluation of GHG Reduction Measures

In support of the PCAP, we first considered a potential list of 70 GHG reduction measures from the literature spanning each major emission sector. These potential measures included both policy- and regulatory-type actions as well as actions that needed new physical infrastructure or modifications to existing infrastructure. Based on preliminary feedback from stakeholders, a more limited set of 14 measures has been included for consideration. These measures have been assessed along with multiple criteria, some of which can be quantified, whereas others are assessed in narrative form; both types of criteria are needed to help in selecting specific actions. The criteria that can be quantified include the amount of GHG reduction per unit of the measure, the cost range for implementing the measure, and the timeline of implementation. The more general criteria to be evaluated in a narrative fashion include co-benefits to the environment, workforce impacts, and benefits to low income/disadvantaged communities.

At this stage of the PCAP, the priority measures are defined in a "unit" form of a reasonable size, rather than as specific projects with defined geographic footprints. For example, the costs and GHG benefits of solar photovoltaic generation as a source of renewable power are described on a per megawatt (MW) basis, with the actual amount of GHG reduction being scaled to the size of projects ultimately implemented. Other criteria, such as co-benefits to the environment, are described in terms of non-GHG atmospheric pollution *avoided* per MW of current generation. Also, criteria such as workforce impacts and benefits to low income/disadvantaged communities, are described in narrative form and can be refined once a specific project or group of projects are defined.

3.3 Estimation of Benefits for Low Income/ Disadvantaged Communities

The Justice40 Initiative is a whole-of-government effort launched by the Federal Government in 2021. It aims to direct at least 40% of the overall benefits from certain federal investments to disadvantaged communities that have been historically marginalized, underserved, and overburdened by pollution. In accordance with this initiative, GHG reduction measures are evaluated by the degree to which they can be targeted to serve and allow participation by low income/disadvantaged communities. Thus, measures that can be focused to allow such participation, i.e., a residential measure such as building energy efficiency or rooftop solar, will be given preference. Similarly, actions that will have co-benefits that help low income/disadvantaged communities, such as reduced air pollution near highway corridors or energy facilities, will be given preference.

3.4 Workforce Considerations

Many GHG reduction measures, even those that are policy-based, ultimately require implementation of changes to the built infrastructure, thus an adequate workforce in terms of both training and capacity. As part of this criterion, we assess the number and qualifications of staff needed to support the growth of individual measures across the state. This may include, for example, additional workforce needs to support deployment and maintenance of newer technologies such as solar rooftops, electric chargers, as well an increased workforce for existing technologies such as upgrading building energy efficiency. Over time, the growth of different GHG measures will create a need for higher education and research, such as new forms of energy storage or better monitoring and management of GHG emissions from natural systems. From the standpoint of prioritizing GHG reduction measures, workforce considerations are a neutral impact (i.e., the need for an expanded workforce is not necessarily a criterion used for measure prioritization). However, it is an important component of long-term planning at the school, community college, and university level to ensure that worker training, recruitment, and retention are sufficient for sustainable growth and stable trends in priority areas.

In addition to the practical considerations related to current and future workforce requirements, certain funding sources from the federal government (for example the IRA, as discussed further in Chapter 5) provide incentives in the form of tax credits for projects that involve apprenticeship opportunities.

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4 Mississippi GHG Inventory

The results of GHG inventory for Mississippi are presented in this chapter. These GHG inventory results include (a) a detailed breakdown of GHG emissions by economic sector in Section 4.1, (b) categorization of GHG emissions by gas in Section 4.2, and (c) reviews of alternative methodologies and datasets for independently evaluating key GHG emission sources in Section 4.3.

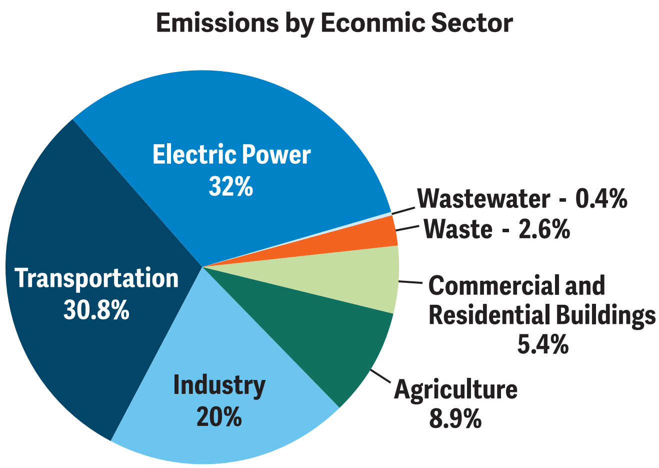
The categorizations of GHG emissions by economic sector and gas type serve as the basis for selecting and quantifying priority GHG reduction measures conducted and discussed in Chapter 3. Specifically, the estimation of key GHG emission sources from different economic sectors was used to help identify the corresponding measures with greater GHG reduction potential. Emissions estimates by type of gas facilitates assessment of the relative importance of different GHGs in Mississippi and helps with prioritizing reduction strategies.

The SIT with its default parameters and datasets was primarily used to calculate GHG emissions for Mississippi in Sections 4.1 and 4.2. MDEQ recognizes the estimation uncertainty associated with the SIT as well as possible alternative methods and datasets that could be applied to GHG emissions. Given that recognition, independent technical reviews were conducted (Section 4.3) to evaluate key GHG emissions sources estimates derived from the SIT. These reviews serve as the foundation for uncertainty analyses for SIT-based GHG inventory results and contribute to developing recommendations in the PCAP.

A summary of the GHG inventory results for Mississippi is presented first. Using 2017 as the baseline year, categorizations and percentages of Mississippi GHG emissions by economic sector and by GHG are presented in Table 4-1 and as pie charts in Figure 4-1. **Emissions for the year 2017 are used as the baseline year in this analysis** because this is a year for which alternative data sources for comparison were available, and this was before the period when COVID-19 had wide-ranging economic impacts (specifically 2020).

Table 4-1. Mississippi GHG emissions by economic sector and by gas (based on CO_2-e). Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Emission Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Electric Power	13.8	15.7	21.6	25.4	26.7	24.8	26.0	**23.8**	25.8	24.6	26.4
Transportation	19.5	22.8	25.5	25.5	23.0	23.0	23.5	**22.9**	23.1	23.7	22.7
Industry	13.2	11.4	15.1	15.3	16.0	14.7	14.1	**14.9**	15.0	15.1	15.1
Agriculture	6.9	7.2	6.5	6.9	6.9	6.6	6.8	**6.6**	6.9	5.7	6.2
Commercial and Residential Buildings	3.3	3.5	4.3	3.5	4.4	4.4	4.1	**4.0**	4.6	4.5	4.3
Waste	1.6	1.6	1.5	2.3	2.5	1.9	1.9	**1.9**	1.9	1.9	1.9
Wastewater	0.3	0.3	0.3	0.3	0.3	0.3	0.3	**0.3**	0.3	0.3	0.3
Land Use, Land-Use Change and Forestry (LULUCF)	-80.0	-82.8	-81.0	-81.2	-81.4	-80.5	-80.2	**-79.0**	-77.7	-76.5	-75.5
CO_2	47.9	51.0	63.4	66.4	66.0	63.6	64.5	**62.6**	65.5	64.8	65.4
CH_4	6.5	6.5	6.0	7.4	7.9	6.0	6.1	**5.7**	5.8	5.2	5.4
N_2O	4.0	4.2	4.1	4.2	4.0	4.1	4.1	**4.2**	4.3	3.7	3.9
Other Gases	0.3	0.6	1.1	1.3	1.8	2.0	2.0	**2.0**	2.0	2.1	2.1
Total Emissions	58.7	62.3	74.6	79.3	79.8	75.7	76.8	**74.5**	77.6	75.7	76.8
Net Emissions	-21.3	-20.5	-6.4	-1.9	-1.7	-4.8	-3.4	**-4.5**	-0.1	-0.8	1.3



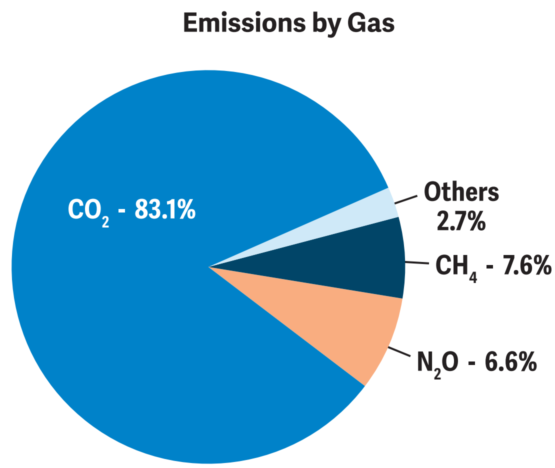


Figure 4-1. Mississippi GHG emissions by economic sector and by gas (based on CO_2-e) in 2017.

The major economic sectors contributing to the GHG emissions in Mississippi (Figure 4-1) include electric power, transportation, industry, and agriculture. The total emissions in 2017 are estimated as 74.5 million metric tons (MMT) CO_2-e, with electric power, transportation, industry, agriculture, and residential and commercial building sectors emitting 23.8, 22.9, 14.9, 6.6, and 4.0 MMT CO_2-e of GHG, respectively.

Annual total GHG emissions in Mississippi exhibit a large increase from 1990 to 2010 and some moderate reductions from 2010 to 2020 (4). Emissions from electric power sector substantially increase during this period, industrial emissions exhibit a moderate increase, and emissions from agriculture decrease slightly, while the other sectors including transportation, commercial and residential buildings, waste, and wastewater do not exhibit notable changes.

Among GHG, CO_2 is the dominant gas for the GHG emissions in Mississippi. Calculated as CO_2-e, CO_2 emissions contribute about 83% of state total emissions in 2017, whereas the CH_4 and N_2O emissions are comparable and around 7-8% of the total emissions.

There is a significant carbon sink from LULUCF in Mississippi (4). In 2017, the estimated carbon sink from natural and working lands in the state are -79 MMT CO_2-e, offsetting the state-wide total emissions. As the SIT with default parameters has been used, it is likely that a more comprehensive uncertainty analysis will be required to better understand variability and potential limits on GHG management decision-making. Historical annual carbon sinks in Mississippi decrease moderately in recent years, however, leading to slightly greater net emissions.

4.1 GHG Emission Inventory by Economic Sector

Further detailed analyses of GHG emissions by economic sector are discussed in this section. Additional accounting efforts were applied to attribute the GHG emission results from the SIT to the common economic sectors (in descending order based on sectoral emissions in 2017): (1) electric power, (2) transportation, (3) industry, (4) agriculture, (5) commercial and residential buildings, (6) waste, and (7) wastewater, and the GHG sinks from (8) LULUCF.

Uncertainties associated with estimating emissions from the SIT using default parameters and datasets, and alternative and potentially more accurate methods and datasets should be acknowledged. As further discussed in Section 4.3, assessment of the methodology and default data used in the SIT and comparison with estimates in other studies were carried out for major GHG emission sources. The results from the SIT were also compared to the estimates from EPA's GHG Inventory by State (USEPA 2023b). The additional reviews in Section 4.3 serve as a starting point for further comprehensive estimation of GHG emissions and sinks in Mississippi, which will be carried out for the CCAP.

4.1.1 Electricity Generation

Historical GHG emissions of the electric power sector were estimated based on the use of four separate modules of the SIT and categorized based on the additional information from the EPA's

GHG Inventory by State (USEPA 2023c; b). The four components of emissions accounted for within the electric power sector are (1) CO_2 emissions from fossil fuel combustion, (2) CH_4 and N_2O emissions from fuel combustion, (3) CO_2, CH_4, and N_2O emissions from incineration of waste for electricity generation, and (4) sulfur hexafluoride (SF_6) emissions from electric equipment. The four SIT modules for these four components are: CO_2 Fossil Fuel Combustion (FFC), Stationary Combustion, Solid Waste, and Industrial Processes modules. Additional discussions for this estimation and comparisons with other estimation/accounting methods are provided in Section 4.3.1.

The results of historical GHG emissions of electric power sector in Mississippi are presented in Table 4-2.

Table 4-2. Historical GHG emissions for electric power sector (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
CO_2 Fossil Fuel Combustion	13.44	15.33	21.35	25.17	26.58	24.68	25.92	**23.74**	25.74	24.51	26.30
Stationary Combustion	0.05	0.05	0.07	0.08	0.07	0.05	0.05	**0.04**	0.04	0.04	0.04
Incineration of Waste	0.03	0.03	-[1]	-	-	-	-	**-**	-	-	-
Electrical Equipment	0.28	0.24	0.17	0.11	0.08	0.05	0.05	**0.06**	0.05	0.06	0.05
Total	13.79	15.65	21.60	25.36	26.73	24.78	26.02	**23.84**	25.84	24.61	26.39

The major emission component from electric power generation in Mississippi is that of CO_2 from fossil fuel combustion (Table 4-2). In 2017, the CO_2 from fossil fuel combustion consists of 23.74 MMT of emissions, contributing to more than 30% of total emissions in Mississippi. The emissions from fossil fuel combustion also exhibit a significant increase from 1990 to 2005 and stay about the same level from 2005 to 2020.

Historical electricity profile information in Mississippi is presented in Table 4-3 to provide additional information on electricity generation and use in Mississippi. The information in Table 4-3 is derived from several Energy Information Administration (EIA) databases (EIA 2021a, 2023a; b). The electricity profile information in Table 4-3 includes the electricity generation by energy source, electricity disposition, and electricity sales by end user (starting from 2005 due to missing data for some categories). Additional discussions can also be found in Section 4.3.

Table 4-3. Electricity profile in Mississippi including historical generation from different energy sources, disposition, and sales by end-user sector (terawatt-hours; TWh). Estimates are shown for 2005-2020 with 2017 defined as the baseline year for this PCAP.

Categories	2005	2010	2015	2016	2017	2018	2019	2020
Natural Gas	15.2	29.3	44.5	49.7	**45.7**	49.0	48.3	53.0
Coal	16.6	13.6	6.4	5.3	**4.6**	5.3	4.4	4.6

[1] Not estimated due to missing source data.

Categories	2005	2010	2015	2016	2017	2018	2019	2020
Petroleum	1.4	0.1	0.0	0.0	**0.0**	0.0	0.0	0.0
Solar	0	0	0	0	**0.1**	0.3	0.3	0.4
Nuclear	10.1	9.6	11.7	5.9	**7.4**	6.9	11.0	6.5
Biomass	0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0
Commercial and Industrial Combined Heat and Power[2]	1.7	1.9	1.9	1.9	**1.9**	1.9	1.9	2.0
Total Generation	45.1	54.5	64.6	62.9	**59.7**	63.5	66.0	66.5
Direct Use	1.2	1.8	1.8	1.9	**1.8**	1.8	1.8	1.9
Transmission and Distribution Losses	3.1	3.1	2.4	2.6	**2.6**	2.6	2.7	2.6
Export	-6.1	-0.5	11.0	8.8	**7.1**	8.3	12.4	15.7
Unaccounted	1.0	0.4	0.8	0.6	**0.3**	0.3	0.1	-0.1
Total Sales	45.9	49.7	48.7	49.1	**47.8**	50.4	49.0	46.5
Sale to Residential Sector	18.0	20.2	18.6	18.5	**17.4**	19.3	18.7	18.0
Sale to Commercial Sector	12.7	13.8	14.4	14.5	**14.3**	14.5	14.2	13.2
Sale to Industry (including agriculture) Sector	15.3	15.7	15.7	16.1	**16.1**	16.5	16.0	15.3
Sale to Transportation Sector	0	0	0	0	**0**	0	0	0

As presented in Table 4-3, electricity generation in Mississippi can be observed with the following trend from 2005 to 2020: (a) total electricity generation exhibits a large increase; (b) electricity generation from natural gas substantially increases whereas the generation using coal decreases; and (c) a moderate increase can be observed for the electricity generation using solar. It should be noted that, given the lower GHG emission rate from natural gas compared to the use of coal, although electricity generation greatly increases from 2005 to 2010, the GHG emissions of electric power sector (as presented in Table 4-3) generally remain unchanged during the same period.

Additionally, the total electricity sales in Mississippi do not exhibit notable changes from 2005 to 2020 as presented in Table 4-3, with sales to each of the three main sectors (residential, commercial, and industry) generally staying at the same level. One notable trend in Mississippi is related to the export of electricity to other states through the regional grid, which presents a substantial increase in recent years. As also discussed in EIA (2023b), Mississippi produced 25% more electricity than the state's consumption in 2021 and this electricity surplus was exported to the neighboring states.

4.1.2 Transportation

Historical GHG emissions of the transportation sector (Table 4-4) were estimated from the following sources using the SIT: (1) CO_2 emissions from fossil fuel combustion, (2) CH_4 and N_2O

[2] Combined heat and power. Not included for the estimation of GHG emissions for electric power sector but included for the emissions of commercial and industry sectors. See Section 4.4 for more technical details.

emissions from fossil fuel combustion, and (3) substitution of ozone depleting substances (ODS) based on additional information from EPA's GHG Inventory by State (USEPA 2023b). The CO_2 emissions and CH_4 and N_2O emissions were estimated using the CO_2 FFC and Mobile Combustion modules of the SIT. Additionally, the emissions from substitution of ODS were estimated using the SIT Industrial Processes module and were subsequently allocated for each of the four sectors: transportation, industry, and residential and commercial buildings. The emissions from substitution of ODS were separately estimated for each of the three sectors because the reductions of emissions from substitution of ODS are targeted as a priority measure and sector-specific emissions are necessary. The estimation of emissions from substitution of ODS for each sector is based on (a) the total emissions for the substitution of ODS calculated using the SIT Industrial Processes module and (b) the fractions of emissions by sector from the results of EPA's GHG inventory by State. Additional evaluation of the emission results for the transportation sector is presented in Section 4.3.2.

Table 4-4. Historical GHG emissions for transportation sector (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
CO_2 from Fossil Fuel Combustion	18.96	21.80	24.05	24.16	21.85	22.25	22.74	**22.21**	22.49	23.07	22.07
CH_4 and N_2O from Mobile Combustion	0.59	0.72	0.75	0.59	0.37	0.25	0.23	**0.22**	0.20	0.21	0.19
Substitution of ODS	0.00	0.23	0.65	0.78	0.80	0.53	0.52	**0.47**	0.43	0.42	0.40
Total	19.55	22.75	25.45	25.54	23.02	23.02	23.49	**22.90**	23.12	23.70	22.66

The transportation sector represents a major source of GHG emissions for Mississippi (Table 4-4), which increase substantially from 1990 to 2005, decrease moderately from 2005 to 2010, and remain at a similar level from 2015 to 2020. The GHG emissions from the transportation sector –totaling 22.90 MMT CO_2-e in 2017 – contribute about 31% of total emissions and serve as the second largest source of emissions behind the electric power sector in Mississippi.

4.1.3 Industry

GHG emissions for the industrial sector calculated from using the SIT include the following components: (1) CO_2 emissions from fossil fuel combustion, (2) CH_4 and N_2O from stationary combustion, (3) CH_4 from natural gas and petroleum/oil systems, (4) CH_4 from coal mining, and (5) CO_2, N_2O, Hydrofluorocarbon (HFC), perfluorocarbon (PFC), nitrogen trifluoride (NF_3), and SF_6 from industrial processes. The SIT modules associated with these sources are the CO_2 FFC, Stationary Combustion, Natural Gas and Oil, Coal, and Industrial Processes modules, respectively. As discussed previously for the transportation sector, the emissions from substitution of ODS for the industry sector were estimated based on the additional information from EPA's GHG Inventory by State. Additionally, the estimation of several selected GHG sources for the industry sector is evaluated and discussed in Section 4.3, including the uncertainty of the method used by the SIT and comparisons with other alternative approaches for GHG emission calculation.

The results of GHG emissions of industry sector in Mississippi are presented in Table 4-5.

Table 4-5. Historical GHG emissions for industry sector (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
CO_2 from Fossil Fuel Combustion	11.47	9.67	10.54	10.33	10.90	10.47	10.01	**10.85**	11.01	11.03	11.12
Natural Gas Systems	0.35	0.28	0.45	0.75	1.08	0.52	0.50	**0.49**	0.45	0.44	0.42
Petroleum Systems	0.49	0.38	0.40	0.37	0.47	0.32	0.25	**0.23**	0.18	0.16	0.15
Coal Mining	0.00	0.00	0.02	0.11	0.12	0.10	0.09	**0.08**	0.09	0.08	0.08
Iron and Steel Production	0.00	0.00	2.57	2.62	2.34	2.34	2.34	**2.34**	2.34	2.34	2.34
Cement Production	0.31	0.36	0.35	0.54	0.38	0.00	0.00	**0.00**	0.00	0.00	0.00
Substitution of ODS	0.00	0.01	0.04	0.08	0.18	0.30	0.33	**0.35**	0.37	0.39	0.38
Lime Production	0.00	0.01	0.01	0.02	0.03	0.02	0.02	**0.02**	0.01	0.02	0.02
Ammonia Production	0.43	0.42	0.49	0.31	0.33	0.45	0.39	**0.41**	0.45	0.46	0.50
Nitric Acid Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Urea Consumption for Non-Agricultural Purposes	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.01**	0.01	0.01	0.01
Adipic Acid Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Electronics Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
CH_4 and N_2O from Stationary Combustion	0.17	0.18	0.16	0.13	0.11	0.11	0.11	**0.11**	0.11	0.11	0.11
Fluorochemical Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Aluminum Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Soda Ash Production	0.03	0.03	0.03	0.03	0.02	0.02	0.02	**0.02**	0.02	0.02	0.02
Magnesium Production and Processing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Total	13.24	11.36	15.07	15.29	15.97	14.67	14.07	**14.90**	15.03	15.06	15.13

Historical GHG emissions from industry sector do not exhibit notable changes from 2000 to 2020 and emissions from fuel combustion and iron and steel production represent the two major sources of emissions, as presented in Table 4-5. The total GHG emissions for industry sector is 14.90 MMT CO_2-e in 2017, which is about 20% of total emissions in Mississippi and is the third largest source behind electric power and transportation sector.

4.1.4 Agriculture

The GHG emissions from the agriculture sector are calculated for the following comnponents: (1) agricultural soil management, (2) enteric fermentation, (3) manure management, (4) rice cultivation, (5) urea fertilization, (6) liming of soils, and (7) mobile combustion. The two SIT modules used for these GHG emissions include the Agriculture and Mobile Combustion modules. An additional review and comparisons between alternative methods of calculating GHG emissions for the agricultural sector are provided in Section 4.3.

The estimated GHG emissions from the agricultural sector as calculated by the SIT are presented in Table 4-6.

Table 4-6. Historical GHG emissions for agriculture sector (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Agricultural Soil Management	3.00	3.00	2.76	2.96	3.06	3.32	3.31	**3.46**	3.53	2.94	3.16
Enteric Fermentation	2.33	2.43	2.03	2.06	1.88	1.76	1.85	**1.74**	1.83	1.64	1.66
Manure Management	0.79	0.93	1.01	1.09	1.02	1.03	1.03	**1.03**	1.05	0.85	0.80
Rice Cultivation	0.69	0.80	0.60	0.73	0.84	0.41	0.54	**0.32**	0.39	0.23	0.46
Urea Fertilization	0.06	0.04	0.05	0.05	0.04	0.05	0.05	**0.05**	0.05	0.05	0.05
Liming	0.04	0.00	0.00	0.03	0.04	0.04	0.04	**0.04**	0.03	0.03	0.03
CH_4 and N_2O from Mobile Combustion	0.01	0.01	0.01	0.01	0.01	0.01	0.00	**0.00**	0.00	0.00	0.00
Total	6.93	7.21	6.47	6.92	6.87	6.61	6.82	**6.64**	6.88	5.74	6.16

Historical GHG emissions for the agriculture sector exhibit a moderate decrease from 1995 to 2020 (Table 4-6), and the major sources include soil management, enteric fermentation, and manure management. The agriculture sector produced about 6.64 MMT CO_2-e in 2017 and contributes about 9% of total emissions in Mississippi. It is important to note that CO_2 emissions from the agriculture sector are relatively small compared to the emissions from other sectors; however, agriculture is the major source for CH_4 and N_2O emissions, as further discussed in Section 4.2.

4.1.5 Commercial and Residential Buildings

GHG emissions from the commercial and residential building sector include (1) CO_2 from fuel combustion of commercial and residential buildings, (2) CH_4 and N_2O from fuel combustion, and (3) substitution of ODS. Importantly, the electricity consumption and GHG emissions from electricity use in commercial and residential buildings are not calculated and included for this sector but are included in the electric power sector. The GHG emissions estimated and presented for the commercial and residential sector in Table 4-7. They mainly include the emissions from combustion of fossil fuels and substitution of ODS. The SIT modules used for the CO_2, CH_4, N_2O emissions from fuel combustion are the CO_2 FFC and Stationary Combustion modules. As described previously for the transportation and industry sectors, the estimation of emissions for substitution of ODS is based on the total emissions for substitution of ODS using the SIT Industrial Processes module and fractions of such emissions by sector from the results of EPA's GHG Inventory by State.

Table 4-7. Historical GHG emissions for commercial and residential buildings (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
CO_2 from Fossil Fuel Combustion (Commercial)	1.35	1.37	1.61	1.41	1.54	1.62	1.55	**1.55**	1.68	1.61	1.55
CO_2 from Fossil Fuel Combustion (Residential)	1.84	1.89	2.37	1.76	1.96	1.61	1.43	**1.31**	1.68	1.63	1.44
CH_4 and N_2O from Stationary Combustion (Commercial)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.01**	0.01	0.01	0.01
CH_4 and N_2O from Stationary Combustion (Residential)	0.09	0.07	0.05	0.05	0.06	0.02	0.02	**0.01**	0.02	0.02	0.02
Substitution of ODS (Commercial)	0.00	0.03	0.11	0.23	0.59	0.76	0.75	**0.75**	0.74	0.76	0.76
Substitution of ODS (Residential)	0.00	0.10	0.13	0.08	0.19	0.37	0.37	**0.40**	0.44	0.46	0.51
Total	3.29	3.47	4.27	3.54	4.36	4.39	4.13	**4.03**	4.56	4.48	4.28

The historical GHG emissions from the commercial and residential building sector (Table 4-7) exhibit a slight increase from 1990 to 2000 and no notable changes from 2000 to 2020. The CO_2 emissions from fuel combustion is the major component of emissions for the commercial and residential building sector, whereas the substitution of ODS (in refrigeration units; chillers; heating, ventilation, and air conditioning [HVAC] equipment; and propellant used in spray foam insulation and fire suppressants) also contributes to a total of 1.15 MMT CO_2-e in 2017. Actions to reduce the emissions from substitution of ODS are therefore identified as a priority reduction measure. In total, the GHG emissions for commercial and residential building sector are 4.03 MMT CO_2-e, which is about 5% of total emissions in Mississippi in 2017.

Because electricity use represents a major source of energy consumption in commercial and residential buildings, historical GHG emissions from electricity use in the commercial and residential building sector were further assessed. Electricity use in the commercial and residential building sector (Table 4-8) includes the consumption from lighting loads, appliance loads, plug loads, HVAC, refrigeration, and electrical systems. The SIT provides a separate module for the estimation of GHG emissions from electricity end use (i.e., the Electricity Consumption module), which was subsequently used.

Table 4-8. Historical GHG emissions (MMT CO_2-e) from electricity consumption in commercial and residential buildings in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Space Heating	0.15	0.16	0.24	0.22	0.14	0.10	0.10	**0.09**	0.10	0.09	0.09
Cooling	0.86	0.95	1.42	1.48	1.51	1.35	1.32	**1.28**	1.29	1.16	1.15
Ventilation	0.51	0.56	0.84	0.91	1.03	0.95	0.93	**0.90**	0.91	0.82	0.81
Water Heating	0.14	0.15	0.23	0.19	0.08	0.04	0.04	**0.04**	0.04	0.03	0.03
Lighting	1.55	1.72	2.57	2.33	1.54	1.09	1.07	**1.03**	1.04	0.93	0.93
Cooking	0.04	0.04	0.06	0.09	0.14	0.14	0.13	**0.13**	0.13	0.12	0.12
Refrigeration	0.48	0.53	0.79	0.89	1.08	1.02	1.00	**0.97**	0.98	0.88	0.87
Office Equipment	0.06	0.06	0.10	0.14	0.25	0.26	0.26	**0.25**	0.25	0.23	0.22
Computers	0.17	0.18	0.27	0.36	0.56	0.56	0.55	**0.53**	0.54	0.48	0.48
Other	0.47	0.52	0.78	0.91	1.17	1.12	1.10	**1.07**	1.08	0.97	0.96
Commercial Total	4.40	4.88	7.30	7.53	7.50	6.63	6.50	**6.30**	6.35	5.70	5.65
Space Heating	0.79	0.91	1.11	0.79	1.25	1.36	1.31	**1.22**	1.34	1.19	1.22
Air-conditioning	1.63	1.89	2.29	2.92	2.33	1.94	1.88	**1.75**	1.92	1.70	1.75
Water Heating	0.79	0.91	1.11	1.23	1.35	1.32	1.27	**1.19**	1.30	1.15	1.19
Refrigeration	0.89	1.03	1.25	1.02	0.92	0.47	0.46	**0.42**	0.47	0.41	0.42
Other Appliances and Lighting	3.18	3.68	4.46	4.71	5.11	3.46	3.35	**3.12**	3.42	3.04	3.12
Residential Total	7.29	8.43	10.22	10.67	10.96	8.55	8.27	**7.70**	8.44	7.49	7.71

In addition to GHG emissions from fuel combustion at commercial and residential buildings, a substantial amount of GHG emissions result from electricity consumption in these buildings (Table 4-8). As noted previously, such emissions from electricity consumption in commercial and residential buildings were accounted with the total emissions for the electric power sector in Table 4-7. An increase in using renewable energy to produce electricity will lead to reductions of GHG emissions from the consumption of electricity in buildings.

4.1.6 Waste

GHG emissions estimated for the waste sector are mainly related to the emissions from landfill of municipal solid waste (MSW). As described previously, the GHG emissions from combustion of MSW were accounted within the electric power sector based on the approach applied in the EPA's GHG Inventory by State (because the majority of MSW is incinerated in power plants to produce electricity in the U.S. (USEPA 2023c)). The Solid Waste module of the SIT was used for estimating GHG emission for waste management. The results are presented in Table 4-9.

Table 4-9. Historical GHG Emissions for waste sector (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Landfill	1.61	1.57	1.48	2.33	2.53	1.94	1.93	**1.91**	1.88	1.88	1.85
Total	1.61	1.57	1.48	2.33	2.53	1.94	1.93	**1.91**	1.88	1.88	1.85

The historical GHG emissions from waste management do not exhibit notable changes over time and are about 1.91 MMT CO_2-e and 2.6% of total emissions in Mississippi. As further discussed in Section 4.2, CH_4 emissions from waste are a major source of CH_4 emissions in Mississippi. Given the importance of waste management for CH_4 emissions, the methodology of estimating GHG emissions from MSW is further examined and discussed in Section 4.3.

4.1.7 Wastewater

GHG emissions from wastewater were estimated as the emissions from the treatment of municipal (M) and industrial (I) wastewater. The Wastewater module from the SIT was used to calculate these emissions. Historical GHG emissions from the wastewater sector are presented in Table 4-10.

Table 4-10. Historical GHG Emissions for wastewater sector (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Wastewater Treatment (M)	0.25	0.26	0.28	0.28	0.29	0.29	0.29	**0.29**	0.29	0.29	0.29
Wastewater Treatment (I)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Total	0.26	0.27	0.29	0.29	0.29	0.29	0.29	**0.29**	0.29	0.29	0.29

Historical GHG emissions from the wastewater sector (Table 4-10) generally remain at a similar level over time and are around 0.29 MMT CO_2-e, with a majority of emissions contributed by municipal wastewater treatment. Total emissions from the wastewater sector accounted for about 0.4% of total emissions in Mississippi in 2017. The wastewater sector is a main source of CH_4 and N_2O emissions (as discussed subsequently in Section 4.2), and consequently, an assessment of the estimation method applied in the SIT was conducted in Section 4.3.

4.1.8 Land Use Land-Use Change and Forestry (LULUCF)

Following the guidelines and recommendations from IPCC (IPCC 2006, 2021), the carbon fluxes (emissions and sinks) related to LULUCF represent the carbon fluxes of the land use sector, which includes forest land, cropland, grassland, wetlands, and settlements. The SIT provides the LULUCF module to estimate the carbon fluxes for LULUCF, which include the estimation of the following major components: (1) remaining forest land, (2) land converted to forest land, (3) forest land converted to land, (4) urban trees, (5) landfilled yard trimmings and food scraps, (6) settlement soils, and (7) agricultural soil carbon flux. The results of estimated historical GHG fluxes for LULUCF in Mississippi are presented in Table 4-11.

Table 4-11. Historical GHG fluxes for LULUCF (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Remaining Forest Land	(78.42)	(81.55)	(79.90)	(79.74)	(80.30)	(79.76)	(79.65)	**(78.47)**	(77.28)	(76.10)	(74.92)
Land Converted to Forest Land	(2.17)	(2.15)	(2.14)	(2.11)	(2.11)	(2.08)	(2.09)	**(2.08)**	(2.08)	(2.08)	(2.08)
Forest Land Converted to Land	2.20	2.23	2.30	2.34	2.37	2.45	2.49	**2.50**	2.50	2.50	2.50
Urban Trees	(0.88)	(0.97)	(1.07)	(1.17)	(1.26)	(1.36)	(1.38)	**(1.40)**	(1.42)	(1.44)	(1.46)
Landfilled Yard Trimmings and Food Scraps	(0.24)	(0.14)	(0.11)	(0.10)	(0.10)	(0.10)	(0.09)	**(0.08)**	(0.10)	(0.10)	(0.10)
N_2O from Settlement Soils	0.08	0.07	0.06	0.05	0.04	0.04	0.04	**0.04**	0.04	0.04	0.04
Agricultural Soil Carbon Flux	(0.55)	(0.33)	(0.17)	(0.49)	(0.06)	0.30	0.50	**0.49**	0.62	0.63	0.53
Total	(79.99)	(82.84)	(81.03)	(81.21)	(81.43)	(80.50)	(80.18)	**(78.99)**	(77.72)	(76.55)	(75.49)

As shown in Table 4-11, forest land and land converted to forest result in a negative carbon flux (i.e., carbon sinks), representing carbon sequestration driven predominantly by the net forest carbon flux from remaining forest land. The total carbon sink from LULUCF was estimated to be around 78.99 MMT CO_2-e in 2017, comparable to the total GHG emissions from the other sectors.

EPA's GHG Inventory by State (USEPA 2023b) estimates a carbon sink of 69.6 MMT CO_2-e for Mississippi in 2017, which is about 9.4 MMT smaller than the carbon sinks in Table 4-11 A key difference in the SIT is the additional consideration of carbon sinks from harvested wood products and related waste for landfill in Mississippi. In 2021, the forestry industry in Mississippi produced $1.12 billion worth of forest products (Measells and Auel 2022). These harvested wood products (e.g., end-use products such as dimensional lumber and paper) along with the wastes produced and stored in solid waste disposal systems serve as a major source of carbon storage (Nichols et al. 2020). 17.78 MMT CO_2-e of carbon is estimated by the SIT to be sequestered annually in Mississippi, although the default data used by the SIT are from more than 20 years ago (1997 and earlier). EPA's GHG Inventory by State (USEPA 2023b), on the other hand, does not provide the state-level estimates for this source of carbon sinks, likely underestimating the total amount of carbon sequestration in Mississippi (given the significance of carbon sinks from harvested wood products and related waste). The results from the SIT were thus determined to be more appropriate, although additional evaluation of SIT methodology and possibly updating the estimation with more recent data will be done for the CCAP.

4.2 GHG Emission Inventory by Gas

The quantification of GHG emissions by individual gases is described in this section. Compared to CO_2, other gases such as CH_4, N_2O, and SF_6 have larger and often substantially greater global warming potentials (GWPs); therefore, actions aimed to reduce the emissions of these gases provide opportunities to disproportionally reduce overall GHG effects. The breakdowns of emissions (in CO_2-e) by key GHGs are therefore provided and discussed in this section.

4.2.1 CO_2

As presented, fossil fuel combustion and industrial processes are the primary emitters of CO_2 (Table 4-12), contributing 59.67 and 2.80 MMT CO_2 of emissions in 2017, respectively.

Table 4-12. Historical CO_2 Emissions (MMT CO_2-e) by source in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Fossil Fuel Combustion	47.05	50.07	59.93	62.83	62.82	60.63	61.65	**59.67**	62.59	61.85	62.47
Industrial Processes	0.77	0.82	3.45	3.53	3.11	2.84	2.77	**2.80**	2.83	2.84	2.88
Waste	0.03	0.03	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Agriculture	0.09	0.04	0.05	0.08	0.08	0.09	0.09	**0.09**	0.08	0.08	0.08
Total	47.94	50.96	63.43	66.43	66.01	63.55	64.52	**62.56**	65.50	64.77	65.43

4.2.2 CH_4

The main sources of CH_4 emissions are agriculture, waste, wastewater, and natural gas and oil systems (Table 4-13). Accordingly, CH_4 emissions from waste and wastewater are identified as important sources of emissions, which are then targeted with corresponding priority reduction measures. CH_4 emissions from waste and wastewater are from point sources, while CH_4 emissions from agriculture are from non-point sources (such as enteric fermentation). The reduction of CH_4 emissions from agriculture is one objective of applying agricultural best management practices (BMPs), considered a priority reduction measure.

Table 4-13. Historical CH_4 Emissions (MMT CO_2-e) by source in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Stationary Combustion	0.17	0.16	0.12	0.12	0.12	0.08	0.08	**0.07**	0.08	0.08	0.08
Mobile Combustion	0.09	0.09	0.08	0.06	0.04	0.03	0.03	**0.03**	0.03	0.03	0.02
Coal Mining	0.00	0.00	0.02	0.11	0.12	0.10	0.09	**0.08**	0.09	0.08	0.08
Natural Gas and Oil Systems	0.84	0.67	0.86	1.12	1.54	0.84	0.75	**0.72**	0.63	0.61	0.57
Agriculture	3.58	3.79	3.25	3.45	3.34	2.85	3.06	**2.72**	2.90	2.34	2.56
Waste	1.61	1.57	1.48	2.33	2.53	1.94	1.93	**1.91**	1.88	1.88	1.85
Wastewater	0.20	0.20	0.21	0.21	0.21	0.21	0.21	**0.21**	0.21	0.21	0.21
Total	6.49	6.49	6.02	7.39	7.91	6.05	6.15	**5.74**	5.82	5.22	5.36

4.2.3 N_2O

Similar to CH_4 emissions, agriculture is the primary emission source for N_2O (Table 4-13). The reduction of N_2O emissions (along with other gases) in agriculture is also a target of the priority reduction measure of agricultural BMPs. Mobile combustion and wastewater also account for some N_2O emissions.

Table 4-14. Historical N_2O Emissions (MMT CO_2-e) by source in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Stationary Combustion	0.15	0.16	0.16	0.16	0.14	0.11	0.10	**0.09**	0.10	0.09	0.09
Mobile Combustion	0.50	0.63	0.67	0.54	0.33	0.22	0.20	**0.19**	0.17	0.18	0.16
Industrial Processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Agriculture	3.25	3.37	3.17	3.40	3.46	3.68	3.68	**3.83**	3.91	3.32	3.53
Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Wastewater	0.07	0.07	0.08	0.08	0.08	0.08	0.08	**0.08**	0.08	0.08	0.08
Total	3.97	4.23	4.08	4.17	4.01	4.08	4.06	**4.19**	4.26	3.68	3.86

4.2.4 Other (HFCs, PFCs, SF_6 and NF_3)

The primary sources of emissions for other gases considered to be GHGs (HFCs, PFCs, SF_6 and NF_3) (Table 4-15) are the substitution of ODS. As described previously, the emissions from the substitution of ODS were accounted for in each of the sectors (transportation, industry, commercial buildings, and residential buildings) based on the fractions of emissions for each sector provided by the EPA GHG Inventory by State. The gases estimated in Table 4-15 represent some of the most potent GHG (e.g., SF_6 has a GWP of 23500). The reduction of emissions during the substitution of ODS was therefore identified as a priority reduction measure in thsi PCAP.

Table 4-15. Historical Emissions of HFCs, PFCs, SF_6 and NF_3 (MMT CO_2-e) in Mississippi. Estimates are shown for 1990-2020 with 2017 defined as the baseline year for this PCAP.

Source	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Industrial Processes	0.28	0.24	0.17	0.11	0.08	0.05	0.05	**0.06**	0.05	0.06	0.05
Substitution of ODS: Transportation	0.00	0.23	0.65	0.78	0.80	0.53	0.52	**0.47**	0.43	0.42	0.40
Substitution of ODS: Industry	0.00	0.01	0.04	0.08	0.18	0.30	0.33	**0.35**	0.37	0.39	0.38
Substitution of ODS: Commercial buildings	0.00	0.03	0.11	0.23	0.59	0.76	0.75	**0.75**	0.74	0.76	0.76
Substitution of ODS: Residential buildings	0.00	0.10	0.13	0.08	0.19	0.37	0.37	**0.40**	0.44	0.46	0.51
Total	0.28	0.62	1.10	1.28	1.84	2.02	2.03	**2.02**	2.03	2.08	2.11

4.3 Independent Review of GHG Emissions for Selected Sectors

Because of the significance of the GHG inventory in planning future activities, it was considered important to perform an independent evaluation of the GHG estimates for Mississippi. Utilizing other related tools and emission databases, we reviewed the reasonableness of the estimates obtained from the SIT. As described below, this additional evaluation focused on the following sectors: electric power generation, transportation, industry, agriculture, and wastewater.

4.3.1 Electric Power

4.3.1.1 Sources of GHG Emissions Considered for Electric Power Sector

Both the GHG Inventory by State and the SIT follow the calculations of GHG emission categories defined by the IPCC (subsequently referred to as IPCC categories), which do not explicitly include an electric power sector. The IPCC categories include energy, industrial processes, agriculture, waste, and LULUCF. In addition to IPCC categories, the EPA's GHG Inventory by State further allocates the calculations of IPCC categories to common economic sectors, i.e., electric power, transportation, industry, agriculture, commercial, and residential (USEPA 2023c; b). The SIT tool, by default, does not characterize the GHG estimation results to common economic sectors as in the GHG Inventory by State. However, similar GHG emission sources (from the IPCC categories) accounted within the electric power sector in the GHG Inventory by State can be found in the SIT calculations. To provide an independent evaluation of the electric power sector, the individual sources of GHG emissions considered and accounted for in the electric power sector by the EPA's GHG Inventory by State are first discussed in this section. A comparison with the SIT calculations is also provided.

In EPA's GHG Inventory by State, the sources of GHG emissions estimated for the electric power sector include five components:

1. CO_2 emissions from fossil fuel combustion for electricity generation. Energy consumption in this case refers to the energy used by utilities and independent power producers (IPP) with a primary business of selling electricity or combined heat and power to the public (EIA 2021a). Energy used by commercial and industrial plants which only provide electricity or combined heat and power to commercial and industrial facilities are not included in this case, but are allocated to the energy consumption by commercial and industry sectors instead. Types of fossil fuels include natural gas, coal, petroleum coke, and distillate fuel.

2. CH_4 and N_2O emissions from fuel combustion for electricity generation. The CH_4 and N_2O emissions are estimated (in both GHG Inventory by State and SIT) as a separate component when considering the emissions from energy consumption for electricity generation. The types of fuel used for the estimation include natural gas, coal, petroleum coke, distillate fuel, and wood.

3. CO_2, CH_4, and N_2O emissions from incineration of solid waste. As described in the EPA document for the methodology of the GHG Inventory by State (USEPA 2023b), the majority of municipal solid waste incineration is used for electricity generation and is therefore included as an additional component of GHG emissions for electric power sector.

4. SF_6 emissions from electricity transmission and distribution systems. SF_6 is included as a substance for electric equipment, especially older equipment (USEPA 2023b), and is therefore estimated and added to the emissions of electric power sector.

5. CO_2 emissions from other process use of carbonates, in this case, from the use of pollution control equipment in power plants.

The SIT provides similar calculations on four of the five sources and does not provide specific calculations on the last source (i.e., CO_2 emissions from other process use of carbonates). The CO_2 emissions from the use of carbonate in pollution control of power plants are considered and calculated in the industrial processes for limestone and dolomite use and soda ash manufacture and consumption in the SIT.

Table 4-16 provides a summary and a comparison of the GHG emission sources for the electric power sector from the GHG Inventory by State and the SIT and their corresponding results for Mississippi in 2017.

Table 4-16. Sources of GHG emissions considered and estimated for electric power sector in the GHG Inventory by State and the SIT.

Source	Gas	Emissions in 2017 for Mississippi in the GHG Inventory by State (MMT CO_2-e)	Emissions in 2017 for Mississippi using the SIT (MMT CO_2-e)	Corresponding IPCC categories (IPCC 2006; USEPA 2023b)	Corresponding Modules in the SIT	Consistency between the GHG Inventory by State and SIT (USEPA 2023d)
CO_2 emissions from fossil fuel combustion	CO_2	23.71	23.74	Energy: fossil fuel Combustion	CO2 FFC Module	Consistent
CH_4 and N_2O emissions from fuel combustion	CH_4, N_2O	0.23	0.04	Energy: stationary non-CO_2 emissions	Stationary Combustion Module	Consistent; IPCC factors used in the SIT (the GHG Inventory by State uses fuel and combustion specific factors)

Source	Gas	Emissions in 2017 for Mississippi in the GHG Inventory by State (MMT CO_2-e)	Emissions in 2017 for Mississippi using the SIT (MMT CO_2-e)	Corresponding IPCC categories (IPCC 2006; USEPA 2023b)	Corresponding Modules in the SIT	Consistency between the GHG Inventory by State and SIT (USEPA 2023d)
Incineration of solid waste for electricity generation	CO_2, CH_4, N_2O	<0.01	NA[3]	Energy: incineration of waste	Municipal Solid Waste Module	Consistent
SF_6 emissions from electricity transmission and distribution systems	SF_6	0.10	0.06	Industry Process and Product Use: electrical transmission and distribution	Industrial Processes Module	The GHG Inventory by State uses transmission lines and other data to allocate to states; the SIT uses state electricity sale data
CO_2 emissions from other process use of carbonates	CO_2	0.09	NA	Industry Process and Product Use: other process uses of carbonates	Industrial Processes Module: limestone and dolomite use; and soda ash manufacture and consumption	The SIT does not provide specific calculations on other process use of carbonates

As presented in Table 4-16, results from the GHG Inventory by State and the SIT are generally consistent for the electric power sector with the exception of the estimated CH_4 and N_2O emissions. As described in USEPA (2023d), the SIT tool utilizes the IPCC factors by fuel type for the calculation of CH_4 and N_2O emissions, whereas the GHG Inventory by State utilizes the factors based on fuel and combustion types. EPA is planning to update the SIT using an approach similar to the GHG Inventory by State (USEPA 2023d), i.e., updating emission factors by fuel and combustion type. While the results presented in Section Emission Source were obtained from the SIT using the default factors to calculate CH_4 and N_2O emissions for the electric power sector, it is recommended that additional integration of the results from the GHG Inventory by State (based on emission factors by fuel and combustion type) be applied for the CCAP.

As discussed previously, the SIT does not provide specific calculations on the CO_2 emissions from the process use of carbonates in the electric power sector. The CO_2 emissions from the process use of carbonates are instead accounted in the SIT calculations of the IPCC category of industrial

[3] Not available. The SIT by default does not provide the estimates for 2017 due to the missing 2017 data for solid waste combustion in Mississippi.

process and product use. EPA is planning to revise the SIT tool to be more consistent with the GHG Inventory by State (USEPA 2023d). Given the relatively small percentage of emissions from this source and to be consistent with the SIT default results, the emissions of the electric power sector presented in Section Emission Source do not include this source. If during the CCAP process, the SIT is revised to include this source and is more consistent with the GHG Inventory by State, this emission source will be accounted for in the emissions of electric power sector.

Based on the results of Table 4-16, the major emission sources for the electric power sector are the CO_2 as well as CH_4 and N_2O emissions from fuel combustion. In subsequent sections , further evaluation of GHG emissions for the electric power sector therefore focuses primarily on the emissions from fuel combustion: Section Emission Source discusses evaluation of the methodology, and Section 4.3.1.3 discusses evaluation of the data used.

4.3.1.2 Evaluation of the Methods Used for Estimating the GHG Emissions from Fuel Combustion

The SIT includes two separate modules for calculations of the GHG emissions for the electric power sector: one focuses on electricity generation (i.e., electricity supply and fuel consumption), and another, optional module focuses on electricity end-use (i.e., electricity demand and consumption). Table 4-16 represents results from the first SIT approach. The differences between the two approaches are:

Estimation based on electricity supply: using fuel consumption data for electricity generation to estimate GHG emissions. Fuel-type-specific emission factors (i.e., metric ton (MT) of CO_2 per unit volume of fuel consumed) are used to estimate GHG emissions. As fuel consumption used by individual power plants are reported by EIA (2023a), the estimation of GHG emissions can be traced back to emissions of individual power plants (discussed in Section 4.3.1.3). Figure 4-2 presents the locations of power plants at Mississippi in 2017 from (EIA 2023c).

Estimation based on electricity demand: using electricity sales data to estimate electricity generation needed and the corresponding GHG emissions. Electricity generation needed is calculated by adding transmission and distribution losses and generation losses to electricity sales. The GHG emissions are subsequently calculated using emission factors [e.g., MT of CO_2e per kilowatt hour (kWh) of electricity generated]. As further breakdowns of electricity end-use are provided by EIA surveys [e.g. EIA (2023d)], the estimation of GHG emissions can be traced back to individual sub-categories of end-users, e.g., space heating in residential buildings.

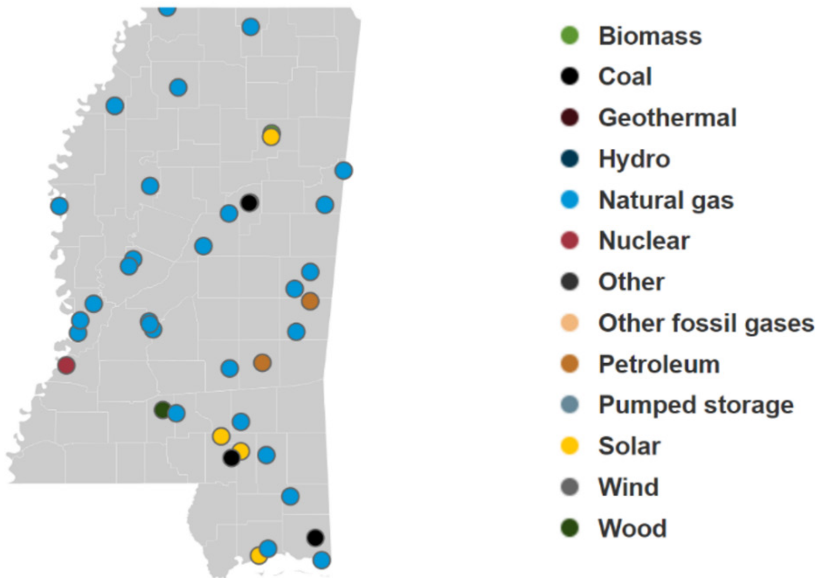


Figure 4-2. The locations of power plants and their main fuel source in Mississippi in 2017. Figure obtained from EIA (2023a).

EPA's GHG Inventory by State applies the first method, [i.e., using the fuel consumption data reported by EIA's State Energy Data System (EIA 2021a)] to calculate GHG emissions for the electric power sector. Some minor adjustments to the state-level fuel consumption data were made for the GHG Inventory by State (USEPA 2023b) to align better with U.S. total fuel consumption.

The first approach of focusing on electricity supply is generally expected to provide more accurate emissions estimates. This is because the first approach is based directly on fuel consumption data at power plants, whereas the second approach is based on electricity sales and subsequent generation needed. The export of electricity – which was more than 25% of total electricity generated in Mississippi in 2021 (as previously discussed in Section Emission Source; disposition of electricity is also discussed in Section 4.3.1.4) – is not included in the second approach of the SIT (calculating emissions only based on electricity sales). Consequently, the GHG emissions of the electric power sector presented in Section Emission Source are based on the first and default approach of the SIT, although the second approach is further used to quantify reduction measures as it directly relates GHG emissions to electricity end use.

4.3.1.3 Evaluation of the Data Used for Estimating the GHG Emissions from Fuel Combustion

Fuel consumption data of individual power plants reported by EIA (2023a) were used in this section to evaluate the data used in the SIT. Specifically, the fuel types and fuel consumptions from each power plant in Mississippi were obtained and compiled to provide an evaluation on the GHG emission estimation. Such information can also facilitate the subsequent analyses of reductions of GHG other air pollutants emissions at individual power plants.

A comparison of GHG emissions in 2017 between the use of power-plant-specific fuel consumption data and the results from the GHG Inventory by State and the SIT is presented in Figure 4-2. Additionally, as EIA (2023a) also reports estimates of CO_2, SO_2, NO_X emissions for individual power plants, these emission estimates are also presented in Figure 4-2.

Table 4-17. Emissions in 2017 for individual power plants in Mississippi and a comparison of emission estimates from individual power plants, the GHG Inventory by State, and the SIT.

Plant Name	Primary Technology	Energy Consumption (Trillion BTU)			Estimated GHG Emissions (MMT CO_2-e)[4]			EIA Reported Emissions (MMT CO_2-e)		
		Natural gas	Coal	Distillate fuel	CO_2	CH_4	N_2O	CO_2	SO_2	NO_x
Attala	Natural Gas Fired Combined Cycle	16.45	-	-	0.87	0.0004	0.0004	0.87	0.00	0.00
Batesville Generation Facility	Natural Gas Fired Combined Cycle	24.57	-	-	1.30	0.0007	0.0006	1.30	0.00	0.00
Baxter Wilson	Natural Gas Steam Turbine	7.06	-	0.01	0.37	0.0002	0.0002	0.38	0.00	0.00
Benndale	Natural Gas Fired Combustion Turbine	0.01	-	-	0.00	0.0000	0.0000	0.00	0.00	0.00
Caledonia	Natural Gas Fired Combined Cycle	31.05	-	-	1.64	0.0008	0.0007	1.65	0.00	0.00
Chevron Oil	Natural Gas Fired Combustion Turbine	14.44	0.00	0.00	0.76	0.0004	0.0003	0.77	0.00	0.00
Choctaw County	Natural Gas Fired Combined Cycle	28.53	-	-	1.51	0.0008	0.0007	1.51	0.00	0.00
Crossroads Energy Center	Natural Gas Fired Combustion Turbine	0.16	-	-	0.01	0.0000	0.0000	0.01	0.00	0.00
Gerald Andrus	Natural Gas Steam Turbine	4.90	-	0.00	0.26	0.0001	0.0001	0.26	0.00	0.00

[4] IPCC emission factors used for individual plants: 1) for CO_2 emissions, 31.8, 57.6, and 44.6 pound (lbs) carbon per million BTU are used for natural gas, coal, and distillate fuel, respectively; 2) for CH_4 emissions (GWP: 28), 0.00095, 0.001, and 0.00301 MT of CH_4 per billion BTU are used for natural gas, coal, and distillate fuel, respectively; 3) for N_2O emissions (GWP: 265), 0.00009, 0.00150, and 0.0006 MT of N_2O per billion BTU are used for natural gas, coal, and distillate fuel, respectively.

Plant Name	Primary Technology	Energy Consumption (Trillion BTU)			Estimated GHG Emissions (MMT CO_2-e)[4]			EIA Reported Emissions (MMT CO_2-e)		
		Natural gas	Coal	Distillate fuel	CO_2	CH_4	N_2O	CO_2	SO_2	NO_x
Grand Gulf	Nuclear	-	-	-	-	-	-	-	-	-
Gulfport Naval Base Csg Pv System	Solar Photovoltaic	-	-	-	-	-	-	-	-	-
Hattiesburg Solar Farm	Solar Photovoltaic	-	-	-	-	-	-	-	-	-
Henderson	Multiple	0.14	0.00	0.00	0.01	0.0000	0.0000	0.01	0.00	0.00
Hinds Energy Facility	Natural Gas Fired Combined Cycle	22.90	-	-	1.21	0.0006	0.0005	1.22	0.00	0.00
Jack Watson	Multiple	17.11	0.00	-	0.91	0.0005	0.0004	0.91	0.00	0.00
Kemper County	Natural Gas Fired Combustion Turbine	2.75	-	0.00	0.15	0.0001	0.0001	0.15	0.00	0.00
L L Wilkins	Natural Gas Fired Combined Cycle	0.00	-	0.00	0.00	0.0000	0.0000	0.00	0.00	0.00
Magnolia Power Plant	Natural Gas Fired Combined Cycle	36.93	-	-	1.95	0.0010	0.0009	1.96	0.00	0.00
Meridian	Petroleum Liquids	-	-	0.00	0.00	0.0000	0.0000	0.00	0.00	0.00
Moselle	Multiple	8.09	-	0.00	0.43	0.0002	0.0002	0.43	0.00	0.00
Paulding	Petroleum Liquids	-	-	0.01	0.00	0.0000	0.0000	0.00	0.00	0.00
Prairie Bluff	Landfill Gas	-	-	-	-	-	-	-	0.00	0.00
Quantum Choctaw Power Llc	Natural Gas Fired Combined Cycle	23.12	-	-	1.22	0.0006	0.0006	1.23	0.00	0.00
R D Morrow	Conventional Steam Coal	-	1.08	0.03	0.11	0.0000	0.0004	0.10	0.00	0.00
Ratcliffe	Natural Gas Fired Combined Cycle	26.42	-	-	1.40	0.0007	0.0006	1.40	0.00	0.00
Red Hills Generating Facility	Conventional Steam Coal	0.10	25.70	-	2.47	0.0007	0.0102	2.43	0.00	0.00
Rex Brown	Multiple	2.04	-	0.01	0.11	0.0001	0.0000	0.11	0.00	0.00
Silver Creek	Natural Gas Fired Combustion Turbine	1.42	-	-	0.08	0.0000	0.0000	0.08	0.00	0.00
Sr Houston	Solar Photovoltaic	-	-	-	-	-	-	-	-	-
Sumrall I Solar Farm	Solar Photovoltaic	-	-	-	-	-	-	-	-	-
Sumrall Ii Solar Farm	Solar Photovoltaic	-	-	-	-	-	-	-	-	-

Plant Name	Primary Technology	Energy Consumption (Trillion BTU)			Estimated GHG Emissions (MMT CO_2-e)[4]			EIA Reported Emissions (MMT CO_2-e)		
		Natural gas	Coal	Distillate fuel	CO_2	CH_4	N_2O	CO_2	SO_2	NO_x
Sweatt	Natural Gas Fired Combustion Turbine	0.06	-	-	0.00	0.0000	0.0000	0.00	0.00	0.00
Sylvarena	Natural Gas Fired Combustion Turbine	1.56	-	-	0.08	0.0000	0.0000	0.08	0.00	0.00
Tva Southaven Combined Cycle	Natural Gas Fired Combined Cycle	27.53	-	-	1.46	0.0007	0.0007	1.46	0.00	0.00
Victor J Daniel Jr	Multiple	53.83	27.00	0.08	5.44	0.0022	0.0120	5.44	0.00	0.00
Yazoo	Natural Gas Fired Combined Cycle	0.00	-	-	0.00	0.0000	0.0000	0.00	0.00	0.00
Total		351.19	53.78	0.14	23.75	0.01	0.03	23.76	0.00	0.01
Estimates From the GHG Inventory By State					23.71		0.23[5]	-	-	-
Estimates From the Sit					23.74	0.01	0.03	-	-	-

The CO_2 emissions calculated using the power-plant-specific fuel consumption data (Figure 4-2) are consistent with the CO_2 emissions calculated for the electric power sector from the EPA's GHG Inventory by State and the SIT. Emissions of CH_4 and N_2O exhibit greater differences between the SIT results (which are consistent with the estimates from using power-plant-specific data) and the results from the GHG Inventory by State, likely because of the emission factors used as described previously (i.e., the GHG Inventory by State utilizes the emission factors by fuel and combustion type).

To further assess the power-plant-specific emission data with an independent source, the reported emissions by power plants of Mississippi in 2017 from the EPA Facility Level Information on Greenhouse gases Tool (FLIGHT) database (USEPA 2023e) were obtained and compared with the results in Figure 4-2. The comparison is presented in Table 4-18.

[5] The sum of CH_4 emissions and N_2O emissions.

Table 4-18. A comparison of the power-plant-specific emissions estimated using EIA (2023a) and reported emissions from EPA.

Plant Name in EIA (2023a)	Plant Name in EPA FLIGHT	Estimated Emissions Using EIA (2023a) (MMT CO_2-e)	Reported Emissions from the EPA FLIGHT (MMT CO_2-e)	Percentage of Absolute Difference (%)
Attala	Attala Generating Plant	0.87	0.91	4.98
Batesville Generation Facility	Batesville Generation Facility	1.30	1.36	4.87
Baxter Wilson	Baxter Wilson	0.37	0.39	3.33
Benndale	*NA*[6]	0.00	-	-
Caledonia	Caledonia	1.64	1.70	3.13
Chevron Oil	Chevron Cogenerating Station	0.77	0.80	5.09
Choctaw County	Choctaw County Gen	1.51	1.54	1.73
Crossroads Energy Center	Crossroads Energy Center (CPU)	0.01	0.01	4.26
Gerald Andrus	Gerald Andrus	0.26	0.27	2.13
Henderson	*NA*	0.01	-	-
Hinds Energy Facility	Hinds Energy Facility	1.21	1.21	0.11
Jack Watson	Watson Electric Generating Plant	0.91	0.91	0.93
Kemper County	Kemper County	0.15	0.15	0.95
L L Wilkins	*NA*	0.00	-	-
Magnolia Power Plant	Magnolia Facility	1.96	2.11	7.89
Meridian	*NA*	0.00	-	-
Moselle	Moselle Generating Plant	0.43	0.44	3.16
Paulding	*NA*	0.00	-	-
Quantum Choctaw Power LLC	Ackerman Combined Cycle (renamed as Ackerman Combined Cycle in 2015)	1.22	1.28	4.27
R D Morrow	R D Morrow Senior Generating Plant	0.11	0.11	3.69
Ratcliffe	David M Ratcliffe	1.40	1.99	42.27
Red Hills Generating Facility	Red Hills Generation Facility	2.48	2.73	10.30
Rex Brown	Rex Brown	0.11	0.14	27.58
Silver Creek	Silver Creek Generating Plant	0.08	0.08	2.94
Sweatt	*NA*	0.00	-	-

[6] Not available in EPA FLIGHT database.

Plant Name in EIA (2023a)	Plant Name in EPA FLIGHT	Estimated Emissions Using EIA (2023a) (MMT CO_2-e)	Reported Emissions from the EPA FLIGHT (MMT CO_2-e)	Percentage of Absolute Difference (%)
Sylvarena	Sylvarena Generating Plant	0.08	0.08	2.50
TVA Southaven Combined Cycle	Southaven Combined Cycle	1.46	1.44	1.13
Victor J Daniel Jr	Daniel Electric Generating Plant	5.46	5.50	0.83
Yazoo	*NA*	0.00	-	-
Total		23.79	25.16	5.78

As shown in Table 4-18, the results from the EPA FLIGHT database are generally comparable to the results using EIA (2023a). Of the 22 power plants (with reported emissions available in the EPA FLIGHT database), 19 exhibit less than 10% differences in 2017 between the estimates using the EIA database and the emissions in the EPA FLIGHT database. One power plant (Ratcliffe) exhibits a difference of more than 40%. The EPA FLIGHT estimate of total CO_2-e emission is 25.16 MMT, compared to the estimate from EIA (2023a) of 23.79 MMT CO_2-e, suggesting a generally acceptable percentage (5.78%) of difference. The emissions calculated from SIT (based on the EIA fuel consumption data) were therefore determined to be appropriate, although a further assessment can be carried out for the CCAP.

4.3.1.4 Evaluation of Disposition of Electricity in Mississippi

A further evaluation of the disposition of electricity was carried out in this section to bridge the two different approaches available in the SIT. As described in Section Emission Source, the first approach of GHG emission estimation in the SIT focuses on electricity supply (i.e., using fuel consumption for electricity generation), whereas the second approach focuses on the electricity demand (using electricity sales). The evaluation carried out in this section aimed to integrate different types of available electricity data to provide a comprehensive disposition of electricity: accounting each end-use type of total electricity generated, e.g., distribution and transmission losses, end-use sales, and imports/exports. Summary results from this analysis are also presented in Section Emission Source. By linking electricity generation (and the related emissions from fuel combustion for generating electricity) with end use, further assessment of potential GHG reduction measures (such as electrification of building appliances) can be facilitated.

Integrating electricity data from multiple EIA datasets (i.e., Table C9 from the State Energy Data System, EIA Mississippi Electricity Profile, and EIA-861 table for historical state data), breakdowns of electricity generation and sales in 2017 are provided in Figure 4-3. Three columns in Figure 4-3 separately present (a) the types of energy used for electricity generation in Mississippi, (b) the disposition of electricity, and (c) the corresponding electricity end-users by sector. Note that commercial and industrial combined heat and power are separately categorized in the first column of Figure 4-3 because the GHG emissions for the electric power sector do not include this portion of electricity generation (which are, instead, accounted as the emissions of the commercial and industrial sectors).

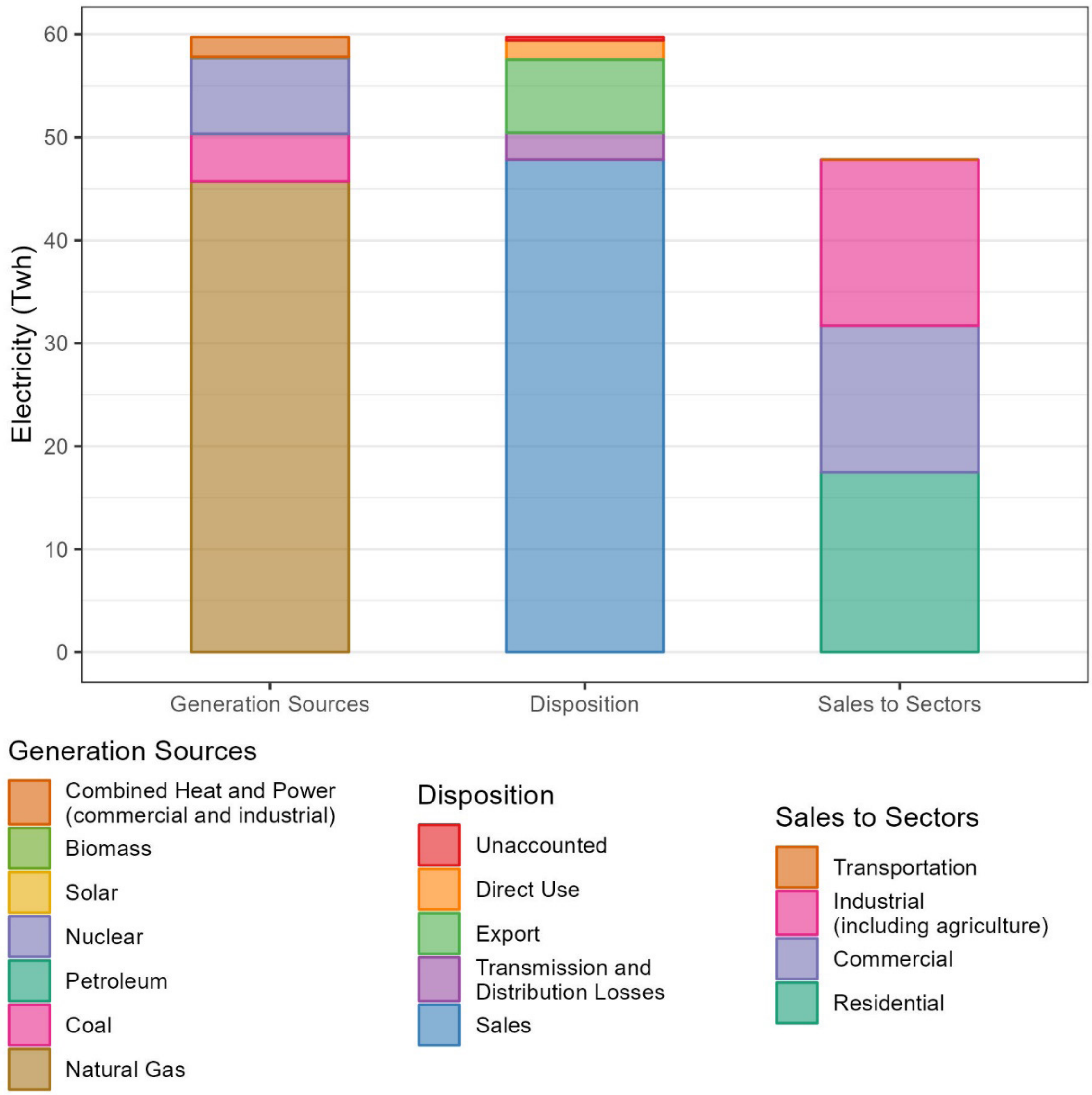


Figure 4-3. Categorizations of electricity by type of energy used, disposition of generated electricity, and end-user sector in 2017 for Mississippi. The first column presents the corresponding electricity generation from different energy sources and does not represent the amount of fuel/energy consumption to generate electricity (because of the efficiency of electricity generation).

The comparison suggests consistent results of electricity generation, disposition, and sales obtained from different EIA sources (Figure 4-3). The total electricity generation matches the total electricity amount from direct use, export, transmission and distribution losses, and sales, with a small percentage (0.6% in 2017) of electricity unaccounted for. The electricity sales from this disposition match the total sales combining all sectors (i.e., transportation, industrial including agriculture, commercial, and residential). Evaluation of electricity disposition for other years also provides similarly consistent results as presented in Section Emission Source.

The categorizations of electricity in Table 4-3 provide opportunities for quantifying the electricity sales to sub-categories of end users (such as space heating in residential sector) and quantifying the GHG emissions from corresponding reduction measures. Specifically, EIA Residential Energy Consumption Survey (EIA 2023d), EIA Commercial Buildings Energy Consumption Survey (EIA 2023e), EIA Manufacturing Energy Consumption Survey (EIA 2021b), and Federal Transit Administration (FTA) National Transit Database (FTA 2023) provide the sector-specific breakdowns of electricity use. These datasets are used as the default data in the second approach of the SIT (electricity consumption module of the SIT), although some datasets included in this SIT module are outdated. The most recent datasets of sector-specific electricity consumption from these EIA and FTA databases were obtained. These sector-specific electricity consumption data are subsequently linked with the disposition of electricity for Mississippi and the energy sources for electricity generation such as presented in Table 4-3 to quantify the GHG emissions from the changes in sector-specific energy and electricity consumption.

4.3.2 Transportation

4.3.2.1 Sources of GHG Emissions Considered for Transportation Sector

The sources of GHG emissions considered and estimated for the transportation sector include the following three components:

1. CO_2 emissions from fossil fuel combustion (i.e., energy consumed) from transportation. Types of fossil fuels include natural gas, coal, petroleum, and other.
2. CH_4 and N_2O emissions from mobile combustion from transportation. The CH_4 and N_2O emissions are estimated in the SIT as a separate component from the CO_2 estimation. Mobile combustion includes vehicle miles travelled by highway vehicles and alternative fuel vehicles, as well as fuel consumption for aviation, boats, locomotives, and other sources.
3. Substitution of ODS accounted for in the transportation sector. These emissions represent the emissions during substitution of ODS materials in refrigeration units in different modes of the transportation sector.

Table 4-19 provides a summary of the two GHG emission sources (the SIT and EPA's GHG Inventory by State) for the transportation sector, along with the estimates of 2017 emissions from the SIT and the GHG Inventory by State.

Table 4-19. Sources of GHG emissions considered and estimated for transportation sector.

Source	Gas	2017 MS Emissions in SIT (MMT CO_2-e)	Corresponding IPCC Categories (USEPA 2023b)	Corresponding Modules in EPA SIT tool	Consistency between EPA inventory and SIT tool
CO_2 emissions from fossil fuel combustion	CO_2	22.21	Fossil Fuel Combustion (Energy sector, Emissions Related to Fuel Use)	CO_2 FFC Module	IPCC factors used in SIT tool; EPA EI uses fuel consumption whereas SIT uses energy consumption

Source	Gas	2017 MS Emissions in SIT (MMT CO_2-e)	Corresponding IPCC Categories (USEPA 2023b)	Corresponding Modules in EPA SIT tool	Consistency between EPA inventory and SIT tool
CH_4 and N_2O emissions from fuel combustion	CH_4, N_2O	0.22	Mobile non-CO_2 emissions (Energy sector)	Mobile Combustion Module	IPCC factors used in SIT tool; EPA EI uses fuel consumption for all mobile sources whereas SIT uses vehicle miles traveled for highway and alternative fuel vehicle mobile combustion
Substitution of ODS	PFCs, HFCs	0.47	Substitution of Ozone-Depleting Substances (Industrial Process and Product Use sector)	Industrial Processes Module	SIT does not further allocate the emissions from substation of ODS to individual sectors such as transportation sector

The CO_2 FFC module in the SIT estimates CO_2 emissions from the transportation sector using fuel consumption data. The CO_2 emitted from fossil fuel combustion depends on the type and amount of fuel consumed, the carbon content of the fuel, and the fraction of the fuel that is oxidized. The fossil fuel combustion module includes coal, natural gas, and petroleum fuels as consumed by the transportation sector. The module follows the methodology of EPA's GHG Inventory by State. The fuel consumption is multiplied by the carbon content coefficients for each fuel and converted into MMT of CO_2-e, same as the calculations of emissions from fossil fuel combustion estimated for other sectors.

The mobile combustion module is used to estimate CH_4 and N_2O emissions (non-CO_2 GHG emissions) from highway vehicles, aviation, boats and vessels, locomotives, other non-highway sources, and alternative fuel vehicles. Emissions from mobile sources are estimated using activity data, information on the combustion technologies used, and information on the type of emission control technologies used during and after combustion. For highway vehicles, non-CO_2 GHG emissions are based on vehicle miles traveled (VMT) across seven classes of vehicles using the Federal Highway Administration (FHWA) vehicle classification; emissions for the remaining transportation types are based on fuel consumption.

As discussed previously and in Table 4-19, SIT does not provide sector-specific calculations on the emissions from substitution of ODS. The emissions from substitution of ODS for the transportation sector therefore were calculated using fractions of emissions for the transportation sector in the GHG Inventory by State (while the total emissions were calculated using the SIT).

The total emissions from the Transportation sector are 22.90 MMT CO_2-e. This accounts for about 31% of the total GHG emissions from the state of Mississippi. As presented in Table 4-19, CO_2

emissions from fossil fuel combustion are substantially greater than CH_4 and N_2O emissions from fuel combustion and the emissions from substitution of ODS.

4.3.2.2 Evaluation of Methods Used for the GHG Emissions from Transportation

EPA considers the SIT to be of acceptable quality to establish a statewide baseline estimate of GHG emissions. The SIT was developed with EPA's Emissions Inventory Improvement Program (EIIP) to give users the ability to estimate GHG at the state level.

There are uncertainties associated with the parameters and as well approaches used by the SIT to estimate CO_2 emissions from the transportation sector. Using fuel use to evaluate GHG emissions from the transportation sector introduces uncertainties because such calculations are based on the assumptions that (a) all fuel combusted in different vehicle classes falls within similar emission ranges and (b) all fuel purchased in the state is used in the state. Furthermore, emissions from international bunker fuels are difficult to calculate and report at the state level; the approach of not subtracting emissions from international bunker fuels may overestimate the emissions of these fuels. Uncertainties associated with carbon content and oxidation efficiencies are relatively low in comparison, because the carbon content of each fuel type (with the exception of coal) does not vary significantly from state to state.

The methodology used by SIT to estimate CH_4 and N_2O emissions consists of multiplying an activity level by an emissions factor. There are uncertainties associated with each parameter of estimating CH_4 and N_2O emissions, as follows:

1. VMT, because the data is collected annually by the FHWA from each state, and the methods used to gather VMT data may vary across states. This leads to varying degrees of uncertainty associated with state activity data. Additionally, the VMT data are apportioned among vehicle types based on national averages rather than state-specific data. This increases uncertainty because of state-specific differences in consumer preferences for vehicle types.

2. Emissions factors for highway vehicles, because they are developed from inputs such as ambient temperature, vehicle speeds, and gasoline volatility, which can vary due to driving conditions, vehicle characteristics, etc.

3. Fuel consumption data, because it is gathered at the national level and apportioned to states.

4. Emissions factors for non-highway vehicles, because little research has been done regarding these modes, and technologies and vehicle characteristics have changed since these factors were originally developed.

4.3.2.3 Evaluation of the GHG Emission Results

The transportation inventory results from the SIT were compared to other data sources to evaluate its reliability and determine areas for refinement in order to better develop a comprehensive inventory. This section highlights potential inconsistencies or uncertainties in data sources and calculation methods between the SIT and the US EPA's National Emissions Inventory (NEI). The NEI is a nationwide estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants from air emissions sources. Emissions estimates are compiled within the Emission Inventory System (EIS) and consolidated into three categories for the transportation sector: nonpoint, on road mobile, and nonroad mobile. EPA staff collaborates with state, local, and tribal (SLT) air agencies to estimate air emissions for each NEI, with additional data coming from the Toxics Release Inventory (TRI) and the Greenhouse Gas Reporting Program (GHGRP).

Given that the NEI relies on SLT agencies to provide emissions data, user error may yield uncertainty as assumptions are made concerning the reliability of SLT-input data. In the NEI, the transportation emissions include (a) vehicles transporting goods or people, e.g., highway vehicles, aircraft, rail, and marine vessels, and (b) other nonroad engines and equipment (such as lawn and garden equipment, construction equipment, engines used in recreational activities, and portable industrial, commercial, and agricultural engines). EPA generates a comprehensive set of mobile source emissions data for criteria and hazardous air pollutants, and GHGs for all states, Puerto Rico, and the U.S. Virgin Islands as part of the NEI. EPA uses models to estimate emissions for most of the mobile source categories. EPA has conducted several checks and quality assurance procedures to reduce uncertainties.

Some discrepancies between the NEI and SIT may exist related to the point source emissions of the transportation sector. Specifically, the NEI does not include stationary or point sources in the transportation sector, including emissions from landing and take-off of aircrafts, ground equipment supports at airports, and locomotive emissions in railyards. These point emission sources may be included for the SIT calculations. To avoid potential uncertainties in future comprehensive emissions inventories for Mississippi, the MDEQ may opt to include or exclude such point emission sources.

The results of GHG emissions from the NEI are presented in Table 4-20.

Table 4-20. GHG emissions estimated for transportation sector from the NEI.

Source	2017 MS Sum of Emissions (tons)	2020 MS Sum of Emissions (tons)	Percent change from 2017 to 2020
Mobile - Non-Road Equipment - Diesel	1,288,666.00	1,308,860.00	+2%
Mobile - Non-Road Equipment - Gasoline	391,677.00	400,754.57	+2%
Mobile - Non-Road Equipment - Other	154,341.00	166,979.35	+8%
Mobile - On-Road Diesel Heavy Duty Vehicles	7,154,466.00	6,159,191.13	-14%
Mobile - On-Road Diesel Light Duty Vehicles	607,360.00	579,368.55	-5%
Mobile - On-Road Non-Diesel Heavy Duty Vehicles	333,125.00	557,476.14	+67%
Mobile - On-Road Non-Diesel Light Duty Vehicles	16,278,013.00	15,278,932.95	-6%
Mobile - Aircraft	32,337.00	Not applicable	Not applicable

Source	2017 MS Sum of Emissions (tons)	2020 MS Sum of Emissions (tons)	Percent change from 2017 to 2020
Mobile - Commercial Marine Vessels	Not applicable	233,880.50	Not applicable
Mobile - Locomotives	Not applicable	373,073.46	Not applicable
Total	**26,239,985.00**	**25,058,516.65**	**-5%**

As presented in Table 4-20, total GHG emissions from transportation decreased 5% from 2017 to 2020. Decreases in the total transportation GHG emissions between these two years may be due to changes in behavior during the COVID-19 pandemic and associated closures. Further uncertainties were identified when comparing 2017 emissions data to 2020:

- 2017 data collection did not include commercial marine vessels and locomotives, which are included in 2020. Given that these sources accounted for just 2% of transportation emissions in 2020, the range of uncertainty is low.
- 2020 data collection did not include aircraft, which are included in 2017. Given that aircraft accounted for just 0.1% of transportation emissions in 2017, the range of uncertainty is low.

4.3.2.4 Top 10 Counties of Transportation Emissions

Transportation behavior varies across the state, and to develop and evaluate potential GHG reduction measures it is necessary to evaluate the transportation sector in a more refined manner. Since transportation emissions are associated with the location of transportation infrastructure and not necessarily of population, it is important to look at geographic areas and to not only focus reduction measures on higher population centers. Figure 4-4 shows the GHG emissions from the 2017 NEI inventory for MS allocated by county, along with the locations of major roads. The darker shaded counties account for higher GHG emissions.

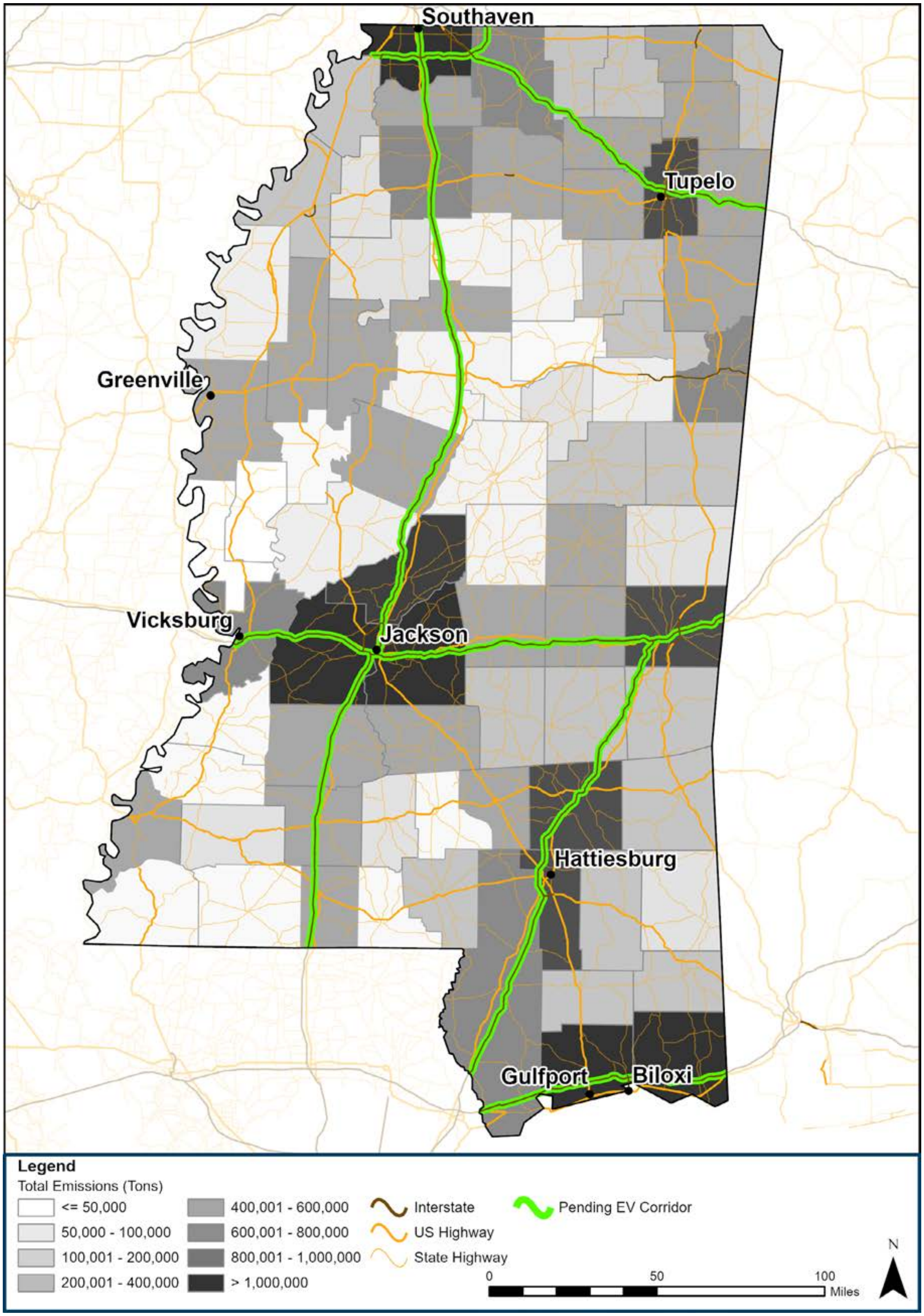


Figure 4-4. 2017 NEI transportation GHG emissions by county with major roadways

In general, the highest emissions are located near and around the major metropolitan areas. However, several rural counties fall within the top ten counties (Figure 4-4).

To evaluate where the greatest opportunity for transportation emission reduction exists in Mississippi, county level emissions were evaluated (Figure 4-4). Whereas urban counties may address emissions through expanding public transportation access and electrifying fleets, increasing pedestrian accessibility, etc. to mitigate single-occupancy vehicle travel, non-urban areas can experience high GHG emissions from through traffic, i.e., traffic initiated and terminated at points outside the county.

Transportation corridors are created across both urban and rural areas due to commuting of single-occupancy vehicles; the disparity of consumer resources, health, and other public services in rural areas; freight transport; and more. Therefore, it is necessary to consider emissions from the transportation sector in conjunction with population density, urban vs. rural status, low income and disadvantaged communities, etc., to best refine emissions and identify areas for improvement.

The NEI results of transportation emissions for the top 10 counties are presented in Table 4-21.

Table 4-21. GHG emissions estimated for the transportation sector from the top 10 counties according to the NEI.

County	2017 MS Sum of Emissions (tons)	2020 MS Sum of Emissions (tons)	Percent change from 2017 to 2020
DeSoto	1,259,881.00	1,297,413.59	+3%
Forrest	632,016.00	661,714.98	+5%
Harrison	1,686,068.00	1,582,737.55	-6%
Hinds	2,044,324.00	1,729,485.06	-15%
Jackson	1,317,915.00	1,342,721.54	+2%
Jones	627,353.00	657,045.56	+5%
Lauderdale	728,412.00	762,455.36	+5%
Lee	764,702.00	755,457.57	-1%
Madison	956,044.00	889,254.76	-7%
Rankin	1,322,400.00	1,274,750.68	-4%
Total	**11,339,115.00**	**10,953,036.66**	**-3%**

Harrison, Madison, and Rankin counties account for the majority of decreases in transportation GHG emissions from 2017 to 2020 at a 26% decrease; these counties make up the Jackson metropolitan area and accounted for 34% of statewide transportation emissions in 2020. This decrease of GHG emissions is indicative of changes in shipping, commuting, and other transportation reflecting reduced activity during the COVID-19 pandemic. NEI data for 2020 found that gasoline highway vehicles accounted for 55% of total mobile source emissions in the state, (i.e., passenger trucks and cars). Telecommuting during the COVID-19 pandemic reduced commutes by gasoline highway vehicles and impacted GHG emissions as a result, especially in metropolitan areas such as Jackson. Behaviors following the initial stages of the COVID-19 pandemic have reverted in recent years and can be expected to yield an impact on GHG emissions from transportation in future data collections.

4.3.2.5 Priority List for Reducing GHG Emissions in the Transportation Sector

The top 10 counties with the most transportation emissions for the baseline year 2017 consist of two primary emissions sources: on-road non-diesel light duty vehicles and on-road diesel heavy duty vehicles. These two sources account for at least 89% of all transportation emissions in the top 10 counties of Mississippi.

On-road non-diesel **light duty vehicles** include ethanol and gasoline fueled highway vehicles; this category accounts for at least 60% of GHG emissions from the transportation sector in each of the top 10 counties.

On-road diesel **heavy duty vehicles** include diesel highway vehicles; this category accounts for at least 23% of GHG emissions from the transportation sector in each of the top 10 counties.

The baseline year 2017 NEI data provide details on the pollutant and sector of emissions, whereas in more recent years the NEI has provided details on source classification code (SCC) levels two and three, which are defined as follows:

- SCC level two: highway vehicles by fuel type, off-highway vehicles by fuel type, commercial marine vessels, pleasure craft, railroad equipment, and other combustion.
- SCC level three: type of vehicle source, such as passenger cars, passenger trucks, motorcycles, school buses, etc.

Given that the ranking of the top 10 emitting counties for 2017 is the same as 2020, NEI data for GHG emissions from transportation in 2020 was supplemented to provide insight on priority emissions sources. According to 2020 NEI data, the highest single emissions source for each of the top 10 counties was gasoline highway vehicles and the second was diesel highway vehicles. Additionally, non-diesel light duty vehicles (i.e., passenger cars and trucks) make up 68% of all on-road vehicles and are the primary Emissions Inventory System (EIS) sector source of GHG emissions in the state at 61% of total GHG emissions from the transportation sector. Diesel heavy duty vehicles make up 27% of all on-road vehicles and account for the second most emissions at 25% of total GHG emissions in the transportation sector.

Reduction in emissions from transportation in Mississippi relies on reducing vehicle miles traveled and increasing transportation efficiencies. The following priority items were determined given the NEI GHG emissions data for 2017 and 2020:

Hinds, Rankin, and Madison counties are part of the Jackson metropolitan area. Harrison and Jackson counties are part of the Gulfport-Biloxi metropolitan area. For these counties surrounding urban centers, the following priority items may best reduce GHG emissions from transportation:

1. Improving public transportation network, infrastructure, and accessibility
    a. Access to public transportation may reduce overall travel, single-occupancy trips, and congestion. Reliable and frequent transit service is needed to increase ridership and reduce emissions from single-occupancy trips.

2. Reducing vehicle miles travelled
    a. Improving bicycle lanes and pedestrian infrastructure may reduce commuter travel and single occupant trips.
    b. Increasing freight and passenger transportation by rail

3. Public fleets transitioning to alternative-fuel vehicles and EV
    a. Clean school bus program
    b. Port and other distribution/drayage or fleets transitioning to ZEV
    c. Incentives for efficient vehicles

4. EV infrastructure
    a. Expanding EV infrastructure access may encourage purchasing of EVs and reduce GHG emissions from consumer vehicles.
    b. Adding EV charging infrastructure along interstates may help facilitate MHD battery electric vehicle (BEV) adoption

5. Reduce idling of public fleets

DeSoto county is not classified as an urban area according to 2020 US Census Bureau data. High GHG emissions are likely from through traffic, i.e., traffic initiated at and traveling to points outside the county.

1. Expanding broadband
    a. Expanding broadband may give rural communities access to e-commerce and telecommuting, which reduces overall transportation demand.

2. State policy that allows for hybrid workplaces and telecommuting
    a. A state policy that allows and encourages hybrid workplaces with reduced or staggered in-office days for public employees may reduce travel, single occupant trips, and congestion; additionally, this may cut energy use in public buildings.

3. Increase efficiencies of freight transport
    a. Reduces emissions from diesel transport trucks
    b. Promote rail for cargo

4. Regional transit connectivity
    a. Encourage more use of public transit across state and connects communities to jobs/services -- Dedicated bus lanes and HOV lanes can encourage transit use and carpooling

4.3.3 Agriculture: Soil Management, Enteric Fermentation, Rice Cultivation

A comparison of GHG emissions for agriculture sector between the SIT and EPA's GHG Inventory by State is presented in Table 4-22.

Table 4-22. GHG emissions (MMT CO_2-e) from the state of Mississippi as calculated by the SIT and GHG Inventory by State for the year of 2017.

Sources of Emissions	SIT 2017	GHG Inventory by State
Enteric Fermentation	1.743	1.7
Manure Management	1.031	0.6
Agricultural Soils	3.456	3.1
Rice Cultivation	0.316	1.0
Liming	0.041	NO
Urea Fertilization	0.051	0.1
Agricultural Residue Burning	0.004	0.0
TOTAL	**6.642**	

The different sources of emissions in agriculture each require a distinct model to estimate GHG emissions, thus, each subsector requires different data inputs to calculations (Table 4-23).

Table 4-23. Sources of GHG emissions considered and data and methods used to estimate these emissions in agriculture sector.

Module Worksheet	Data Required	Gas(es)
Enteric Fermentation	Emission Factors by Animal Type Animal Population Numbers	CH_4
Manure Management-CH4 Manure Management-N_2O	Typical Animal Mass (TAM) Volatile Solids (VS) Production Maximum Potential CH_4 Emissions (Bo) Kjeldahl (K) Nitrogen Excreted* Animal Population Numbers	CH_4, N_2O
Agricultural Soils-Plant-Residues & Legumes Agricultural Soils-Plant-Fertilizers Agricultural Soils- Animals	Residue Dry Matter Fraction Residue Applied Nitrogen Content of Residue Kjeldahl (K) Nitrogen Excreted Crop Production Fertilizer Utilization TAM*	N_2O
Rice Cultivation	Seasonal Emission Factor Area Harvested	CH_4

Module Worksheet	Data Required	Gas(es)
Liming of Soils	Emission factors for CO_2 emitted from use of crushed limestone and dolomite (ton carbon/ton limestone) Total limestone and dolomite applied to soils (MT)	CO_2
Urea Fertilization	Emission factors for CO_2 emitted from the use of urea as a fertilizer (tons carbon/ton urea) Total urea applied to soils (MT)	CO_2
Agricultural Residue Burning-CH_4 Agricultural Residue Burning-N_2O	Residue/Crop Ratio Fraction of Residue Burned Dry Matter Fraction* Burning Efficiency Combustion Efficiency Carbon Content Nitrogen Content	CH_4, N_2O

Below is a short analysis of the methodologies used to estimate state and local emissions from the agricultural sector. This analysis is focused on the SIT provided by EPA.

4.3.3.1 Enteric Fermentation

Enteric fermentation is one of the largest emitters of GHG from the agricultural sector. The Tier 2 models used to calculate emissions from enteric fermentation are applicable to dairy and beef cattle. Emissions from the enteric fermentation process from other livestock follow a Tier 1 methodology. New methodologies for a Tier 2 approach to calculate emissions from the enteric fermentation of poultry and other livestock such as swine and horses are being investigated. The current methodologies of the NEI/ National Inventory Report (NIR), United States Department of Agriculture (USDA) and SIT to calculate emissions from the enteric fermentation rely on the most up to date methodologies and data available for the state of Mississippi. Current methodologies for the state of Mississippi would benefit from refined data regarding animal population and feeding or grazing conditions across the state. Such refined data would be essential to assess the effectiveness of mitigation strategies related to livestock management and changes in feedlot conditions. Table 4-23 shows the total estimated emissions from the process of enteric fermentation as calculated by the SIT and the NEI/NIR.

4.3.3.2 Manure Management

Manure management is the third largest emitter of GHG from the agricultural sector. The treatment, storage, and transportation of manure from livestock emits N_2O and CH_4. Tier 1 and Tier 2 methodologies to calculate emissions from manure management from livestock operations in the state use a combination of the most recent regional data available and default climate-based conversion factors published by IPCC. Improvements can be made to refine the conversion factors and emission factors to improve the accuracy of the estimations for the state of Mississippi; these improvements require multiagency collaborations that are already being explored by EPA. In the meantime, the methodology by NEI/NIR and SIT represent the best available methodology to calculate emissions from manure management.

4.3.3.3 Agricultural Soils-Plant-Residues and Legumes Agricultural Soils-Plant-Fertilizers Agricultural Soils- Animals

Emissions of N_2O from agricultural soils include direct emissions due to cropping practices; direct and indirect emissions from soils from fertilizer application; and direct and indirect emissions from agricultural soils due to animal production. This subsector represents the largest source of GHG from the agricultural sector in the state of Mississippi. As shown in Figure 4-5 (developed by the SIT tool), emissions from agricultural soils also represent the only subsector that has shown a net increase in GHG emissions since 1990.

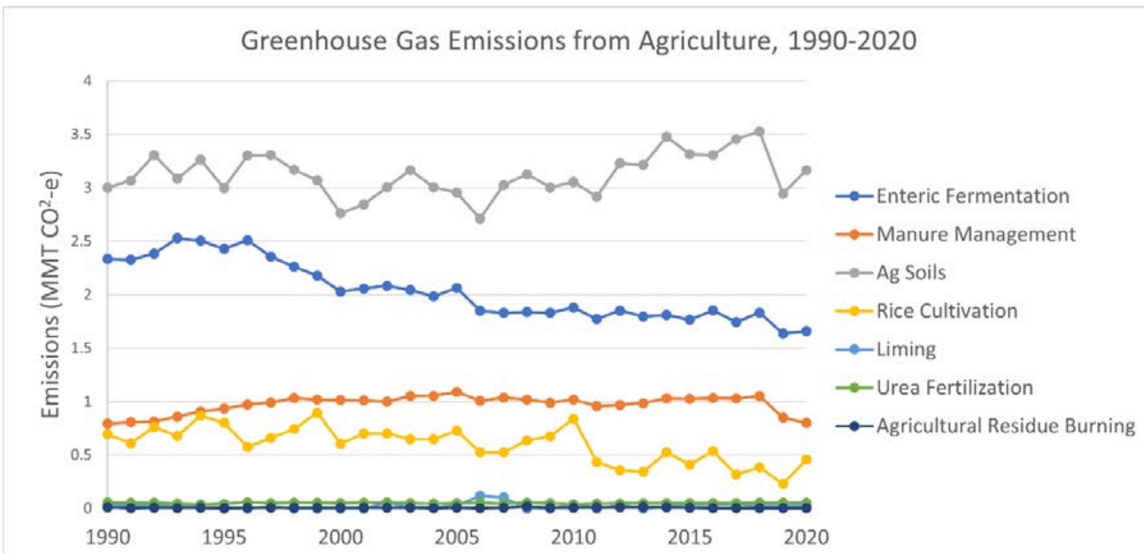


Figure 4-5. GHG emissions from agricultural sources in the state of Mississippi as calculated by the state inventory tool.

The SIT calculates emissions from Agricultural Soils with a Tier 1 methodology while the NIR/NEI use a combination of TIER 2 and TIER 3. The use of a refined methodology in NIR/NEI shows higher direct emissions from agricultural soils with 3.6 MMT CO_2-e compared to 3.1 MMT CO_2-e from using a Tier 1 methodology.

On the one hand, the SIT tool estimates emissions using activity level such as the production of each type of nitrogen-fixing crop multiplied by the residue to crop mass ratio for each crop, the residue dry matter fraction, and the nitrogen content in each crop. For forage crops, the total nitrogen input is simply calculated as the production of nitrogen-fixing forage crops multiplied by the nitrogen content of the crop. On the other hand, the NIR/NEI estimates emissions based on the process-based model DayCent that simulates the interaction of nitrogen inputs, land use, and management and environmental conditions in the state. In addition, the NIR/NEI also accounts for nitrogen stored on the ground and emitted in later years. This storage process is not considered in the SIT and will have implications for the assessment of future emission reduction strategies. The retention of crop residues in the field for nitrogen-fixing legumes and non-legume crops and subsequent mineralization of nitrogen during microbial decomposition reduces N_2O emissions, whereas, burning or collecting residues are the largest source of N_2O from the agricultural sector in the state (Table 6). Therefore, the retention of nitrogen and future emissions of N_2O that are dependent on agricultural residue management practices and weather conditions are not represented in the SIT. In summary, reductions of N_2O from agricultural soils will not be appropriately represented if the SIT is to be used to estimate emission reductions due to improvement in management practices.

4.3.3.4 Rice Cultivation

Emissions of GHG from rice cultivation are caused by anaerobic conditions in the flooded rice paddies. The main climate pollutant emitted by rice paddies is CH_4. As shown in Figure 4-6, the Mississippi River basin is the largest area of CH_4 emissions (converted to CO_2 eq) from rice cultivation in the nation.

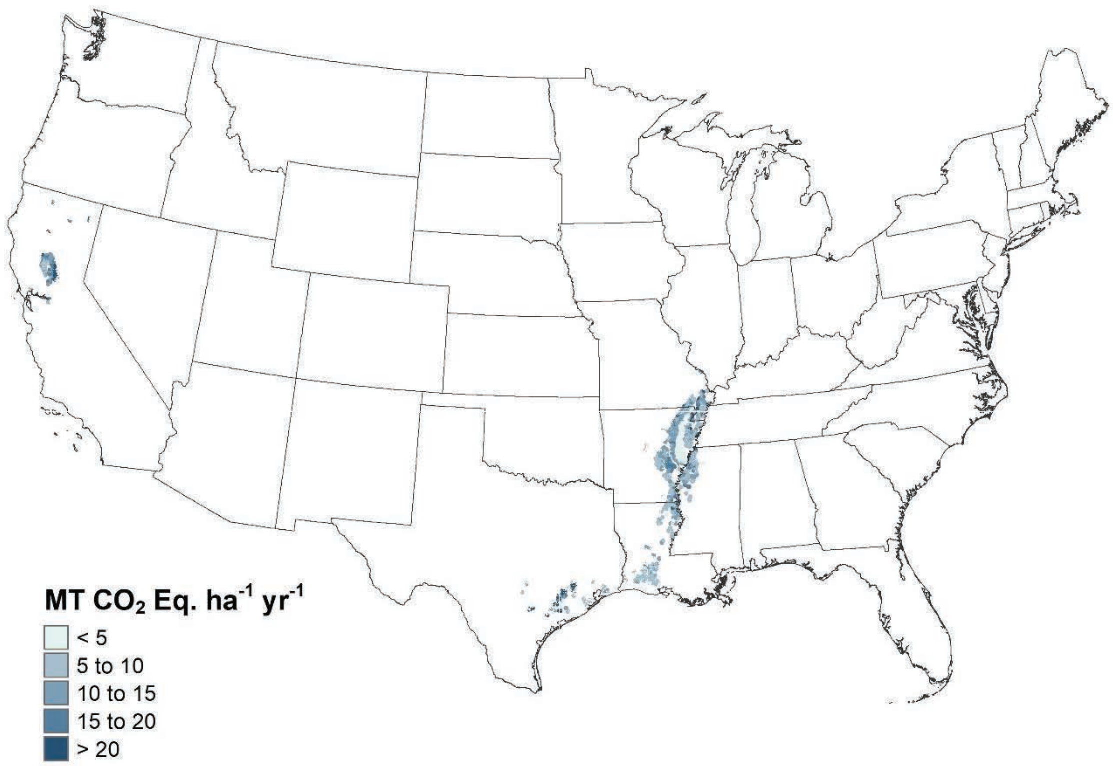


Figure 4-6. Annual CH_4 Emissions from Rice Cultivation, 2015.
Source: Inventory of U.S. GHG emissions and Sinks 1990-2019.

The methodology in the SIT to estimate GHG emissions from rice cultivation uses a seasonal emission factor for primary and ratoon crops. The SIT estimates emissions from rice cultivation as 0.316 MMT CO_2-e for the year 2017 when using default values. Like the N_2O emissions from agricultural soils, the SIT methodology does not account for crop management, rotation with other non-flooding crops, or ratooning practices. In turn, the NEI/NIR simulates emissions with the use of the DayCent process-based model. The NEI/NIR only uses DayCent for crops that are continuously used as flooded rice paddies. Crop rotation hasn't been tested with the use of DayCent. When rice cultivation is simulated using the DayCent process-based model, the resulting emissions are almost twice the emissions calculated by the SIT (1.12 MMT CO_2-e). In summary, reductions of GHG from rice cultivation will not be appropriately represented if the SIT is to be used to estimate the emission reductions due to improvement in management practices in continuously flooded rice paddies. The GHG emissions estimation would benefit from incorporating and testing the DayCent model with rotating non flooded crops. Additionally, emissions estimated for the year 2017 with the DayCent model were interpolated from previous years due to the lack of data after 2015. GHG estimations would also benefit from updated 2017 data for the state of Mississippi, including winter flooding data which accounts for an estimated 50% of the GHG emissions from rice paddies.

4.3.3.5 Liming of Soils

The Tier 2 methodology used to estimate GHG emissions from lime of soils in the SIT is the same as the methodology used in the NEI/NIR. The methodologies and data used to estimate GHG from Liming of soils used the most up to date activity data and emission factors. The emission factors that are used to estimate GHG emissions from Liming of soils in the United States has been developed with studies performed in the lower Mississippi river basin.

4.3.3.6 Urea Fertilization

The Tier 1 methodology used to estimate GHG emissions from lime of soils in the SIT is the same as the methodology used in the NEI/NIR. The methodology used to estimate emissions from urea fertilization utilizes the most up to date emission factors. The annual amounts of urea applied to croplands were derived from the state-level fertilizer sales data provided in Commercial Fertilizer reports however no data was available for 2017. Therefore, urea application in the 2016 through 2019 fertilizer years were estimated using a linear, least squares trend of consumption over the data from the previous five years (2011 through 2015) at the state scale. The GHG emissions estimations from urea application would benefit from local and regional data regarding fertilizer sales.

4.3.3.7 Agricultural Residue Burning-CH_4 Agricultural Residue Burning-N_2O

A Tier 2 country specific method is used to estimate the GHG emissions from agricultural burning. The data is based on 1990 to 2014 agricultural residue to interpolate for 2015 to 2019. The crop production, residue and area are available for all the contiguous United States for 1990 to 2014 and further interpolation was needed to estimate crop data for 2017. The NEI/NIR and the SIT both use the IPCC 1997. According to the NEI/NIR, "*The rationale for using the IPCC/UNEP/OECD/IEA (1997) approach rather than the method provided in the 2006 IPCC Guidelines is as follows: (1) the equations from both guidelines rely on the same underlying variables (though the formats differ); (2) the IPCC (2006) equation was developed to be broadly applicable to all types of biomass burning, and, thus, is not specific to agricultural residues; (3) the IPCC (2006) method provides emission factors based on the dry matter content rather emission rates related to the amount of carbon and nitrogen in the residues; and (4) the IPCC (2006) default factors* *are provided only for four crops (corn, rice, sugarcane, and wheat) while this Inventory includes emissions from twenty-one crops*". Agricultural residue burning is not as large of a source of GHG as other activities considered in the agricultural sector; however, 2017 local and regional crop data would benefit the estimation of emissions and the assessment of emission reductions.

4.3.3.8 Summary on the Review of Agriculture Sector

The GHG emissions from the agriculture sector calculated by the SIT use a combination of Tier 1, Tier 2, and Tier 3 methodologies. With the exceptions of N_2O from ag soils and rice cultivation, the methodologies considered in the SIT are used throughout diverse emission inventories such as the NEI/NIR and USDA. However, all emission inventories would benefit from local and regional data for 2017 and, as proposed in the NEI, improvements in the methodologies used by DayCent such that all agricultural activities with local and regional data are incorporated and synchronized. Better methodologies with DayCent will provide holistic improvements resulting from better management practices that take place across agricultural activities.

4.3.3.9 Commercial and Residential Buildings

Three emission sources for commercial and residential buildings as included in the EPA Sources and Sinks inventory and the SITs. These included CO_2 from fossil fuel combustion, CH_4 and N_2O from stationary combustion, and the substitution of ODS. The category "*CO_2 from fossil fuel combustion" accounts for the combustion of coal, distillate fuel, kerosene, hydrocarbon gas liquids (i.e., propane), natural gas, and other fuels. Similarly, the "Stationary Combustion*" emissions are a product of the same fuel-use cases, however it estimates GHG emissions from CH_4 and N_2O. Finally, the "Substitution of ODS" derives emissions from the substitution of ODS materials in refrigeration units, chillers, HVAC equipment, and propellant used in spray foam insulation and fire suppressants. This includes HFC and PFC refrigerant gases which have GWPs ranging from approximately 90 – 23,500.

4.3.3.10 CO_2 from Fossil Fuel Combustion

The approach for determining national-level FFC emissions is based on Tier 2 bottom-up methodology. This is a hybrid approach where state-level data were used when available and in cases where state-level data were not available, national-level estimates were used with available surrogate data to determine state-level percentages of each fuel use. The EPA uses EIA Monthly Energy Reviews (MER) and EIA State Energy Data Systems to collect activity data. EIA data is collected through data surveys from energy suppliers that report consumption, sales, or distribution of energy at the state level. Therefore, the totals are highly dependent on the quality of the data provided to EIA. Those data are broken out by fuel type and sector (residential, commercial, industrial, transportation, and electric power) and are available for the years 1960–2020. The sum of the state estimates is equivalent to the national totals for each energy type and end-use sector, and energy consumption estimates are generally comparable to the national statistics in EIA's MER because both datasets rely largely on the same survey returns for producers and consumers.

However, the totals from SEDS do not always align with the U.S. total energy data used in the national inventory. Consequently, an alternative approach was employed to ascertain fuel use by type and sector at the state level:

1. If SEDS data totals matched national totals without requiring further adjustments, the SEDS data were directly used to represent state-level energy consumption.

2. For fuels with unmatched SEDS and national totals (e.g., coal, natural gas, and petroleum coke), fuel use in each sector was adjusted to align with the national totals used in the national Inventory. This adjustment was based on the percentage of each fuel used in each state, as indicated by the SEDS data. In the industrial sector, this adjustment was made after subtracting uses in the IPPU sector.

3. For other fuels with unmatched sector totals (e.g., gasoline and diesel fuel), the totals for each fuel type were generally adopted from the national Inventory, and the SEDS data or other proxy data sources were utilized to determine state-level percentages of each fuel consumption.

Infrastructure-based fuels should be fairly accurate due to metering and rate structures for different end uses: commercial, residential, industrial. Delivered fuels (distillate oil, LPG, wood) may be more difficult to track depending on the records kept from distributors and the quality of survey responses.

Therefore, EPA used a hybrid approach when needed, using state-level data when available and if not available, using national-level estimates and available surrogate to determine state-level percentages for each fuel use. The levels of uncertainty for the national estimates in 2020 for FFC were 2% - 4% for CO_2. It is assumed that there is 100% combustion efficiency resulting in all Carbon converted to CO_2 which is an ideal case resulting in maximum potential of CO_2 emissions. The national level Carbon-content is used for all fuels which appears appropriate for MS since most of the fuel used is natural gas (95% for residential and 75% for commercial) and distillate fuel (14% for commercial). Wood may have varied carbon content but only accounts for 5% of residential fuel use.

4.3.3.11 CH_4 and N_2O from Stationary Combustion

CH_4 and N_2O from stationary combustion includes four fuel types: coal, fuel oil, natural gas, and wood. The EPA used the Tier 1 and Tier 2 methods along with the EIA MER and SEDS data to determine emissions from stationary combustion. For most categories, a Tier 1 approach was used, which multiplies the adjusted activity data on fuel use by default emissions factors to determine emissions. Otherwise, national level emissions for all sectors were allocated across states based on the same percentage as CO_2 emissions from those sectors and fuel types. For the residential, commercial, and industrial sector, it is reasonable to assume non-CO_2 emissions by fuel type would be proportional to CO_2 emissions across states because the fuel use activity data are the same and only one non-CO_2 emissions factor was applied per fuel type per category for each gas.

4.3.3.12 Substitution of ODS

EPA used the Vintaging Model to estimate national use, banks, emissions, and transition of ODS-containing equipment and products to substitutes, including HFCs and PFCs. Emissions for each end-use were estimated by applying annual leak rates and release profiles, which account for the lag in emissions from equipment as it leaks over time. The model uses a Tier 2 bottom-up modeling methodology to estimate emissions; however, a hybrid approach was used applying population data as a proxy while incorporating data provided at a finer geographical distribution. The levels of uncertainty for national estimates in 2020 for ODS were -3.4% to +14%. Data inaccuracies arise from the challenges in collecting data and characterizing use. The vintaging model is used to track equipment and products sold each year as well as the anticipated leak rates and release profiles from maintenance.

4.3.4 Industry

4.3.4.1 General Methodology Used by the SIT to Estimate GHG Emissions of Industry Sector

Emissions for the industry sector mainly include (1) GHG emissions from fossil fuel combustion, and (2) a summation of the GHG emission from industrial processes. Several SIT modules were used to calculate these emissions for industry sectors: FFC, Industrial Processes, Natural Gas and Oil, Coal Mining, and Stationary Combustion modules.

To calculate CO_2 from FFC in the industrial sector, the following steps are taken:

- The CO_2 emissions from non-energy consumption multiplied by carbon storage factors are removed for each fuel type;
- The result is multiplied by a carbon content coefficient that is appropriate for each fuel type and the percentage of carbon oxidized during combustion ('combustion efficiency');
- The results are converted in various steps to MMT CO_2-e and totaled.

For the Industrial Processes module, various industrial processes were evaluated, as shown in Table 1. A breakdown of the processes evaluated is presented below:

- Iron and Steel Production emissions estimates are from process-related emissions. The default values used are based state -level production assigned to production method (based on the national method);
- The substitution of ODS is estimated using national level data and apportioning estimates based on population; therefore, emission factors and activity are not required for use in the SIT;
- Ammonia production and Urea consumption are both calculated using the amount of ammonia produced and appropriate emission factors for each process;
- Limestone production emission estimates are derived from the consumption of limestone in industry. The consumption is multiplied by appropriate emission factors.

Limestone consumption in the industrial sector consists of flux stone production, glass manufacturing, and flue gas desulfurization; and

- Soda ash production emission estimates are calculated by multiplying the quantity of soda ash consumed by respective emission factors.

The four remaining sources where GHG emissions were evaluated are presented below:

- Natural gas systems emission estimates are calculated using the emissions from the following sources in Mississippi: on-shore wells, off-shore shallow water platforms, and offshore deepwater platforms. Site-specific emission factors are used to emissions are summed across the three sources;
- Oil (petroleum) systems emission estimates, like natural gas systems, are calculated using the sum of three sectors – production, refining and transportation. Oil consumed is used with appropriate emission factors and summed across the three sources;
- Stationary Combustion emission estimates are estimated using a Tier 1 approach, similar to the emission estimates of CO_2 from FFC. For both GHGs (N_2O and CH_4), non-energy consumption is subtracted from energy consumption by fuel type. Appropriate emission factors are used and the results are multiplied by the GWP and summed.
- Coal Mining emission estimates are performed using the emissions from underground mines, surface mines, and post-mining activities. Emissions from underground mines are associated with CH_4 emitted from both ventilation systems and CH_4 emitted from degasification systems. Surface mine emissions are the product of a coal mine production and appropriate emission factors. Emissions from post-mining activities are estimated from the emissions from transportation and coal handling and use the coal production multiplied by a basin and appropriate emission factor.

Compared to the SIT, the EPA's GHG Inventory by State takes a top-down approach using national level data and statistics to provide a comprehensive picture of GHG emissions from man-made sources in the US, including the industry process and product use (IPPU) sector. For the IPPU sector, this approach covers both large and small emitters and includes emissions from mineral sources, chemical, metals, and product use. Also included in the emission estimates are those emissions associated with energy use and waste. The general approach taken when estimating state-level emissions from the IPPU sector was the Approach 2 Method, meaning the estimates were disaggregated from national level estimates using a variety of indicators (such as population, production capacity, or the GHGRP). This approach was taken on the majority of the IPPU sector with the remaining IPPU sectors taken the Approach 1 (applying national methods directly to more geographically disaggregated data) or a Hybrid Approach (a combination of Approaches 1 and 2). Approach 2 was used more frequently as the data needed for Approach 1 was not readily available and/or was incomplete.

For the industry sector, approximately nine of the source categories that were presented in the National Inventory are also presented in the SIT. In general, the SIT and the National Inventory present similar data, with the largest difference in CO_2 from FFC. As previously described, the SIT estimates approximately 10.85 MMT CO_2-e, from FFC, the National Inventory estimated 9.5 MMTCO_2-e from FFC, as shown in Table 4-24.

Table 4-24. A comparison between the estimates from the EPA GHG Inventory by State and the results from the SIT.

GHG Source	Emission Estimate from National Inventory (MMT CO_2-e)	Emission Estimate from SIT (MMT CO_2-e)
Ammonia Production	0.4	0.411
Nitric Acid Production	1.3	0.000
CO_2 from FFC	9.5	10.850
Stationary Combustion	0.1	0.101
Coal Mining	0.1	0.079
Natural Gas Systems	2.1	0.490
Petroleum Systems	0.2	0.230
Total	**13.7**	**12.16**

The following subsections outline the sources where emission estimates were provided in the National Inventory. The descriptions provide the approach taken, the factors considered, and the uncertainty levels for each sector. The year evaluated was for 2017.

4.3.4.2 Mineral Sources

The following mineral sources were evaluated in the national inventory: cement production, lime production, glass production, other process uses of carbonates and CO_2 consumption. A total of 0.1 MMT CO_2-e was estimated to be generated from the mineral sector, all emitted from other process uses of carbonates. To define other process uses of carbonates, the National Inventory calculated emission estimates associated with heating of the material to calcine it and emit CO_2 as a by-product (limestone and dolomite) and soda ash not associated with glass production. The approach taken in estimating state-level emissions from these sources was the Approach 2 method, allocating total national process emissions to all applicable US states and territories using state level consumption (limestone and dolomite) and state population or population statistics (soda ash). The overall uncertainty was in a range of -11% to +14% for CO_2.

4.3.4.3 Chemical Sources

The following chemical sources were evaluated in the national inventory: ammonia production, urea consumption for non-agricultural purposes, nitric acid production, adipic acid production, caprolactam, glyoxal and glyoxylic acid production, carbide production and consumption, titanium dioxide production, soda ash production, petrochemical production, hydrochlorofluorocarbon (HCFC)-22 production, and phosphoric acid production. A total of 2.5 MMT CO_2-e was estimated to be generated from the chemical sector, emitted from ammonia production (0.4 MMT CO_2-e), nitric acid production (1.3 MMT CO_2-e), and titanium dioxide production (0.8 MMT CO_2-e). The approach taken in estimating state-level emissions from these sources was the Approach 2 method. Process emissions reported to GHGRP were used as was the production capacity by state. The overall uncertainty for CO_2 was in a range of -4% to +4% for ammonia production, and -13% to +13% for titanium production. For N_2O, the overall uncertainty was -5% to +5% for nitric acid production.

4.3.4.4 Metal Sources

The following metal sources were evaluated in the national inventory: iron and steel production, ferroalloy production, aluminium production, magnesium production and processing, lead production, and zinc production. During the reporting year, 0.0 MMT CO_2-e were estimated to be generated from the metal sector. Reviewing the national data, either the production was not occurring or emission estimates did not exceed 0.005 MMT CO_2-e. Prior to 2016 and from 2020-2021, iron and steel production did occur with an estimated emission of 0.1 to 0.5 MMT CO_2-e. However, the remaining processes have not been occurring in Mississippi (as recorded by EPA) in the last decade.

4.3.4.5 Product Use Sources

The following product use sources were evaluated in the national inventory: electronics industry, substitution of ozone-depleting substances, electrical transmission and distribution, and N_2O from product uses. A total of 0.3 MMT CO_2-e was estimated to be generated from the product use sector, all emitted from substitution of ozone-depleting substances. The approach taken in estimating state-level emissions from these sources is Hybrid Approach, combining both the Approach 1 and Approach 2 methods. EPA gathers extensive data to use its Vintaging Model to estimate both national level and state level emission estimates. The approach uses a combination of the disaggregation of the population (assuming the state's proportion of national emissions is equal to the state's proportion of the national population) and incorporating data that is gathered on a finer geographical level. The overall uncertainty for HFC emissions was in a range of -4.2% to +14.7%.

4.3.4.6 Fossil Fuel Combustion

FFC was the highest emitter in the industry sector, accounting for a total of 9.5 MMT CO2-e. The approach in estimating state-level emissions uses emission factors and activity level data on fuel consumption, obtained from the EIA's MER. The information is broken out by fuel type and energy consuming sectors (residential, commercial, industrial, transportation, and electric power). Adjustments are made to the estimates to adjust for emissions that are accounted for elsewhere in the national inventory. A hybrid approach was used to determine state-level emissions for FFC by taking data directly from national-level data/ from the EIA and adjusting it to state-level emissions or taking data from directly from industry. The overall uncertainty for CO_2 emissions was in a range of -2% to +4%.

4.3.4.7 Coal Mining

During RY2017, approximately 0.1 MMT CO_2-e were estimated to be generated from coal mining. Estimations of emissions from coal mining comes from the following activities: underground mining, surface mining, and post mining. The approach taken in estimating state-level emissions from underground mines uses an Approach 1 method where the EPA develops emission estimates for each mine and totals the mine-specific estimates to obtain a state-level total. Underground coal mining emissions come from ventilation systems or degasification systems. To estimate net emissions, the CH_4 that is recovered and used is accounted for and subtracted from the total to estimate net emissions released to the atmosphere. To estimate emissions from surface mining and post-mining activities, the EPA uses data from the EIA (Annual Coal Report) to obtain basin-specific coal production data as mine-specific data is not available. Using the data from the EIA, and conservative emission factors and gas contents, emissions estimates are apportioned based on coal production by each state. The overall uncertainty for CO_2 was in a range of -68% to +76% for and for CH_4 the overall uncertainty was -10% to +22%.

4.3.4.8 Natural Gas and Petroleum Systems

During RY2017, approximately 2.3 MMT CO_2-e were estimated to be generated from natural gas (2.1 MMT CO_2-e) and petroleum systems (0.2 MMT CO_2-e). Estimations of emissions from these two systems comes mostly from fugitive emissions associating with leaks, venting, and flaring. Emissions from the combustion of CO_2 are not included in these estimates, except those from flaring.

To estimate emissions from petroleum systems, the EPA uses the Hybrid Approach. For petroleum systems, both CO_2 emissions and CH_4 emissions are associated with exploration, production, refining, and transportation (CH_4). In compiling emission estimates from exploration and production, national level data is now obtained from the GHGRP, from oil well counts, production levels and total crude oil production reported in the EIA. To estimate emissions from transport, the EPA uses the data from the EIA (deliveries data), from the American Petroleum Institute, and from the Oil and Gas Journal. To allocate to state-level emissions, the EPA looked at the emissions associated with venting, tanks, pump stations, and floating roof tanks, and used the known oil production from offshore wells in state waters, oil well production in each state, and oil refineries located in each state. The overall uncertainty for emission estimates from petroleum systems for CO_2 and N_2O was in a range of -13% to +19% for and for CH_4 the overall uncertainty was -10% to +15%.

For natural gas systems, fugitive emissions ($CO_{2,}$ CH_4) are estimated to be from normal operations, routine maintenance, and systems upsets. Similar to petroleum systems, the EPA estimates emissions from each segment of natural gas systems (including exploration, production, processing, transmission and storage, distribution, and post meter sources) and uses a Hybrid Approach in estimating emissions. In compiling national level emission estimates from exploration and production data is now obtained from the GHGRP, production well count data, and offshore production emissions data. The overall uncertainty for emission estimates from natural gas systems for CO_2 and N_2O was in a range of -13% to +15% for and for CH_4 the overall uncertainty was -17% to +17%.

Another tool available for estimating state-level GHG emissions from the industry sector is FLIGHT. FLIGHT summarizes the data provided to the EPA for large facilities that report on annual basis. Similar to the SIT tool, FLIGHT does not present data from every sector that the National Inventory does. However, FLIGHT does present emission estimates on a state-level and breaks out the emissions to the following sectors: power plants, petroleum and natural gas systems, refineries, chemicals, other, minerals, waste, metals, and pulp and paper. From there, the tool allows the user to refine their search by fuel type, GHG, emission range, and location (on a county level). The tool also gives the name and type of facility as well as the historic data that has been reported. When comparing the emission estimates found on FLIGHT to the other two tools previously described in this section, emission estimates for the entire sector only tend to be slightly higher than what was previously presented, as shown in Table 4-25.

Table 4-25. Sector totals of GHG emissions from GHG Inventory by State, SIT Model, FLIGHT tool.

Emission Estimate from National Inventory (MMT CO_2-e)	Emission Estimate from SIT (MMT CO_2-e)	Emission Estimate from FLIGHT (MMT CO_2-e)
15.9	15.0	17.0

4.3.5 Solid Waste and Wastewater Management

4.3.5.1 General Methodology Used by the SIT to Estimate GHG Emissions of Waste and Wastewater Sectors

The waste management sector encompasses solid waste management and wastewater treatment. The EPA SIT tool defines emissions for the waste sector through the following the two modules:

- The Municipal Solid Waste module calculates CH_4 emissions from landfilling of municipal solid waste (MSW), and CO_2 and N_2O emissions from the combustion of MSW. The two sectors within the Municipal Solid Waste module, landfills and combustion, are treated separately.
- The Wastewater module calculates CH_4 and N_2O emissions from the treatment of municipal and industrial wastewater. The industrial sectors covered are fruits and vegetables, red meat, poultry, and pulp and paper.

Table 4-25 provides a summary of the two GHG emission sources for the waste sector, along with the estimates of 2017 emissions from the EPA SIT and the methods used for the estimation in EPA inventory and EPA SIT tool. As presented in Table 4-25, CO_2-e emissions from landfills are approximately 6.5 times greater than CO_2-e emissions from wastewater.

Table 4-26. Sources of GHG emissions considered and estimated for waste sector.

Source	Gas	2017 MS Emissions in SIT (MMT CO_2-e)	Corresponding Modules in EPA SIT tool	Differences between EPA inventory and SIT tool
CH_4 emissions from landfilling of MSW	CH_4	1.91	Municipal Solid Waste module	SIT default data are based on national landfilling rates and state population. The EPA Inventory uses GHGRP data that is scaled up to account for non-reporting landfills.
CO_2 and N_2O emissions from combustion of MSW	CO_2 and N_2O	<0.01	Municipal Solid Waste module	Total GHG emissions used in EPA Inventory
CH_4 and N_2O emissions from municipal wastewater	CH_4 and N_2O	0.29	Wastewater module	-
CH_4 emissions from industrial wastewater	CH_4	<0.01	Wastewater module	SIT default data is not available for all industrial sources. The EPA Inventory allocates national emissions for each industry based on state share of national production. The EPA Inventory includes additional industries (i.e., petroleum refining, breweries, and starch-based ethanol production).

The SIT Municipal Solid Waste module follows the general methodology from the NIR GHG Inventory by U.S. State. However, municipal waste default data in SIT are based on national landfilling rates and state population, while the GHG Inventory by U.S. State uses GHGRP data that is scaled up to account for non-reporting landfills. Additionally, industrial waste SIT default data uses a percent of MSW emissions to estimate industrial landfill emissions (default is 7%), whereas the GHG Inventory by U.S. State uses production volumes of pulp & paper, fruit & vegetables, and meat, which is then multiplied by a country and sector specific disposal factor and used to calculate CH_4 emissions.

The SIT Wastewater module follows the general methodology from the NIR GHG Inventory by U.S. State. However, SIT default data are not available for all sources (e.g., fruits and vegetables, poultry, pulp & paper, ethanol refineries, breweries, and petroleum refineries).

The waste sector inventory results from the SIT were compared to other data sources to evaluate their reliability and determine areas for refinement for the PCAP. Both the solid waste and wastewater source categories use Approach 2, as described in the EPA state inventory documentation. This approach applies a top-down methodology, in which estimates are disaggregated from national-level estimates using geographic proxies or other indicators (e.g., population, production capacity, GHGRP). In the EPA state inventories, this approach was used for categories where the type of state data used in Approach 1 (applying national methods directly to at state-level data) were not available or were incomplete.

Additional reviews and evaluate on the SIT methodology of calculating GHG emissions of the waste and wastewater sectors were conducted and are discussed in the subsequent sections.

4.3.5.2 Solid Waste

The EPA inventory applies the following procedure to disaggregate the national inventory for MSW landfills for the years 2010 – 2021. The percentage of net CH_4 emissions by state (aggregated total as reported by landfills in each state to Subpart HH) is applied to the national CH_4 net emissions for each year. The state percentage approach accounts for all emissions, including those calculated by scaling up emissions to account for smaller landfills that do not report through Subpart HH.

As described in Chapter 7 of the national inventory, the levels of uncertainty in the national estimates in 2021 were −19%/+26% of the estimated CH_4 emissions for MSW landfills. State-level estimates likely have a higher uncertainty due to (1) apportioning the national emissions estimates to each state based on assumptions made to disaggregate the national emissions estimates, which are based on state percentages as reported to the GHGRP, and (2) the application of the scale-up factor to nationally compiled landfill gas recovery databases used in the national Inventory.

For municipal landfills, SIT default data are based on national landfilling rates and state population. The EPA state inventory uses GHGRP data that is scaled up to account for non-reporting landfills. To calculate CH_4 emissions from landfills, SIT uses a first-order decay model to estimate emissions. Using this model, the CH_4 emission rate is a function of the quantity of waste deposited in landfills over the previous 30 years. The national Inventory uses both the first-order decay method as well as a back-calculation method that is based on directly measured amounts of recovered CH_4 from landfills and reported to GHGRP. This leads to slight differences in emissions estimates between the EPA state inventory and SIT.

For industrial landfills, SIT uses a percent of MSW emissions to estimate industrial landfill emissions, using a default of 7%. The EPA state inventory uses production volumes of pulp and paper, fruit and vegetables, and meat which is multiplied by a country and sector specific disposal factor and then used to calculate CH_4 emissions.

Table 4-27 presents a comparison of the solid waste GHG emissions estimates from the SIT and the EPA state inventory, broken down between municipal and industrial landfills.

Table 4-27. Comparison of solid waste GHG emissions estimates from the EPA inventory and the SIT.

Source	Gas	2017 Emissions in SIT (MMT CO_2-e)	2017 Emissions in EPA (MMT CO_2-e)
Emissions from landfills (MSW)	CH4	1.91	1.7
Emissions from landfills (Industrial)	CH4	0.13	0.3
Total GHG Emissions	--	2.04	2.0

4.3.5.3 Wastewater Treatment

EPA estimated state-level domestic wastewater treatment and discharge emissions (CH_4) using a simplified approach to apportion the national emission estimates to each state based on population and state-level septic data. EPA calculated state- and territory-level emissions by multiplying the proportion of the U.S. population on centralized treatment or septic systems in each state or territory by the national CH_4 and N_2O emissions. This approach assumes the following: (1) every state has the same wastewater treatment system usage as the national inventory; (2) every state has same distribution of discharge to various waterbody types as the national inventory; (3) kitchen disposal usage is the same in every state, and wastewater biochemical oxygen demand (BOD) produced per capita, with and without kitchen scraps, is the same in every state (i.e., assumes total wastewater BOD produced per capita is the same as national production); and (4) per capita protein consumption in the United States is the same in every state (i.e., assumes per capita consumption is the same as national consumption).

As described in Chapter 7 of the national inventory, levels of uncertainty in the national estimates in 2021 were −29%/+32% for CH_4 and −34%/+193% for N_2O. State-level estimates have a higher uncertainty due to apportioning the national emissions estimates to each state based solely on state population (for domestic) or state industry sector production (for industrial). This approach does not address state-level differences in the type of wastewater treatment systems in use or in the conditions of the state's receiving waterbodies. State-level emissions for the time series were estimated based on limited years of state-level data, which also results in higher uncertainty for the state estimates.

The SIT directly calculates CH_4 and N_2O emissions from the treatment of municipal and industrial wastewater, using population data or production data for industry. As described above, the GHG Inventory by U.S. State downscales national inventory estimates by state-level population or share of U.S. population.

For the SIT, default data is provided for most inputs, but some data is not provided by the tool (e.g., tons poultry production). The SIT lacks additional industries that the EPA inventory includes: (1) petroleum refining, (2) breweries, and (3) starch-based ethanol production.

Table 4-28 presents a comparison of the wastewater treatment GHG emissions estimates from the SIT and the EPA state inventory, broken down between domestic and industrial wastewater treatment sources.

Table 4-28. Comparison of wastewater GHG emissions estimates from the EPA inventory and the SIT

Source	Gas	2017 Emissions in SIT (MMT CO_2-e)	2017 Emissions in EPA (MMT CO_2-e)
Emissions from wastewater (domestic)	CH_4 and N_2O	0.29	0.3
Emissions from wastewater (industrial)	CH_4	<0.01	0.2
Total GHG Emissions	--	0.29	0.5

For domestic wastewater, an independent review was completed using an alternate tool, the *Greenhouse Gas Accounting Tool for Water Sector Lending Projects* (World Bank 2018a; b). This tool was developed by the World Bank to evaluate the GHG impacts on future World Bank lending for water sector projects, including wastewater treatment. Figure 4-7 compares the CH_4 and N_2O emissions from domestic wastewater treatment calculated for 2017 using the World Bank and SIT methodologies. The World Bank tool and SIT show a close level of agreement for total emissions, with the World Bank tool predicting 0.23 MMT CO_2-e and the SIT predicting 0.29 MMT CO_2-e. This exercise lends support to use of the SIT for state-level estimates of emissions from domestic wastewater treatment plants.

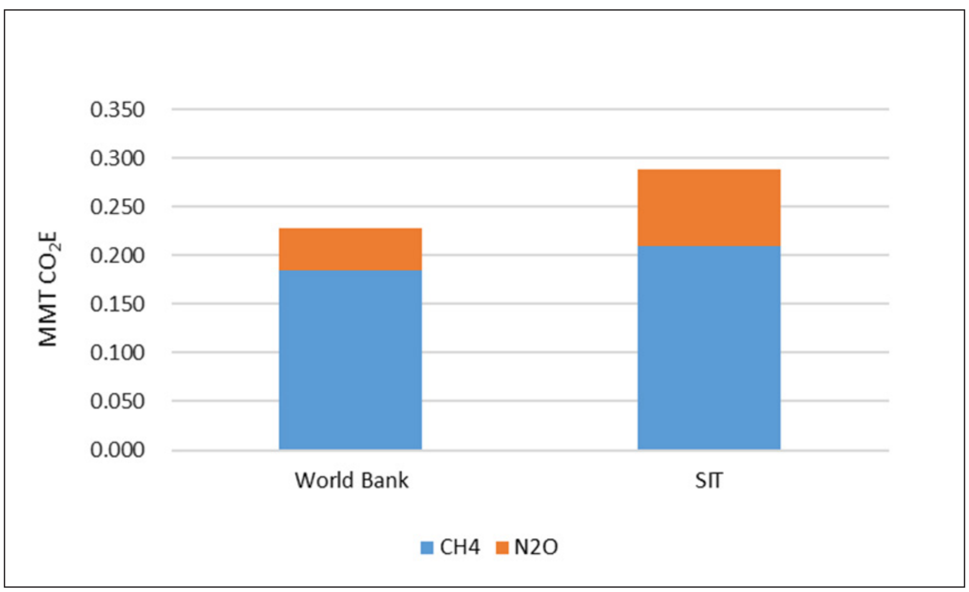


Figure 4-7. Comparison of 2017 population-level emissions estimates from domestic wastewater treatment for Mississippi as calculated by the World Bank Tool and SIT.

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5 Projected Nationwide Changes from Recent Federal Legislation

Prior to the passage of key federal legislation related to GHG reductions (the Infrastructure Investment and Jobs Act [IIJA] in 2021 and the IRA in 2022), the U.S. federal government has established several important targets (Department of State and the United States Executive Office of the President, DOS and EOP 2021) to reduce GHG emissions in accordance with the Paris Agreement (i.e., holding the increase of global mean temperature to well below 2°C and pursuing to limit to 1.5°C). In April 2021, the U.S. formally communicated the Nationally Determined Contribution of reducing net GHG emissions by 50-52% below 2005 levels in 2030 (DOS 2021). As stated in DOS and EOP (2021), two additional goals were established: 100% carbon pollution-free electricity by 2035 and net-zero emissions by 2050. These three near-term and long-term targets present an ambitious and trackable national commitment to reduce GHG emissions, serving as an important policy background for future activities in Mississippi.

The projected nationwide changes from the passages of IIJA and IRA are discussed in this chapter, as they are expected to significantly stimulate national changes such as energy transition and economy-wide GHG reductions in absence of additional reduction measures from state governments. A particular attention and consideration are given to the IRA, which serves as the most prominent piece of climate legislation by the U.S. government (Bistline et al. 2023). IIJA, as described in the 2022 U.S. Climate Ambition Report (DOS 2022; a national communication and biennial report to UNFCCC), also provides substantial resources and investments to various sectors and facilitates GHG reduction measures such as upgrades of transmission grids and buildouts of EV charging networks. Brief descriptions of the provisions in the IIJA and IRA related to the GHG reductions of individual economic sectors are subsequently provided. Other recent legislations, e.g., the CHIPS and Science Act passed in 2022, and federal executive and regulatory actions will also contribute to national GHG emission reductions and accelerate nation-wide decarbonization (NASEM 2023), although these additional legislations and executive actions and their effects are not further discussed.

5.1 Overview of Nationwide GHG Reductions Related to the IIJA and IRA

Given the expected nationwide changes driven by the IIJA and IRA, an overview of key policies and measures provided by the provisions of these two legislations is presented in this section. Some of the energy-related provisions in the IIJA and IRA are also modeled and quantified in the EIA's Annual Energy Outlook (AEO) 2023 (EIA 2023f). Although it should be noted that, because of the complexity of the legislations and related modeling difficulty and uncertainty, AEO 2023 does not incorporate all energy-related provisions in the IIJA and IRA. The modeling results from AEO 2023 (EIA 2023g) are further used and discussed in Sections 5.2 and 5.3 to present the projected effects of the IRA on the electricity generation and energy consumption for the Mississippi regions. The provisions of the IIJA and IRA included and modeled in AEO 2023 and other notable provisions in the two legislations are described in this section. These provisions are broadly separated into major economic sectors, i.e., electric power, residential, commercial, transportation, industry, agriculture, and waste, and as well as LULUCF. Further discussions about the IIJA and IRA effects and projected GHG emission reductions can also be found in a number of recent reports and studies (DOS 2022; EIA 2023g; NASEM 2023; O'Boyle et al. 2022).

Table 5-1 provides a summary of key provisions in the IIJA and IRA related to GHG emission reductions and their inclusion in the modeling of AEO 2023 (EIA 2023f).

Table 5-1. A list of key provisions in the IIJA and IRA for nationwide GHG reductions

Sector	Description	Legislation	Citations	Modeled in AEO 2023
Electric Power	Civil nuclear credit program	IIJA	Section 40323	✓
	Extend and modify tax credits for renewable generation	IRA	Sections 13101, 13102	✓
	Create new tax credits for renewable generation	IRA	Sections 13701, 13702	✓
	Create new tax credits for existing nuclear generation	IRA	Section 13105	✓
	Extend and modify tax credits for CO2 capture	IRA	Section 13104	✓
Residential	Extend, increase, and modify tax credits for home energy efficiency improvements and modifications	IRA	Section 13301	✓
	Extend tax credits for clean energy projects	IRA	Section 13302	✓
	Extend, increase, and modify tax credits for new energy-efficient homes	IRA	Section 13304	✓
Commercial	Capitalization for Efficiency Revolving Loan Funds, Efficiency and Renewable Energy Grants for public schools, Energy Efficiency and Conservation Block Grant Program, Weatherization Assistance Program, and State Energy Program	IIJA	Multiple	

Sector	Description	Legislation	Citations	Modeled in AEO 2023
	Extend and modify tax credits for properties with renewable energy generation	IRA	Section 13102	✓
	Create new tax credits for clean energy generation	IRA	Section 13702	✓
	Modify tax credits for cost recovery from clean energy investments such as energy storage	IRA	Section 13703	✓
Transportation	Improve public transportation and passenger rail, support buildout of EV charging networks, support domestic battery manufacturing and supply chains, low- and no-emission bus grants, and Clean School Bus Program	IIJA	Multiple	
	Extend tax credits for clean vehicles	IRA	Section 13401	✓
	Support battery manufacturing, support installations of charging equipment in low-to-moderate income and rural communities, and provide programs for advanced vehicle technologies, cleaner freight and mail delivery vehicles, and cleaner ports	IRA	Multiple	
Industry	Require drawdown and sale of crude oil	IIJA	Section 90002	✓
	Regional Clean Hydrogen (H2) Hubs, Capture Demonstration Projects Program, support plugging, remediation, and restoration of CH4 leaks, and support reclamation of abandoned coal mines	IIJA	Multiple	
	Extend and modify tax credits for CO2 sequestration (oil and gas supply)	IRA	Section 13104	✓
	Increase royalty rates for offshore fossil fuel leases	IRA	Section 50261	✓
	Modify royalty rates for onshore oil and natural gas leases	IRA	Section 50262	✓
	Lease sales under 2022 Outer Continental Shelf Leasing Program (requiring the leasing program to be completed)	IRA	Section 50264	✓
	Extend incentives for renewable fuels such as biodiesel	IRA	Section 13201	✓
	Extend incentives for second-generation of biofuel production	IRA	Section 13202	✓
	Create credits for sustainable aviation fuel	IRA	Section 13203	✓
	Create tax credits for clean fuel production	IRA	Section 13704	✓
	Extend and modify tax credits for combined heat and power production	IRA	Section 13102	✓
	Create tax credits for H2 production, Advanced Industrial Facilities Deployment Program, procurement provisions, support standardizing Environmental Product Declarations	IRA	Multiple	

Sector	Description	Legislation	Citations	Modeled in AEO 2023
Agriculture	Support climate-smart practices, and support innovative, cost-effective measurements and verification of climate benefits from agriculture	IRA	Multiple	
LULUCF	Ecosystem Restoration Program and Community-Based Restoration Projects	IIJA	Section 40804, Division J	
	Support the protection and restoration of forecast lands	IRA	Multiple	

It is important to note that the IRA includes different levels of tax credits for various incentives. The requirements for bonus tax credits include wage and apprenticeship requirement, domestic content used, and locations of projects (whether they are located in energy communities, i.e., brownfield sites, communities having employment and tax revenues largely dependent on energy production, or census tracts with a recent closure of coal mines and coal-fired power plants). As listed and assessed in EIA (2023g), these bonus credits are available for the incentives related to (a) production and investments of utility-scale clean electric power, (b) investments of clean energy at residential and commercial sectors, (c) investment of combined heat and power in industry, (d) carbon capture and sequestration, (e) production of nuclear power at existing facilities, and (f) production of clean fuels.

These different levels of tax credit uptakes from the IRA, according to EIA (2023g), can greatly affect the projected national changes such energy transition and GHG emission reductions. Fulfilling the wage and apprenticeship requirement, for example, leads to a five-time greater tax credit than the base credit. This substantial increase of tax credits based on the wage and apprenticeship requirement can significantly increase the benefits of workforce-related programs for Mississippi, e.g., a strong workforce training and apprenticeship program can facilitate the uptake of bonus tax credits for employers while employers are incentivized and able to pay prevailing wages. Depending on tax credit uptake, the different results of EIA (2023g) – which are discussed in the subsequent sections – provide an important basis for proposing enabling policies such as workforce-related programs as a component of GHG reduction measures in this PCAP.

5.2 Projected IRA Effect on Electricity Generation in the Mississippi Region

Given the significance of the IRA, the projected clean electricity production under the effect of the IRA is discussed in this section. The results from AEO 2023 (EIA 2023h) were obtained and are discussed. In addition to the reference scenario, a low- and a high-level of tax credit uptake were considered and modeled in AEO 2023 (EIA 2023g) as low-uptake and high-uptake scenarios. As discussed in the previous section, the different levels of tax credit uptake are dependent on the fulfillment of requirements related to wage and apprenticeship, domestic content, and project locations. Additional definition and assumptions made for the four scenarios can be found in EIA (2023g). The three different scenarios (reference, low-uptake, and high-uptake scenarios) in EIA (2023g) are assessed in this section to highlight the importance of the state's role in facilitating higher tax credit uptake.

AEO 2023 does not provide state-level projections on electric power sector and the results instead are based on Electricity Market Module Regions (EIA 2023g). Figure 5-1 presents the map of the 25 Electricity Market Module Regions analyzed in AEO 2023.

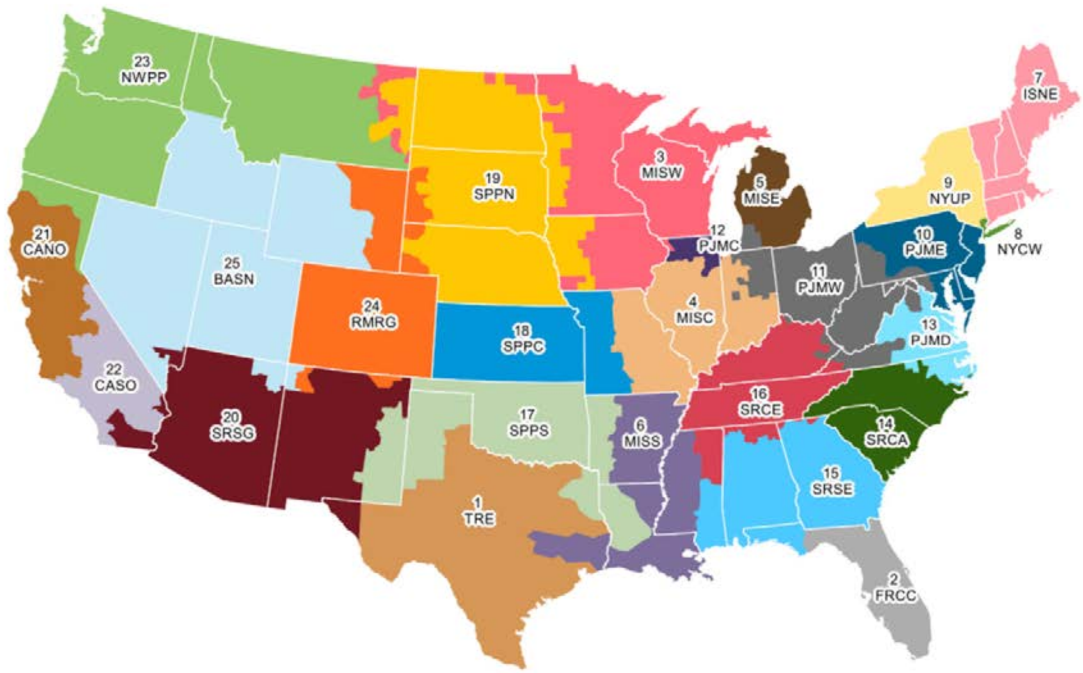

Figure 5-1. Electricity Market Module Regions modeled for AEO 2023 (EIA 2023c).

To assess the projected changes in electric power sector for Mississippi, the results from three regions covering the State of Mississippi in Figure 5-2 were obtained: Region 6 (Midcontinent ISO / South), Region 15 (SERC Reliability Corporation / Southeastern), and Region 16 (SERC Reliability Corporation / Central). The electricity generation from these three regions was subsequently aggregated together as total generation.

The results of the projected electricity generation for the aggregated total of the three regions are presented in Figure 5-2, and additionally, the emissions from electric generations were also calculated by AEO 2023, which are presented in Figure 5-3. The four scenarios are included in these two figures.

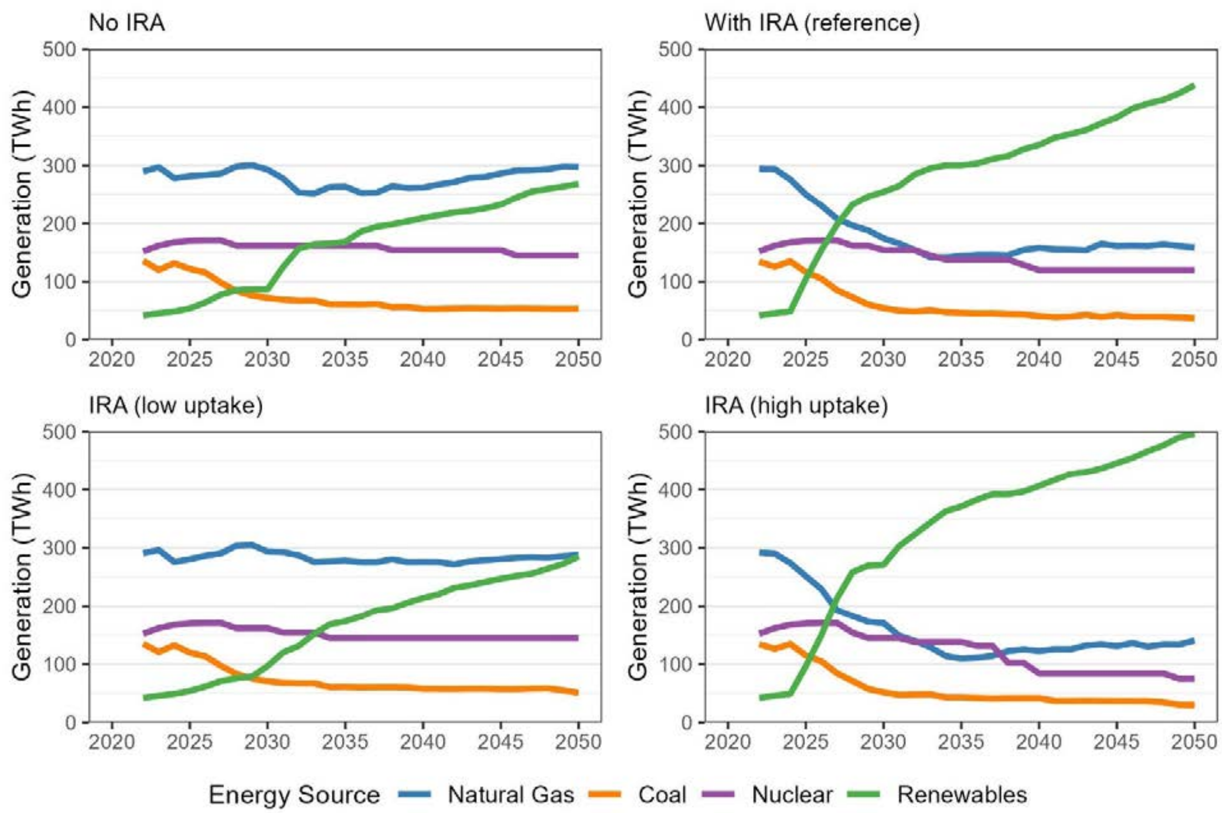

Figure 5-2. Projected electricity generation (sum of the three regions within Mississippi) from AEO 2023 with four policy scenarios related to the implementation of IRA.

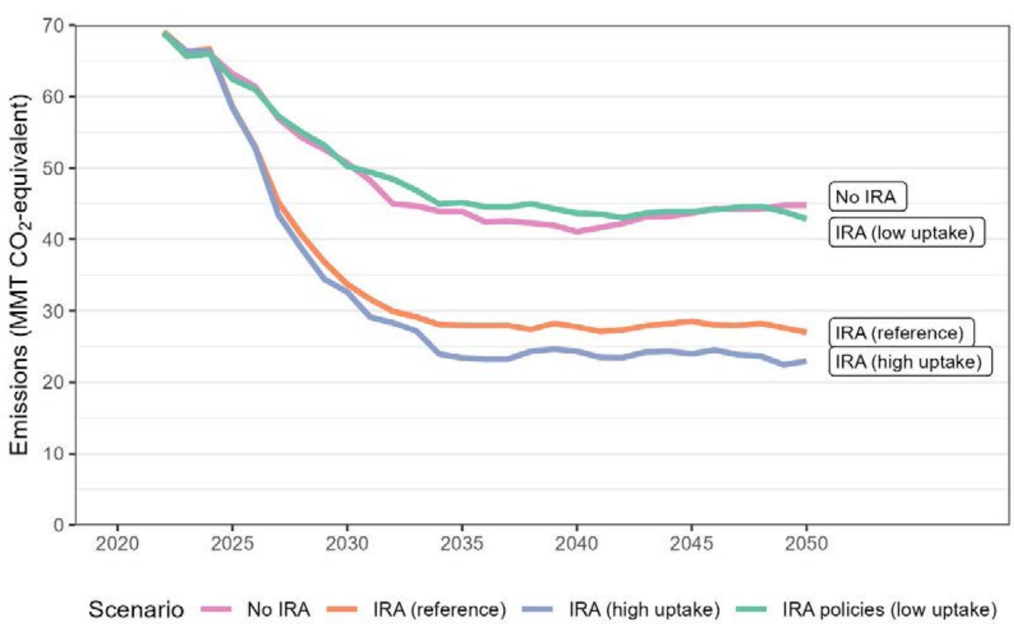

Figure 5-3. Projected CO_2-e emissions from electricity generation (sum of the three regions within Mississippi) from AEO 2023.

The results of Figure 5-2 and Figure 5-3 suggest a significant effect of the IRA on the use of renewables and nuclear energy for regional electricity generation and the subsequent reductions of emissions from electricity generation. Under the reference scenario, generation from use of renewables increases from around 50 TWh in 2023 to slightly less than 450 TWh in 2050, whereas the generation from using natural gas reduces by half (from around 300 TWh in 2023 to 150 TWh in 2035). Consequently, the projected emissions (under the reference scenario) for the three regions decreased from around 70 MMT CO_2-e to less than 30 MMT in 2035 with almost 60% of reduction. This substantial effect of emissions reduction from the implementation of IRA is also consistent with the results on a national scale in the previous studies (e.g., Bistline et al. 2023). Without the IRA, the generation from using renewable is also projected to increase (replacing more expensive coal-fired power plants (EIA 2023g)), leading to some reductions of emissions from electricity generation.

Figure 5-2 and Figure 5-3 also indicate a large uncertainty and sensitivity of the results with respect to the levels of tax credit uptake. Under the low-uptake scenario, both the electricity generation from using different sources of energy and the emissions from electricity generation are similar to the results of the scenario without the IRA. As described previously and also in EIA (2023g), fulfilling the wage and apprenticeship requirement (not assumed in the low-uptake scenario) can result in a five-time greater tax credit than the base credit, leading to substantially greater investment on and transition to renewables as presented in Figure 5-4. Such results emphasize the importance and benefits of meeting the bonus tax credit requirements and increasing uptake during the implementation of the IRA. State and local policies – e.g., enabling electricity providers with efficient processes of investing clean energy especially in energy communities and using domestic products, facilitating a greater uptake of tax credits with workforce training and apprenticeship programs, and stimulating regional economy around clean energy leveraging the fundings and resources provided by the IRA – can potentially lead to the large differences between the low-uptake and reference (or the reference to high-uptake) scenarios presented in Figure 5-2 and Figure 5-3. This uncertainty among the different IRA scenarios underscores the importance of state's role and state-level actions on facilitating the IRA implementation.

Additionally, although AEO2023 did not provide the Mississippi-specific electricity generation projections, the total electricity generations from the three regions can be used to empirically scale to the annual electricity generation in Mississippi. The objective of such an empirical scaling method aimed to obtain the projected energy use for electricity generations in Mississippi under the effect of the IRA, which will be used in the subsequent sections to quantify the effect of several GHG reduction measures e.g., electrification of vehicles and building appliances (given that the effect of reducing GHG emissions from these measures depends on the energy transition in electric power sector).

The empirical scaling was applied in a preliminary manner and includes the following steps to calculate the projected GHG emissions from electric power sector under the effect of IRA: (1) calculating the annual percentages of different energy sources used for future regional total electricity generation, (2) calculating the annual changes of future percentage values and adding these future changes to historical percentages of different energy sources in Mississippi, (3) scaling these obtained future percentages of energy sources in Mississippi to a total of 100%, and (4) calculating the GHG emissions per unit of electricity generated (e.g., kg of CO_2-e per kWh of electricity generation). Instead of using the empirical scaling, further and more comprehensive analyses with the projected changes in total electricity generation and subsequent quantification of GHG emissions in Mississippi will be carried out during the CCAP processes.

The estimated annual percentages of electricity generation from different energy sources in Mississippi based on the empirical scaling approach are presented in Figure 5-4.

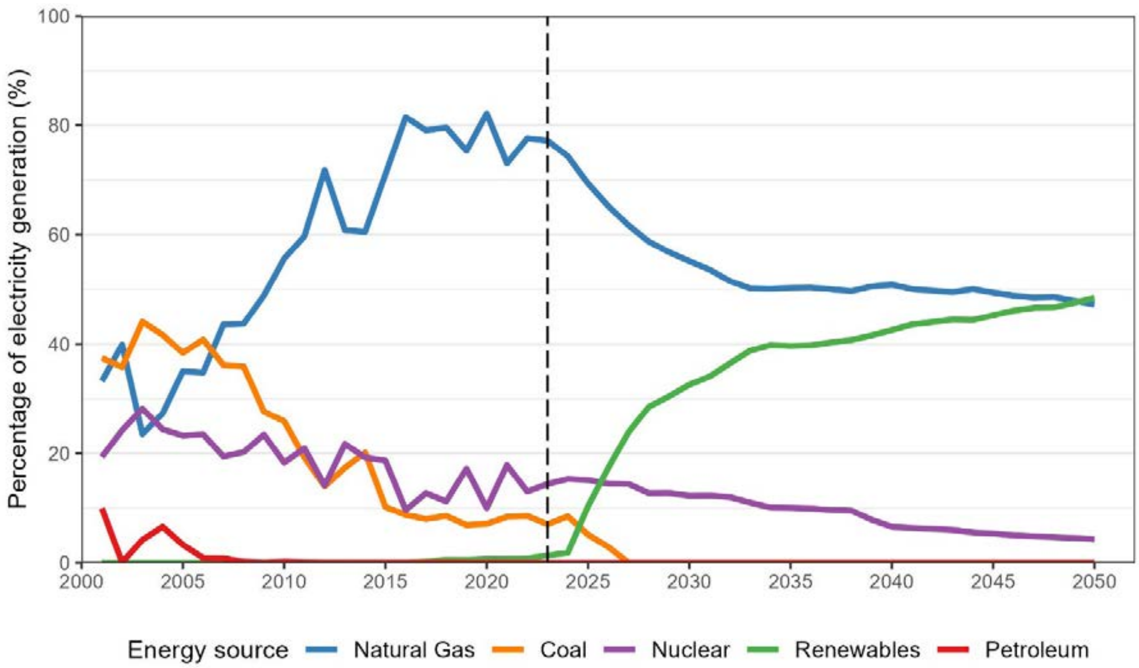

Figure 5-4. Historical and estimated future percentages of electricity generations by energy source in Mississippi under the effect of the IRA.

Based on the results presented in Figure 5-4, the GHG emissions from the electricity end use (considering additional transmission and distribution losses) were quantified and the results are presented in Figure 5-4.

Table 5-2. Historical and estimated future GHG emissions per kWh of electricity end use in Mississippi.

Year	GHG emissions (kg CO_2-e per kWh of electricity end use)
2010	0.535
2015	0.408
2017	0.430
2020	0.424
2025	0.335
2030	0.222
2040	0.201
2050	0.186

The results of Table 5-2 will be used in subsequent sections to quantify related priority measures, e.g., the electrification of building appliances.

5.3 Projected Energy Consumption by Sector in the Mississippi Region

In addition to incentivizing clean energy transition for electric power sector, the IRA provides substantial investments in other sectors to reduce GHG emissions from their energy consumption as presented in Table 5-1. To assess the potential effect of the IRA on these sectors, the projected energy consumption for different economic sectors from AEO 2023 (EIA 2023g) are assessed in this section. Similar to the projected electricity generation discussed in the previous section, these modeling results from AEO 2023 are based on the IRA and other existing policies (EIA 2023f). AEO 2023 does not provide state-level projections and the results of the East South Central (based on U.S. Census Bureau divisions; including four states: Alabama, Kentucky, Mississippi and Tennessee) are presented in this section. Furthermore, AEO 2023 does not provide regional results with the four different scenarios presented in the previous section, and consequently the reference scenario with the IRA is presented and discussed.

The projection results of delivered energy to four sectors (residential, commercial, industry, and transportation) in the East South Central region are presented in Table 5-2.

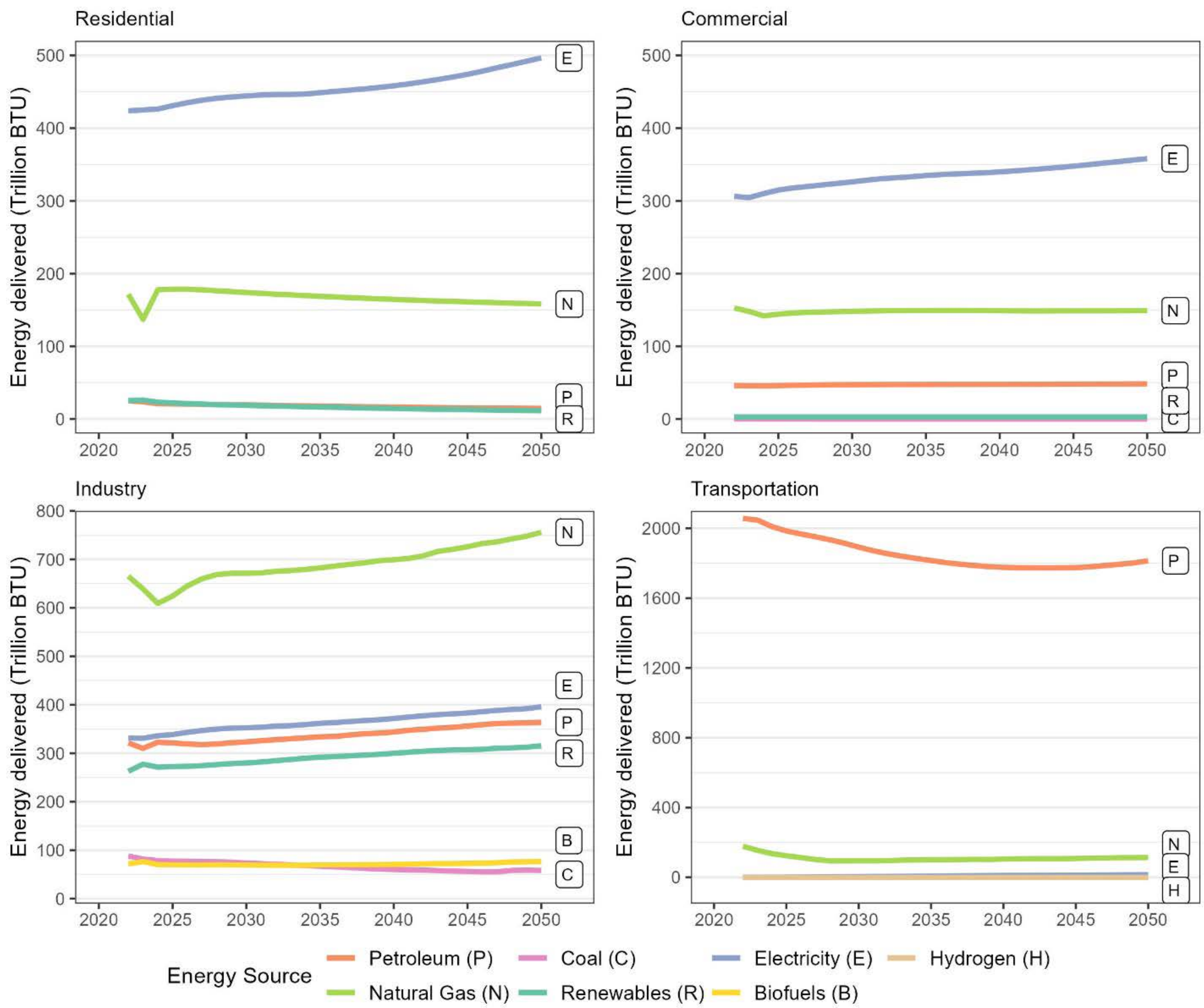

Figure 5-5. Projected energy deliveries to residential, commercial, industry, and transportation sectors in the East South Central region from AEO 2023 (reference scenario). Electricity delivered for end use are presented and does not include electricity-related losses (e.g., generation losses).

As presented in Table 5-2, some changes of energy consumption at different economic sectors can be observed. Electricity consumption is projected to increase across all four sectors, with more than 50 trillion BTU of increase for the residential, commercial, and industry sectors each. Some reductions of natural gas consumption can be found for the residential and transportation sectors, the natural gas consumption of the industry sector increases, while the commercial sector does not exhibit a notable change on natural gas consumption. A large reduction of petroleum consumption is projected for the transportation sector, as a result of a projected increase in EVs (percentage sales of light-duty EVs including electric and plug-in hybrid increases from 2.6% in 2023 to 8.6% in 2050 for the East South-Central region). As discussed in EIA (2023g), the IRA generally accelerates the pace of EV sales in near term, while long-term (such as 2050) projections of EV sales do not change substantially and the traditional, gasoline- and diesel-fueled vehicles are still in demand based on the projections.

Compared to electricity generation in Table 5-2, the energy transitions of other sectors in Table 5-2 do not exhibit changes as substantial as electric power sector for the greater Mississippi region. AEO 2023 (EIA 2023g) additionally includes national results on the energy consumption by sector with the four different scenarios (reference, no-IRA, low-uptake, and high-uptake scenarios). These results of energy consumption at the residential, commercial, industry, and transportation sectors generally do not exhibit an uncertainty level as large as the projections in electricity generation. Regional results with these alternative scenarios are not available in AEO 2023, although the different scenarios for the energy consumption (of the four sectors) at Mississippi are expected to be similar and do not exhibit changes as substantial as electricity generation.

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6 GHG Reduction Strategies and Priority Measures

In support of the PCAP for Mississippi, we first considered a potential list of approximately 70 GHG reduction measures from the national literature spanning each major emission sector. These potential measures included both policy- and regulatory-type actions as well as actions that needed new physical infrastructure or modifications to existing infrastructure. Based on preliminary feedback from stakeholders as part of the outreach described in Chapter 2, a more limited set of 14 measures has been included for consideration in this PCAP, and these are further described in this section. These measures span different sectors and different GHGs, and can be implemented at varying scales, from modifications to individual facilities to statewide programs. These include the following:

- Residential and commercial distributed solar generation and storage
- Utility solar generation and storage
- Electricity transmission and distribution upgrades
- Cargo transportation to rail
- Vehicle transition
- School bus electrification
- Alternative fueling infrastructure
- Biofuel use for transportation or as an energy source
- Building energy efficiency improvements
- Refrigerant replacement
- Forest carbon management
- BMPs for agricultural land
- Landfill CH_4 capture
- Wastewater CH_4 capture

At this stage of the PCAP, the priority measures are defined in a "unit" form of a reasonable size, rather than as specific projects with a defined geographic footprint. For example, the costs and GHG benefits of solar photovoltaic generation as a source of renewable power are described on a per MW basis, with the actual amount of GHG reduction being scaled to the size of projects ultimately implemented. Other criteria, such as co-benefits to the environment, are described in terms of non-GHG atmospheric pollution avoided per MW of current generation. Also, criteria such as workforce impacts and benefits to low income/disadvantaged communities, are described in narrative form and can be refined once a specific project or group of projects are defined.

The supporting information for each priority measure, both quantitative and narrative, allows eligible entities across Mississippi (including state, local, and regional governments and agencies) to develop applications to seek grant funding from EPA or other federal sources. These applications may choose to focus on one or multiple measures. At the grant application stage, it is expected that a potential grantee will propose a specific program—defining size, geographic location or range, and specific activities, such as subsidies or other incentives, or actual creation of infrastructure, for example—that builds on the information presented in this chapter.

6.1 Residential and Commercial Distributed Solar Generation and Storage

6.1.1 Description of Reduction Measure

GHG emissions from electric power contribute more than 30% of total emissions in Mississippi in 2020 and represent the largest emission source among economic sectors (as discussed previously in Section 4). Planning and implementing measures to reduce the emissions from electric power sector are therefore critical to reduce the overall GHG emissions. Both national target from the Federal government (i.e., 100% carbon pollution-free electricity by 2035 (DOS and EOP 2021)) and action plans previously prepared by other states in the Southeast have identified and addressed the GHG emission reductions from electric power sector (e.g., State of Louisiana is proposing to establish Renewable and Clean Portfolio Standard in the state's action plan (State of Louisiana 2022)).

One priority reduction measure for electric generation was identified as incentivizing and promoting distributed energy resources, including rooftop solar systems and small-scale electricity storage systems. These distributed energy resources generally refer to the deploying of small-scale electricity generation and storage units by electricity customers at the end-use locations such as residential and commercial buildings. Common distributed energy resources include rooftop solar systems and small-scale battery storage systems with a net generation capacity less than 1 MW based on the EIA Monthly Electric Power Industry Report (EIA 2023i). These distributed energy resources allow electricity customers to manage and reduce the electricity consumption from the grid and sometimes inject power to the grid (NASEM 2023).

As described previously in Chapter 5, programs and funding provided by the IRA – e.g., EPA GHG Reduction Fund including Solar for All, United States Department of Energy (DOE) National Community Solar Partnership program, and tax credits for clean energy projects at residential and commercial sites – offer promising opportunities and resources to advance the development of these distributed energy resources and reduce the overall GHG emissions from electric power sector.

In addition to reducing GHG emissions, development of distributed energy resources can provide multiple co-benefits to environment and benefits to low income/disadvantaged communities. By reducing the overall electricity demand from grid, emissions of other air pollutants such as SO_2 and NO_x can be reduced from corresponding electricity generation. Local electricity generation and storage can also lower down the requirements on utility-scale generation and distribution capacity and increase the resilience of electricity systems by offering alternative supply options. Distributed energy generation such as rooftop solar systems additionally provide savings on electricity bills; together with fundings and resources from such as the EPA's Solar for All program to streamline investments on distributed energy resources to low income/disadvantaged communities, the development and investments on these distributed energy resources can facilitate and provide affordable electricity and improve just and equitable energy transitions.

Promoting and advancing distributed energy resources is therefore assessed in this section as one priority GHG reduction measure with a particular emphasis on small-scale solar systems. The actions for this reduction measure include (a) providing tax incentives, subsidies, financial assistance – in addition to existing national programs – to reduce the installation costs of distributed energy resources such as rooftop solar at residential and commercial sites; (b) leveraging the resources and technical assistance (including the lessons learned from other jurisdictions (NASEM 2023)) provided by IRA-funded programs to promote the accessibility to and deployment of distributed energy resources; and (c) providing and supporting workforce development related to distributed energy resources such as installing and maintenance of rooftop solar and battery storage systems.

6.1.2 Quantification of GHG Reduction Per Unit of Measure

Quantification of GHG reduction potential from distributed energy resources is presented with a focus on rooftop solar systems at residential and commercial sites. Other distributed solar systems at residential and commercial sites (e.g., at parking lots) can be quantified in a similar manner. Small-scale electric storage systems such as battery storages can also contribute to reduction of GHG emissions by providing flexibility on the demand of electricity from the grid or electricity generated from rooftop solar, although the GHG reductions from these storage units by themselves are likely less compared to the reductions from distributed electricity generation systems and are more difficult to estimate. Aligning with the methodology of estimating GHG emissions for electric power sector in Section 4.1.1 (i.e., the SIT Electricity Consumption Module), the quantification of GHG reductions for this reduction measures is based on generation of electricity: (a) estimating the expected generation from added distributed solar systems, which equals to the reduction of electricity demand from the grid, (b) calculating the reduction of electricity generation for electricity providers by including additional savings from transmission and distribution losses, and (c) quantifying the corresponding reduction of GHG emissions from the reduced electricity generation.

The following data were used to quantify the reduction measures:

a. Form EIA-861M (Monthly Electric Power Industry Report (EIA 2023i)) provides the monthly distributed small-scale (< 1MW) solar capacity and generation by state. The capacity in 2022 (averaged for the year) for Mississippi is 6.42 MW and 6.19 MW (in alternative current, AC) for residential and commercial solar, respectively, whereas the total generation is 10805 megawatt hour (MWh) (residential) and 10602 MWh (commercial) in 2022. Annual total generation from distributed small-scale solar exhibit a strong linear relationship with annual average capacity, and consequently the calculations on annual total electricity generation from distributed solar systems are based on historical capacity and generation data from 2015-2022 EIA-861M files (EIA 2023i).

b. EIA Residential Energy Consumption Survey in 2020 (as the most recent survey (EIA 2023d)) and Commercial Energy Consumption Survey in 2018 (as the most recent survey (EIA 2023e)) provide the separate surveys of residential and commercial buildings including accounting of buildings installed with small-scale solar systems. The number of residential homes with rooftop solar systems for the state of Mississippi in 2020 was estimated to be 12700 homes, about 1.2% of all residential homes (including mobile homes, single family detached and attached homes, and apartments). Although the estimates of commercial buildings installed with small-scale solar systems are not available at a state level, 0.15% of commercial buildings in 2018 are installed with small-scale solar in the East South Central Census Division. It should be noted that these estimated numbers and percentages of residential and commercial buildings are likely subject to relatively larger uncertainty compared to other Census Divisions, regions, or states, because the numbers of surveyed buildings with small-scale solar in Mississippi and the East South Central Census Division are smaller and can lead to greater estimation errors. The total number of homes in Mississippi is 1.08 million, while the total number of commercial buildings in Mississippi is not available in the survey.

c. EIA State Energy Data System (EIA 2021a) provides the fuel consumption data for electric power sector (which can be used to quantify GHG emissions) and EIA State Electricity Profiles (EIA 2023b) provide disposition of electricity generation for Mississippi. Specifically, total generation (including industrial and commercial combined heat and power) for Mississippi in 2020 is 66.58 TWh, of which transmission and distribution losses are estimated as 2.59 TWh (i.e., around 3.89% of total generation). Note that the total electricity generation in Mississippi – excluding the generation from industrial and commercial combined heat and power (not used for estimation of GHG emissions of electric power sector as described previously) – is 64.52 TWh. These data were also used in the previous sections to quantify and assess the GHG emissions for the electric power sector.

d. Lawrence Berkeley National Laboratory (Barbose et al. 2023) provides annual reports on the trends (such as annual added capacity and costs) associated with distributed solar systems in the U.S., serving as supplemental information to the previously discussed EIA data and results. Notably, the average installed capacity for residential buildings in Mississippi is 9 kilowatt (kW) in direct current (DC) in 2022 (Barbose et al. 2023). The national average inverter loading ratios (i.e., DC capacity over AC capacity) are 1.22 for residential, 1.20 for small non-residential (< 100 kW size), and 1.26 for large non-residential buildings. The national median costs for installing distributed small-scale solar in 2022 are $4.2 (with an 80% uncertainty range of $3.2-5.2) per $watt_{DC}$, $3.2 (with an 80% uncertainty range of $2.4-4.5) per $watt_{DC}$, and $2.2 ($1.7-3.0 as the 80% range) per $watt_{DC}$ of capacity at residential, small non-residential, and large non-residential buildings, respectively. Cost estimates for some states are also provided by (Barbose et al. 2023), although state-level cost information is not available for Mississippi. Additionally, (Barbose et al. 2023) reports their cost comparisons with other studies, suggesting the estimated costs from other studies can be slightly lower and exhibit a range of $2-4 per $watt_{DC}$ as a national average for residential buildings and $1.5-2.5 per $watt_{DC}$ for large-scale (> 100 kW) non-residential buildings.

Based on these data and information, the following calculation procedures were applied to estimate the emission reductions per unit (MW) of additional small-scale solar capacity: (1) generation factors (i.e., MWh of generation per megawatt alternating current [MW_{AC}] of capacity) were calculated using the historical annual total generation and annual average capacity data for Mississippi; (2) reductions of electricity generation for electricity providers were calculated by adding the generation from small-scale solar with transmission and distribution losses (i.e., 3.89%); (3) reductions of GHG emissions from the reduced generation for electricity providers were calculated by multiplying amount of reduced generation by the emission factor in 2020 (i.e., MT of CO_2-e per MWh of electricity generated). The summary of these calculation results is presented in Table 6-1.

Table 6-1. Estimated GHG reductions per unit of added capacity from installations of small-scale solar at residential and commercial buildings in Mississippi.

Results		Residential	Commercial
Recent historical data	Capacity in 2022 (MW_{AC})	6.42	6.19
	Generation in 2022 (MWh)	10805	10602
Estimated factors (based on year 2020)	Annual generation factor (MWh per MW_{AC} capacity)	1680.5	1702.1
	Reduced generation factor (including losses; MWh per MWAC capacity)	1748.5	1771.0
	GHG Emission factor (MT CO_2-e per MWh)	0.409	0.409
Reduction per unit measure	Annual GHG emission reduction from the 2020-level per added capacity (MT CO_2-e per MW_{AC})	715.14	724.34

Existing percentages of residential and commercial buildings with small-scale solar systems provided by EIA surveys (EIA 2023e; d) are further assessed and the results are presented in Table 6-2. It should be noted that, as described previously, the results presented in Table 6-2 are expected to be subject to relatively large uncertainty because of the limited sample sizes of the surveyed residential and commercial buildings with small-scale solar in Mississippi and the East South Central Census Division.

Table 6-2. Existing residential and commercial buildings with installation of small-scale solar in Mississippi or the East South Central Census Division and existing total capacity and annual generation.

Results		Residential Buildings for Mississippi (Based on 2020 survey)	Commercial Buildings for the East South Central Census Division (Based on 2018 survey)
Survey results	Number of buildings (million)	1.08	0.347
	Percentage of buildings with small-scale solar	1.2%	0.15%
Historical data	Estimated capacity in 2020/2018 (MW_{AC})	4.05	60.73
	Total generation in 2020/2018 (MWh)	6,813	98,400

Based on the survey results in Table 6-2, the average installed capacity for each residential and commercial building can be estimated, although such results may be subject to large uncertainty as discussed previously. Specifically, a total of 12,700 residential buildings was estimated to have installed small-scale solar systems with an average 320 watt alternating current ($watt_{AC}$) of capacity installed at each home, which is substantially lower than the average installed size per home estimated in other studies, e.g., Barbose et al. (2023) estimated that the average installed size in 2022 for Mississippi is 9 KW_{DC} per home. Average installed solar capacity at non-residential sites is not available for Mississippi in Barbose et al. (2023), while the median installed size nationally is 98 kW_{DC} (Barbose et al. 2023), comparable to the estimated 116- kilowatt alternating current (kW_{AC}) size per commercial building based on the data presented in Table 6-2.

Consequently, 9 kW_{DC} and 125 kW_{DC} capacity systems are assumed to be the average installation sizes for the distributed solar systems at the residential and commercial buildings in Mississippi, respectively. The inverter loading ratios are assumed to be 1.2 and 1.25 in residential and commercial buildings, resulting in the AC capacities of 7.5 and 100 KW_{AC}. Combining the results of the GHG reductions per unit capacity in Table 6-1, the estimated GHG reductions per residential and commercial buildings are presented in Table 6-3.

Table 6-3. Assumed installed capacity of distributed solar for each residential and commercial building in Mississippi and associated GHG reductions from 2020 level.

Estimated Factors per Unit Measure	Residential	Commercial
DC Capacity per building (kW_{DC})	9	125
AC Capacity per building (kW_{AC})	7.5	100
Annual emission reduction from 2020 level per building (MT CO_2-e)	5.4	72.4

6.1.3 Quantification of Cost Range

The estimation of installation prices for small-scale solar systems at residential and commercial buildings is primarily based on the cost information from Barbose et al. (2023), with additional comparisons and evaluation using estimated costs from other studies. Compared to a national average, the costs of installing distributed solar systems in Mississippi may be lower given the relatively lower labor costs while the constraints from the existing workforce and market size in Mississippi may also lead to higher costs. The cost estimates from Barbose et al. (2023) are also moderately higher than the other studies.

Therefore, the installation price for a 9 kW_{DC}/7.5 Kw_{AC} rooftop solar at residential buildings in Mississippi is assumed to be $3 per $watt_{DC}$ (i.e., $27000 for a 9 kW_{DC}/7.5 Kw_{AC} system at a residential building), whereas the price for installing a 125 kW_{DC}/100 kW_{AC} solar system at commercial buildings in Mississippi is assumed to be $2.5 per watt (i.e., $312500 for a 125 kW_{DC}/100 kW_{AC} system at a commercial building).

Currently, the IRA provides a subsidy in the form of a tax credit for installation of solar panels to the building owner. Mississippi may choose to provide additional targeted subsidies as a percent of the installation cost to qualifying homes and commercial facilities in low income/disadvantaged communities. The scale of such a program will be defined in future grant applications.

6.1.4 Timeline of Implementation

This is a mature technology and may be deployed immediately, and the scale will depend on funding support and workforce availability. The timeline can be assessed from the historical installation rate in Mississippi and comparing with the pace of installations at neighboring states. The total small-scale solar capacity at residential and commercial buildings in Mississippi in 2022 is 12.61 MW_{AC}, increased from 1.0 MWAC in 2015 and with a rate of around 1.7 MW_{AC} per year. Kentucky, with one of the highest rates of distributed solar growth in the East South Central Census Division, increased from 8.0 MW_{AC} in 2014 to 63.8 MW_{AC} in 2022 for the total distributed solar at residential and commercial sites, with a rate of about 7.0 MW_{AC} per year.

Given the existing national programs provided the IRA and the implementation of this reduction measure, the adoption may be expected to greatly surpass the historical rate of distributed solar systems in Mississippi (1.7 MWAC per year) and potentially match or surpass the historical rates in neighboring states like Kentucky (7.0 MW_{AC} per year). A rate of 7.0 MW_{AC} per year, for example, indicates a rate of adding around 470 residential homes (7.5 kW_{AC} per home) plus 35 commercial buildings (100 kW_{AC} per building) with small-scale solar systems for each year.

6.1.5 Co-benefits to Environment

Similar to the calculations of GHG emission reductions, the reductions of other air pollutants from electricity generation can also be calculated. Plant-level emission data were obtained from EIA (as also presented previously in Section 4.3.1 (EIA 2023a)) and used to estimate the emission reductions of SO_2 and NO_x per unit of added capacity and per installed solar system at a residential/commercial building. These results are presented in Table 6-4.

Table 6-4. Estimated SO_2 and NO_X emission reductions per unit of added capacity and per building with installations of small-scale solar systems in residential and commercial buildings in Mississippi.

Results		Residential	Commercial
Emission factors (based on year 2020)	SO_2 Emission factor (kg SO_2 per MWh of electricity generation)	0.037	0.037
	NO_X Emission factor (kg NO_X per MWh of electricity generation)	0.19	0.19
Reduction per unit measure	Annual SO_2 emission reduction from 2020 level per added capacity (kg SO_2 per MWAC)	64.7	65.5
	Annual NOX emission reduction from 2020 level per added capacity (kg NO_x per MWAC)	332	336
	Annual SO_2 emission reduction from 2020 level per building (kg SO_2)	0.5	6.6
	Annual NO_X emission reduction from 2020 level per building (kg NO_x)	2.5	33.7

6.1.6 Workforce Considerations

The reported employment by sector and by state from DOE United States Energy and Employment Report (DOE 2023a) was used to evaluate the potential impact on workforce from this reduction measure. For example, the numbers of employment by technology application for the electric power sector in Mississippi in 2022 are presented in Figure 6-1.

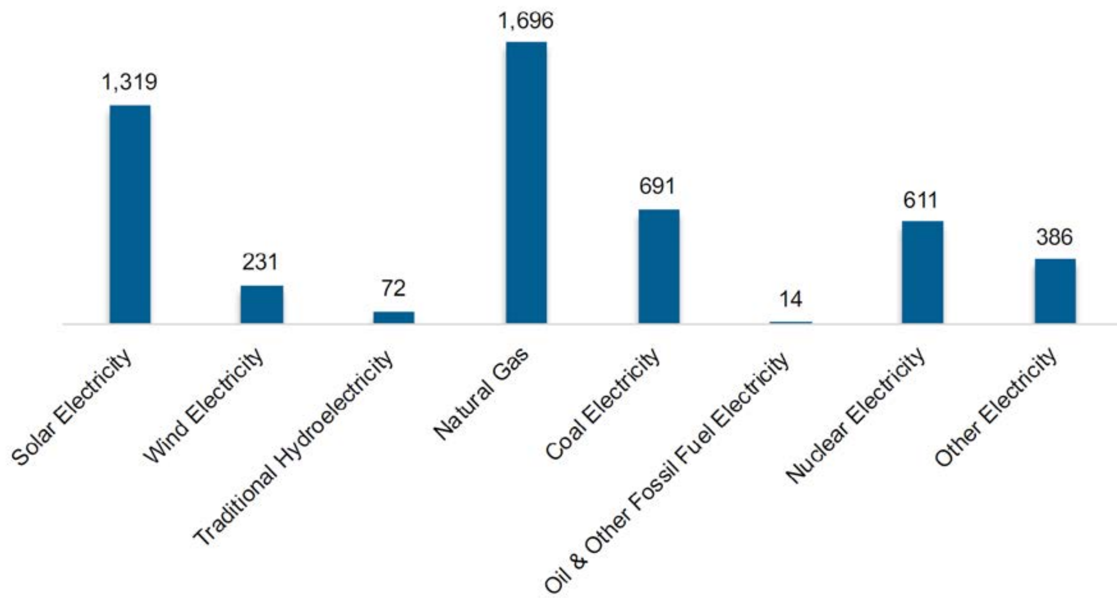

Figure 6-1. Number of workers employed in the Mississippi's electric power sector in 2022. Figure obtained from (DOE 2023a).

As presented in Figure 6-1, 1,319 workers were employed for solar electricity (including work related to utility-scale and small-scale solar systems) in Mississippi in 2022, serving as the second largest employment behind natural gas among different technology applications in the electric power sector.

Although more detailed information such as the employment data specifically related to small-scale solar systems in Mississippi are not available in DOE (2023), this is expected to substantially increase employment. For example, the total electricity generation capacity in 2022 for Mississippi is 16,365 MW, of which 319 MW of capacity is provided by utility-scale solar systems. Together with the small-scale solar systems (an additional 12.6 MW of solar capacity in 2022), the total solar generation capacity and facilities are considerably smaller than other electricity generation types but have contributed to about 26% of employment in the electric power industry. Further increases in the total amount and the rate of installation of small-scale solar systems are therefore expected to substantially stimulate job growth in this field. Comparisons with the employment for solar electricity in neighboring states additionally confirm the positive impact of this reduction measure on the workforce. For example, the numbers of employment for solar electricity installation in Louisiana, Georgia, Tennessee and are 3,810, 7,761, and 5,123, respectively.

6.1.7 Benefits to Low Income/Disadvantaged Communities

By providing low income/disadvantaged communities with higher incentives and investments and leveraging funding and resources from existing federal programs, this reduction measure could be expected to provide substantial benefits to these communities. EPA's Solar for All program, for example, aligns with objectives of this reduction measure and presents substantial opportunities to subsidize the installation costs of small-scale solar systems in low income/disadvantaged communities. The installation of small-scale solar systems serves as a valuable means to provide affordable electricity, whereas the promotion of solar system installations can lead to job creation for low income/disadvantaged communities. Adding small-scale solar systems can also provide a local energy source, increasing the energy resilience during periods of grid failures during extreme weather events. Overall, this reduction measure is expected to greatly facilitate and promote a just and equitable energy transition.

6.2 Utility Solar Generation and Storage

6.2.1 Description of Reduction Measure

Aligning with the previous reduction measure of promoting and increasing distributed energy resources for electricity, this reduction measure aims to increase the clean electricity generation at utility-scale power plants, specifically, the addition of solar power plants (e.g., 52.5 MW_{AC} Meridian III solar power plant in operation since 2019). It should be noted that the reduction of GHG emissions from electricity generation or generation of carbon pollution-free electricity (DOS and EOP 2021) includes both utilizing renewables such as solar and wind and as well as adopting/implementing other technologies like nuclear power and natural gas power plants with carbon capture and storage. While the electricity generation from these technologies such as wind, nuclear, natural gas with carbon capture can also help reduce the GHG emissions, solar electricity is considered a priority measure in this plan given the existing and developing solar projects statewide (MPSC 2023) and as well as in neighboring states. Promoting and facilitating the construction and operation of additional solar power plants are therefore identified as a priority measure in this report.

Similar to distributed, small-scale solar systems, the increase of utility-scale solar power plants provides important co-benefits to environment and benefits to low income/disadvantaged communities in addition to the reductions of GHG emissions for electric power sector. Reducing fossil fuel consumption leads to reduction of other air pollutants (SO_2 and NO_X). The construction, operation, and maintenance of utility-scale solar power plants can lead to substantial job creation. By directing and targeting the investments to low income/disadvantaged communities (e.g., leveraging the IRA bonus tax credits for energy communities and establishing workforce training programs as previously discussed in Section 5) can both benefit those communities and as well as lowering down costs for electricity utilities and increasing the pace of energy transitions.

6.2.2 Quantification of GHG Reduction Per Unit of Measure

Quantification of GHG reduction potential from utility-scale solar power plants is conducted, aligning with the methodology used to estimate GHG inventory and the reductions from small-scale solar systems described in the previous sections. Specifically, the estimation of GHG emission reduction is based on the additional generation from additional solar power plants by: (a) estimating the expected generation from added utility-scale solar power plants, which equals to the reduction of electricity generation from fossil fuels and (b) quantifying the corresponding reduction of GHG emissions from the reduced generation from using fossil fuels.

The following data were used to quantify the reduction measures:

a. Same electricity generation and fuel consumption for electricity production data from EIA State Energy Data System (EIA 2021a) and EIA State Electricity Profiles (EIA 2023b) used previously sections were applied in this section to quantify emission reductions from utility-scale solar for Mississippi. Specifically, total electricity generation from fossil fuels in 2022 for Mississippi is 58.3 TWh with the estimated 26.39 MMT CO_2-e of GHG emissions. The generation from additional solar power plants will therefore replace the same amount of electricity generation from fossil fuels and reduce the corresponding GHG emissions.

b. As also used in the previous section, EIA (2023a) provides the plant-specific information on generation capacity and annual total generation. These data were therefore used to quantify the generation factors for future solar power plants in Mississippi, i.e., annual electricity generation (MWh) per solar capacity added (MW).

c. Bolinger et al. (2023) reports the estimated national and regional costs related to utility-scale solar projects. Specifically, the national median price for installation is $1.32 per $watt_{AC}$ in 2022, whereas the price estimated for Southeast Regional transmission organization is $1.12 per $watt_{AC}$ in 2022, 15% lower than the national average. Additionally, the estimated operation and maintenance (O&M) cost in national median is $10.8 per kW_{AC} per year.

The following calculation procedures were applied to estimate the emission reductions per unit (MW_{AC}) of additional utility-scale solar capacity: (1) generation factors (i.e., MWh of generation per MW_{AC} of capacity) were calculated using historical annual total generation from individual solar power plants in Mississippi and their capacity information; (2) annual total generation from new solar power plants was calculated, which equals to the reduction of electricity generation from fossil fuels (note that the calculations were based on the electricity demand/generation and emission level in year 2020); (3) reductions of GHG emissions from the reduced generation from fossil fuels were then calculated by multiplying the amount of reduced generation by the emission factor in 2020.

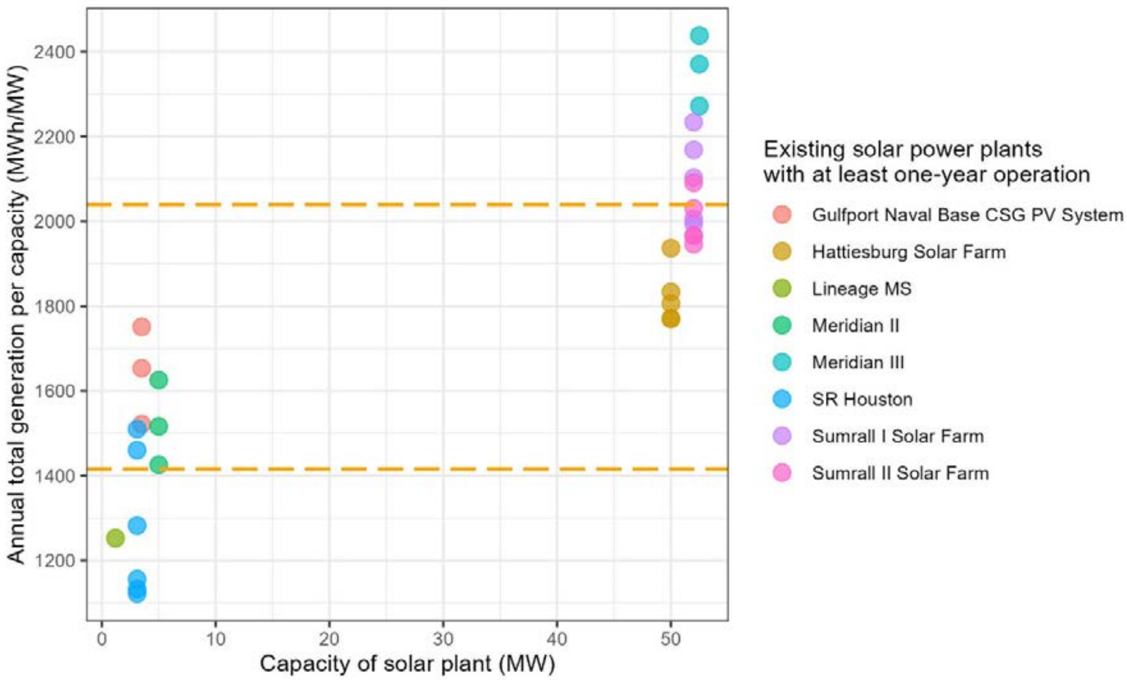

Figure 6-2. Annual electricity generation versus the AC capacities of existing solar power plants in Mississippi during 2018 to 2022. Two horizontal dashed lines show the average annual generation per AC capacity from smaller and larger systems. Data obtained from EIA (2023a).

As presented in Figure 6-2, larger solar power plants generally exhibit greater capacity factors and have higher values in the annual total generation per capacity. The existing solar power plants can generally be categorized as smaller plants (< 10 MW_{AC}) and larger ones (around 50 MW_{AC}) in Mississippi. To provide improved estimation of electricity generation from these facilities, the subsequent calculations were therefore conducted for these two different sizes separately.

The estimated emission reductions per added capacity is presented in Table 6-5.

Table 6-5. Estimated GHG reductions per unit of added utility-scale solar capacity in Mississippi.

	Smaller Facilities (<= 10MW)	Larger Facilities (> 10MW)
Annual generation factor (MWh per MW_{AC} capacity)	1500	2100
Emission factor (MT CO_2-e per MWh)	0.452	0.452
Annual emission reduction from the 2020 level per added capacity (MT CO_2-e per MW_{AC})	678.1	949.4

Based on the existing solar power plants in Mississippi, the average AC capacity of a smaller solar power plant is subsequently assumed to be 5 MW whereas a larger solar power plant is assumed to have a 50 MW_{AC}. Based on the results presented in Figure 6-2, the estimation of annual GHG emission reduction per utility-scale solar power plant are presented in Table 6-6.

Table 6-6. Assumed installed capacity of utility-scale solar facilities in Mississippi and associated GHG reductions from 2020 level.

	Smaller Facilities (< 10MWAC)	Larger Facilities (> 10MWAC)
Assumed AC capacity of one facility (MW_{AC})	**5**	**50**
Annual emission reduction from the 2020 level per facility (MT CO_2-e)	**3391**	**47469**

6.2.3 Quantification of Cost Range

Based on the cost information provided by Bolinger et al. (2023), it is possible to estimate the installation and O&M costs for a small-scale (5-MW_{AC}) and a large scale (50-MW_{AC}) solar power plant. Based on the regional installation price of $1.12 per $watt_{AC}$ and national median O&M cost of $10.80 per kW_{AC} per year, the estimated costs for a 5-MW_{AC} solar power plant is $5.6 million as installation price and $54000 per year as O&M cost, whereas 50-MW_{AC} plant is estimated to cost $56 million and $0.54 million per year as installation price and O&M cost, respectively.

The associated costs of constructing and operating utility-scale solar power plants in this reduction measure will primarily be covered by electricity producers and the investments from the IRA. As discussed in Section 5, the IRA provides production tax credits and investment tax credits to incentivize the production of renewable energy. Depending on whether additional requirements on wages, apprenticeship, locations, and domestic content are met, the tax credits can significantly increase, e.g., an investment tax credit of 6% can increase up to 50%. This substantial amount of investment from the IRA is expected to significantly stimulate the deployment of solar power plants in Mississippi.

The main strategy of this reduction measure is to leverage existing fundings from the IRA and facilitate the investment, construction, and operation of additional solar power plants in Mississippi with enabling policies. These policies include streamlining processes for procurement, establishing workforce training and apprenticeship programs, and leveraging technical assistance provided by the IRA programs. The overall cost for implementing this reduction measure is expected to be relatively low, with the expenditure mainly resulted from overhead costs and training programs.

6.2.4 Timeline of Implementation

The construction of utility-scale solar plants is currently growing rapidly in Mississippi, much more rapidly than solar rooftop capacity. As described in Section 5, the modeling of the IRA effect on the regional energy transition has been conducted by EIA (2023h), which suggests a substantial increase of utility-scale solar generation to 2050 and the highest rate of increase during the period of 2023 to 2030. Many utility-scale solar projects have been proposed and are pending reviews and approval in Mississippi (MPSC 2023). Consequently, the timeline of the implementation of this reduction measure is near-term, with a range of 0 to 10 years and beyond.

6.2.5 Co-benefits to Environment

Similar to the calculations of GHG emission reductions, the reductions of other air pollutants from electricity generation can also be calculated. Plant-level emission data were obtained from EIA (as also presented previously in Section 4.3.1 (EIA 2023a)) and used to estimate the emission reductions of SO_2 and NO_x per unit of added capacity and per installed solar system at a residential/commercial building. These results are presented in Table 6-7.

Table 6-7. Estimated SO_2 and NO_x emission reductions per unit of added capacity and per utility-scale solar facilities in Mississippi.

	Smaller Facilities (< 10 MW_{AC})	Larger Facilities (> 10 MW_{AC})
Emission factor (kg SO2 per MWh of electricity generation)	0.0408	0.0408
Emission factor (kg NOX per MWh of electricity generation)	0.215	0.215
Annual emission reduction per added capacity (kg SO2 per MW_{AC})	61.2	85.7
Annual emission reduction per added capacity (kg NOx per MW_{AC})	146.1	204.6
Annual emission reduction per facility (kg SO2)	306	4287
Annual emission reduction per facility (kg NOx)	731	10229

6.2.6 Workforce Impact

Together with the measure of promoting distributed solar, this reduction measure is expected to greatly stimulate job creation in the solar electricity industry. The employment growth is expected on the associate sectors such as project development, installation, manufacturing, and O&M. As discussed previously, 1319 workers are employed for solar electricity in Mississippi in 2022 (with about 330 MW of total solar capacity in operation). The projected increase of solar projects (e.g., a total of 2413 MWac of solar projects have been approved by Mississippi Public Service Commission (MPSC 2023) since 2015) is therefore expected to significantly increase the related employment in the state.

6.2.7 Benefits to Low Income/Disadvantaged Communities

Aligning with existing investments and resources provided by the IRA, this reduction measure is expected to provide substantial benefits to low income/disadvantaged communities. The IRA provides bonus tax credits for projects located in energy communities, which will be leveraged by this reduction measure to direct investments to these communities to facilitate local employment growth and economic development. This reduction measure additionally aims to establish workforce training and apprenticeship programs targeting the solar electricity industry with a particular emphasis on the low income/disadvantaged communities. These training programs and other enabling policies will facilitate the workforce from the low income/disadvantaged communities to obtain prevailing wages, while also providing opportunities for electricity providers to obtain bonus tax credits to speed up solar power investments and deployment.

6.3 Electricity Transmission and Distribution Upgrades

6.3.1 Description of Reduction Measure

This priority measure aims to reduce transmission and distribution losses and reduce overall electricity generation needed through increased transmission and distribution efficiency. As presented previously in Table 4-3, annual electricity transmission and distribution losses account for 2.6 TWh (~4.4% of annual total generation) in Mississippi in 2017. Losses occur at various stages of electricity transmission and distribution, e.g., use of transformers to increase and decrease voltage and transmission and distribution lines, providing different opportunities to reduce losses at these individual stages. The transmission and distribution losses are a function of the distance between generators and consumers (i.e., the longer the transmission distance, the greater the losses), the voltage and resistance of transmission lines (i.e., the quality of transmission lines), and the amount of energy flowing through transmission lines (i.e., higher loads generally lead to more heat and more losses).

6.3.2 Quantification of GHG Reduction Per Unit of Measure

Quantification of GHG reductions from improving electricity transmission and distribution was conducted based on the disposition of electricity generation in Mississippi as presented in Table 4-3. A 5% reduction of transmission and distribution losses (i.e., a 5% reduction of losses in 2017 is about 130,000 MWh of electricity) from this measure is estimated to result in 59,000 MT CO_2-e of GHG reductions from electricity savings.

Additionally, a coordination between Mississippi and Tennessee has been conducted to determine GHG reduction potentials from this reduction measure for the Tennessee Valley Authority (TVA) service territory. The SIT was used to quantify the GHG reductions from improving transmission and distribution by 0.5% to 4.0%. The estimated annual GHG reduction for the TVA service territory within Mississippi is 16,700 MT of CO_2-e.

6.3.3 Quantification of Cost Range

Upgrades of electricity transmission and distribution can be performed for different stages of transmission and distribution, e.g., transformers, conductors, and electric motors, which are associated with different costs and effectiveness. As described in NACAA (2015), selecting and using high-efficient components during the time of system upgrades (with a slightly higher capital cost) are highly cost-effective and provide substantially higher benefit-to-cost ratios than retrofitting and replacing the existing components. DOE Programs such as Grid Resilience and Innovation Partnerships Program (DOE 2023b) also provide additional resources and opportunities for implementation of this measure.

6.3.4 Timeline of Implementation

The programs for upgrading electricity transmission and distribution can be implemented with different timelines including at a near-term timeframe. DOE Grid Resilience and Innovation Partnerships Program (with three separate programs for increasing grid resilience, deploying smart grid technologies, and leveraging grid innovation) has a period of performance of 5-8 years (DOE 2023b). Aligning with these DOE programs, this measure of improving and upgrading electricity transmission and distribution in Mississippi can be implemented with a similar near-term timeline of within the next 10 years.

6.3.5 Co-benefits to Environment

In addition to GHG reductions, reducing the total electricity generation by improving electricity transmission and distribution can lead to reductions of other air pollutants from electricity generation. Similar to the NO_X and SO_2 reductions calculated for the previous measures, a 5% reduction of losses in 2017 (i.e., 130,000 MWh of electricity) can lead to 28 MT and 5.3 MT of NO_X and SO_2 reductions, respectively.

6.3.6 Workforce Impact

Together with the other measures implemented for electric power sector, this reduction measure is expected to greatly stimulate job creation including positions related to updating grids and transmission lines and manufacturing. Related workforce training and apprenticeship programs can be integrated to further create employment opportunities, stimulate local economies, and increase the positive impact of this measure.

6.3.7 Benefits to Low Income/Disadvantaged Communities

Aligning with other measures implemented for electric power sector, this reduction measure is expected to provide substantial benefits to the low income/disadvantaged communities. Modernizing electrical infrastructure enhances the overall system efficiency and may reduce outage occurrences, supports cost savings, increases affordability of electricity, and improves quality of life at low income/disadvantaged communities. By developing programs specifically emphasizing on improving electricity distribution at these communities, this measure provides resources to improve employment opportunities and provide benefits to the low income/disadvantaged communities.

6.4 Cargo Transportation to Rail

6.4.1 Descriptions of Reduction Measure

According to the U.S. Department of Transportation and the Association of American Railroads (Association of American Railroads 2024; FHWA 2024), national freight transportation constituted about 8% of total GHG emissions in the U.S. in 2018, with Mississippi contributing approximately 6 MMT of CO_2-e during the same year. Trucking accounted for 4.5 MMT CO_2-e, while rail contributed less than 0.5 MMT CO_2-e. Shipping by truck generally has an energy intensity

5-14 times higher than shipping by rail, depending on various factors. By incentivizing cargo transportation by rail, Mississippi could potentially reduce CO_2 emissions between 0.5 and 3.5 MMT CO_2-e annually, with the potential for further reductions through the adoption of electric or H_2 locomotives and transitioning to cleaner electricity. The Port of Gulfport is already promoting rail transportation of cargo, and the Coastal Plain Regional Group is poised to support and enhance this initiative with additional funding.

6.4.2 Quantification of GHG Reduction Per Unit of Measure

Results of a previous study conducted by California Air Resources Board (2020) can be used to quantify the emission differences between trucking and rail shipping, which are subsequently used to quantify the emission reductions from this measure of promoting rail transportation. Specifically, the comprehensive comparison of GHG, NO_X, and PM emissions between trucking and train shipping conducted by California Air Resources Board (2020) focuses on transporting a specific cargo quantity 300 miles. The 2016 scenario, applicable to Mississippi's fleet, indicated 'well-to-wheel' GHG emissions of 160 MT CO_2-e by truck and 38 MT CO_2-e by rail for 260 containers (Figure 6-3). In 2017, the state dealt with 146,000 containers, and using rail exclusively could reduce emissions by 3.5 MMT CO_2-e, primarily due to the improved energy intensity of rail transport. However, as national policies decrease trucking emissions, the rail sector is expected to adopt more stringent standards and consider compressed natural gas, liquefied petroleum gas, electric, H_2, and biofueled trains to maintain efficiency and air quality advantages. Future emission reductions therefore depend on the mix of actions and policies utilized and implemented.

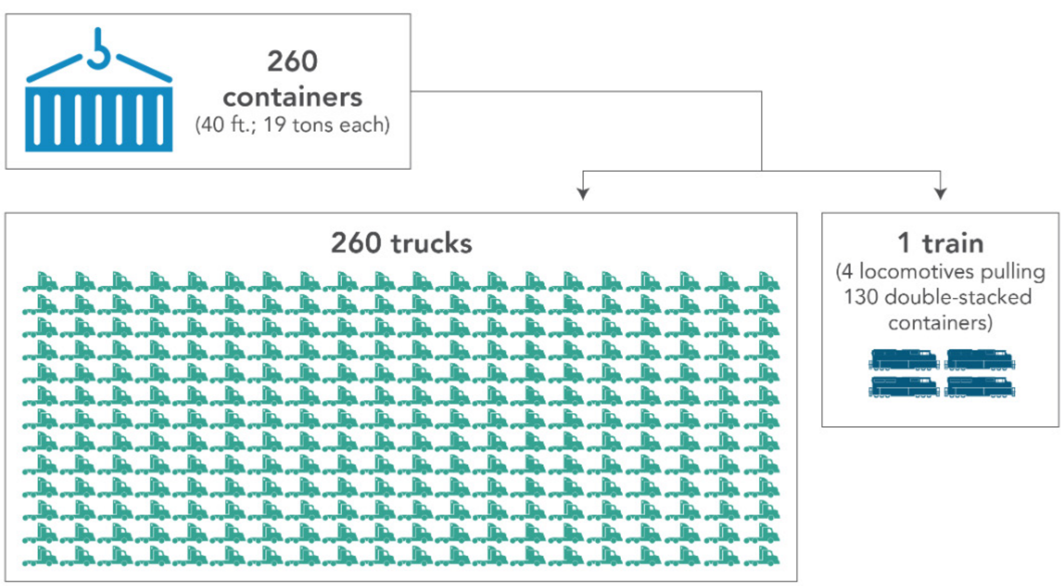

Figure 6-3. Emissions Analysis for moving containers 300 miles (California Air Resources Board 2020).

6.4.3 Quantification of Cost Range

Associated costs from implementing a cargo-by-rail initiative depend on program scale and scope. A cargo-by-rail initiative program includes efforts and expenditures related to administration, detailed emission estimates, promotion efforts, comprehensive cost and benefit assessments, funding for rail line improvements, capital cost offsets, and zero-emission/low-emission locomotives and infrastructure. This program aims to support revenue generation in Mississippi by lowering transportation costs for shippers, leading to increased cargo transport needs and clientele.

6.4.4 Timeline of Implementation

This measure of implementing a cargo-by-rail initiative program has a timeline of five years. The tasks involved for this 5-year program include: (1) establishing program administration and evaluating emissions, costs, infrastructure, and a commercial plan, and engaging with local communities and industries in Year 1; (2) tracking shipments and piloting conversion campaigns including incentives in Year 2; (3) adjusting and potentially expanding conversion efforts in Year 3; and (4) focusing on adding electric or H_2 trains, evaluating emission reductions, comparing costs to projections, and adjusting the program as needed in Years 4 and 5.

6.4.5 Co-benefits to Environment

This GHG reduction measure is expected to provide additional benefits in reducing co-pollutants and improving air quality. According to California Air Resources Board (2020), cargo transportation by rail transportation can emit lesser amount of particulate matter and NO_X compared to emissions from cargo transportation by truck especially for long-distance transport.

6.4.6 Workforce Impact

This measure is expected to result in a transition of employment in trucking and rail industries and creation of new jobs related to rail infrastructure. Although this measure could reduce the number of trucking jobs, drivers could transition to drayage and last-mile drivers (i.e., delivery drivers who operate at the final step of the supply chain) through workforce cross-training programs. Additional jobs are expected to be created to support train upgrades and rebuilds, infrastructure improvement, logistics, and planning. A detailed workforce assessment is needed however to evaluate the willingness of the existing trucking workforce related to the transition to alternate positions.

6.4.7 Benefits to Low Income/Disadvantaged Communities

Table 6-4 shows the existing rail lines in MS overlaid with the low income and disadvantaged communities.

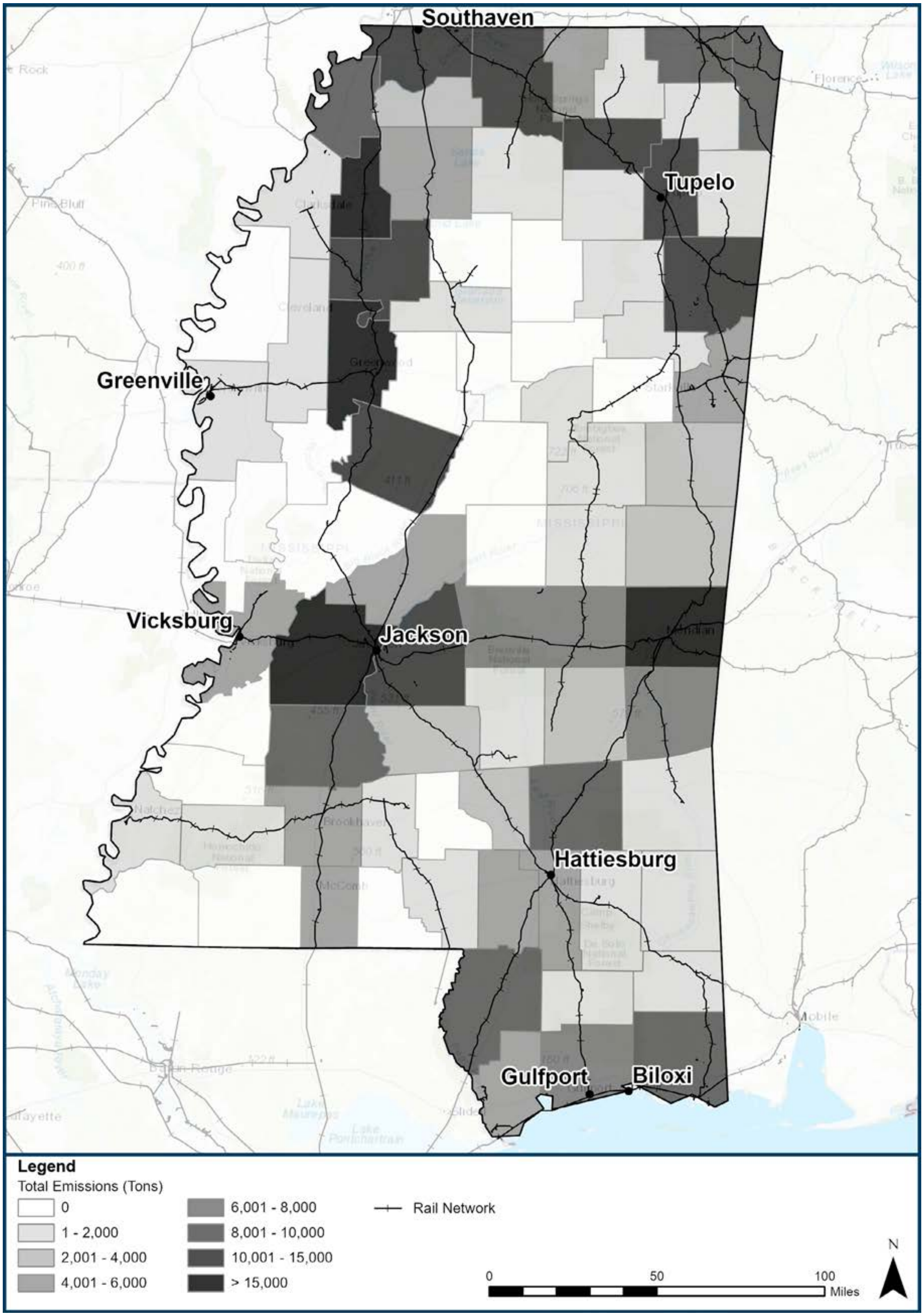

Figure 6-4. Existing Mississippi rail lines overlaid with total GHG emissions.

Most of the major rail lines in Mississippi run through several low income and disadvantaged communities and track major transportation routes. Low income and disadvantaged communities near both rail lines and trucking routes would benefit from reduced air pollution. In urban areas, train and truck routes vary and moving cargo to rail could result in new emissions in some low income and disadvantaged communities. Engagement with impacted communities and detailed emissions estimates at a county or local level should be conducted to evaluate the benefits and burdens of this reduction measure.

A study conducted by the Congressional Budget Office released in 2015 (Austin 2015) found that moving cargo via rail costs about 5.1 cents per ton-mile, compared to 15.6 cents per ton-mile when using trucks. Additionally, Austin (2015) found that external costs per ton-mile amounted to about \$2.62 – \$5.86 for road transport compared to only \$0.3 – \$0.82 for rail transport. A lower cost of transit for goods could result in lower costs for goods to consumers, additionally benefiting low income and disadvantaged communities.

6.5 Vehicle Transition

6.5.1 Descriptions of Reduction Measure

Mississippi aims to achieve GHG reductions in the transportation sector, which accounts for over 25% of statewide emissions. This proposed reduction measure focuses on accelerating the state's transition to alternative fuels, including battery electric, plug-in hybrid, or H_2 vehicles. Key priorities involve supporting public and commercial fleet transitions, enhancing charging infrastructure access, and addressing concerns related to cost and reliability. Notably, alternative fuel vehicles like battery electric and H_2 fuel cell vehicles produce lower tailpipe emissions. This measure aligns with ongoing initiatives, emphasizing vehicle transition (including transition to battery electric, plug-in hybrid, or H_2 vehicles).

This priority measure targets the transition of vehicles at various weight classes (including light-duty trucks) with a particular focus on the transition of medium- and heavy-duty vehicle (MHDV) to alternative fuels. The categories of light-, medium-, and heavy-duty are classified by FHWA weight classes (DOE 2023c). MHDVs belong to Class 3 to Class 8, including long haul semitrucks and work vehicles like garbage trucks.

Both opportunities and challenges exist for deploying wide vehicle transition especially for MHDV. Recent motor vehicle registration data for Mississippi reveals 2,067,498 registered vehicles, with 39.9% being automobiles and 59.7% trucks (DOT 2022). GHG emissions show automobiles contribute to 62% of transportation GHG emissions, and trucks contribute 30%. Most MHDVs use petroleum-based diesel, while battery electric MHDVs offer higher efficiency and lower emissions. Limited EV adoption is attributed to shorter range and longer refueling times compared to internal combustion engine vehicles. According to MHDV manufacturers, current battery technology allows for ranges of 150- (e.g., Kenworth T680E and Peterbilt 579EV) to 500-miles (e.g., Tesla Semi). This range suits local fleet operations, which should be targeted during transition of MHDV in near term. However, broad adoption faces challenges due to the higher cost of plug-in hybrid and EV vehicles. Short-term efforts should concentrate on achieving cost parity, enhancing alternative fuel infrastructure, and providing workforce development to promote increased adoption.

Substituting internal combustion engine vehicles with alternative MHDV such as EV yields a significant reduction in life cycle GHG emissions, ranging from 46% to 86%, contingent on the carbon intensity of the electric grid (O'Connell et al. 2023). A well-to-wheel analysis (Liu et al. 2021) indicates that Class 2 vehicles emit 395 g of CO_2-e per mile, while Class 8 trucks emit 1862 g CO_2-e per mile. GHG reduction potential for garbage trucks, using locally sourced renewable energy, is approximately 60%, contrasting with long-haul trucks heavily reliant on the fossil fuel-dependent electricity generation. Similarly, the emissions of co-pollutants such as PM and SO_2 from the electricity used by EVs are also dependent on the energy used in electricity generation. Despite these challenges, increased EV adoption supports long-term GHG reductions and local air quality improvement, with MHDV emission reduction potential ranging from 719 to 2205 g CO_2-e per mile.

6.5.2 Quantification of GHG Reduction Per Unit of Measure

Quantification of GHG reductions for this measure of vehicle transition focuses on the transition to EV specifically in this section, given that the more information is available for EV (compared to other types such as H_2 vehicles). The calculations also focus on battery EV, because other types of vehicles such as hybrid EV can be more complex to estimate. GHG reductions from transition to other types of vehicles can be quantified for more comprehensive CCAP if needed.

The quantification of GHG reductions from transition to EV is based on three key parts: (1) estimated average VMT for different types of vehicles in Mississippi; (2) the corresponding fuel consumption and GHG emissions from the distances traveled; and (3) the electricity consumption and emissions from the electricity generation for alternative EV with same distances traveled.

It is also important to note that the VMT, fuel consumption, and emissions per fuel use depend on the type of vehicles (e.g., light duty gasoline vehicles, light duty diesel truck, and heavy-duty diesel vehicles as defined in the SIT and by USEPA (DOE 2023c)) and as well as model years of vehicles. During the calculations of GHG emissions for transportation sector in Section 4, the SIT provides separate calculations of CH_4 and N_2O emissions (and alternative CO_2 emission calculation) for different types of vehicles and different model years. The quantification of GHG emissions and reductions from vehicle transition conducted in this section thus are consistent with the inventory estimates from using the SIT in Section 4. Additionally, the vehicle types defined and used in the SIT and USEPA (2023c) – for which the quantified GHG reductions were separately estimated in the subsequent discussions – are slightly different from the FHWA weight classes (DOE 2023c).

Annual VMT and vehicle population for different types of vehicles and different model years in Mississippi were estimated based on the data and information provided by the FHWA (2019) and

USEPA (2023c). Specifically, FHWA Highway Statistics 2019 (FHWA 2019) was used to obtain the total VMT and vehicle registration numbers in the U.S. and in Mississippi, whereas USEPA (2023c) provides the estimated percentages of different model years for different vehicle types in the U.S. (estimated using the USEPA's MOVES model and using the same FHWA highway statistics data source; Mississippi-specific estimates are not available). These data and estimates therefore facilitate the calculations of annual VMT for different vehicle types and different model years in Mississippi.

As of 2019, there are 2.06 million registered vehicles in Mississippi (1.93 million light duty vehicles, 0.10 million single-unit and combination trucks, 31.5 thousand motorcycles, and 7.43 thousand buses), with a total of 41.1 billion miles traveled. Average VMT per registered vehicle in Mississippi is therefore around 19,900 miles per year, 69% greater than the national average (~11,800 thousand miles). Depending on the vehicle types, the median ages of vehicles in the U.S. are between 7 to 12 years, whereas the average miles traveled (which also depends on the model years) is around 10,000 miles for light duty vehicles, 21,000 miles for heavy duty diesel vehicles, and 1,800 miles for motorcycles (USEPA 2023c). Based on this information and statistics, the estimated annual average miles traveled for different types of vehicles in Mississippi (i.e., national average of VMT by vehicle scaled with a 169% to consider the greater average VMT per registered vehicle in Mississippi) are presented (Table 6-8).

Table 6-8. Estimated annual average VMT and corresponding fuel consumption by vehicle type in Mississippi.

Vehicle type (DOE 2023c)	Annual average VMT per vehicle (mile)	Fuel	Annual average fuel consumption (gallon)
Light duty gasoline vehicle	19000	Gasoline	788
Light duty gasoline truck	21000	Gasoline	1130
Heavy duty gasoline vehicle	20000	Gasoline	2830
Light duty diesel vehicle	20000	Distillate Fuel Oil	616
Light duty diesel truck	21000	Distillate Fuel Oil	951
Heavy duty diesel vehicle	40000	Distillate Fuel Oil	6070
Heavy duty diesel buses	32000	Distillate Fuel Oil	4860
Motorcycle	4000	Gasoline	80

The fuel consumption and subsequent emissions per VMT by vehicle type and by model year were calculated based on the default parameters and coefficients used in the SIT. The results of estimated fuel consumption for the annual average VMT by vehicle type are also presented in Table 6-8. Emissions of CO_2, CH_4, and N_2O can subsequently be estimated using the fuel consumption in Table 6-8 and based on the coefficients provided by the SIT.

Quantification of GHG reductions from the transition to EV additionally requires an estimation of GHG emissions from the electricity consumption in EV. The emission factors for electricity end use have been calculated and is presented previously in Section Emission Source. Because the electricity generation from using renewables (as also described in Section Emission Source) are projected to increase, the GHG reduction benefits are therefore expected to increase as well. To quantify the greater benefits of GHG reductions from cleaner electricity, the emission factors for electricity end use at year 2020 and 2030 (as presented previously in Figure 5-4) were used to quantify the GHG reductions from transition to EV.

Additionally, energy efficiency ratios of EV analyzed and estimated in the previous studies (California Air Resources Board 2018; Singer et al. 2023) were used to calculate the electricity consumption of EV for the same amount of VMT. These electric vehicle efficiency ratios represent the relations between the energy used from internal combustion engine vehicles and the energy (i.e., electricity) used for EV for the same amount of travel. Generally, the heavier and slower the vehicle, the higher the EV efficiency ratios and the greater benefits from the EV (California Air Resources Board 2018). The technology development of EV also led to the increase of EV efficiency ratios in recent studies (Singer et al. 2023). The EV efficiency ratios were therefore assumed as 4.5 for light duty vehicles (based on the EPA classifications) and 5 for heavy duty vehicles based on the information provided in the previous studies (California Air Resources Board 2018; Singer et al. 2023).

Annual GHG reductions per 1000 vehicles transitioned to EV were therefore quantified for each of the following vehicle types: light duty gasoline vehicles, light duty gasoline trucks, heavy duty gasoline vehicles, light duty diesel vehicles, light duty diesel trucks, and heavy duty diesel vehicles (Table 6-9).

Table 6-9. Estimated GHG reductions in Mississippi per 1000 vehicles transitioned to EV by vehicle type.

Number and types of vehicles	Annual GHG emissions from fuel/electricity used (MT CO_2-e)			Annual GHG reductions (MT CO_2-e)	
	Internal-combustion-engine vehicles	Equivalent EV (with 2020 electricity generation)	Equivalent EV (with projected 2030 electricity generation)	With 2020 electricity generation	With projected 2030 electricity generation
1000 light duty gasoline vehicles	6550	2720	1430	3830	5120
1000 light duty gasoline trucks	9430	3910	2050	5520	7380
1000 heavy duty gasoline vehicles	23500	8780	4600	14720	48900
1000 light duty diesel vehicles	6420	2350	1230	4070	5190
1000 light duty diesel trucks	9840	3630	1900	6210	7940
1000 heavy duty diesel vehicles	62600	20840	10900	41760	51700
Total reduction (6000 vehicles)				**76100**	**96200**

It should be noted that, as described previously, the vehicle types presented in Table 6-9 are slightly different from the FHWA weight classes (DOE 2023c). The vehicle types presented in Table 6-9 are based on the EPA classifications: vehicles with gross vehicle weight ratings less than 8,500 pounds are classified as light duty, whereas the ones more than 8,500 pounds are classified as heavy duty. FHWA vehicle classes are also based on the gross vehicle weight ratings, but vehicles with the weight ratings less than 10,000 pounds are classified as light duty, 10,001 to 26,000 pounds as medium duty, and ones with more than 26,000 pounds are classified as heavy duty. Consequently, the MHDV based on FHWA classifications generally corresponds to the estimation results for heavy duty vehicles presented in Table 6-9.

6.5.3 Quantification of Cost Range

The cost of one EV semitruck is over $350,000, more than double the cost of a new internal combustion engine truck of the same size. New charging infrastructure for MHDV is typically in the $200,000 range after utility coordination, stakeholder engagement and design and construction are complete. Light duty pickup vehicles like the Ford Lightning or the GM Silverado EV cost between $40,00 and $65,000. Home and public charging options can be between $6,000 and $18,000. Home level 2 chargers may require electrical upgrades. To support the transition to EV and other lower emission alternative fuels, the state intends to support fleets and truck owners with access to existing programs and provide additional fundings especially for low income and disadvantaged communities where assistance accessing capital may be needed.

6.5.4 Timeline of Implementation

A 3-5 year timeline is needed for vehicle transition beginning with identifying a team, program, and funding in the first year followed by continuously monitoring and tracking progress, and evaluating successes and needs to increase EV adoption.

6.5.5 Co-benefits to Environment

Substituting internal combustion engine vehicles with EV (and other alternative vehicles) not only decreases NO_2 pollution but also addresses health risks associated with diesel particulate emissions, including cardiovascular issues and respiratory problems. The vehicle transition is expected to reduce tailpipe emissions for communities near roadways, though evaluations and mitigation measures for potential emissions from increased energy generation are essential. Coupled with a transition to clean electricity, the co-benefits of reducing air pollution can further increase for this measure.

6.5.6 Workforce Impact

Vehicle transition in MS would support new jobs in the manufacturing industry and other employment related to driving, safety, and maintenance. Additionally, construction, engineering, and electrical work will be required to build the charging infrastructure. Further workforce impact analysis is needed to examine the transition of employment opportunities such as the jobs related to vehicle fueling; workforce cross-training programs should also be established to prevent job loss due to the transition and to provide additional employment opportunities.

6.5.7 Benefits to Low Income/Disadvantaged Communities

Benefits include improved public health from reductions of co-pollutants, creation of high-quality jobs and workforce development opportunities, reductions of energy costs, increase of energy security, and reduced noise pollution.

6.6 School Bus Electrification

6.6.1 Descriptions of Reduction Measure

Deploying electric school buses (ESBs) is established as a reduction measure for Mississippi, which includes providing gap funding for ESBs and infrastructure, establishing municipal electrification hubs, supporting state green banks, creating a technical assistance center, implementing workforce development programs, and setting statewide ESB adoption targets. While the expansion of ESBs benefits communities by reducing air pollution and lowering fuel costs, it may adversely affect stakeholders such as diesel bus mechanics, utilities, and school districts preparing for charging infrastructure needs. Specific criteria and details of these measures could impact stakeholders differently, underscoring the need for careful consideration in their implementation.

6.6.2 Quantification of GHG Reduction Per Unit of Measure

Quantification of GHG reductions for this measure of deploying ESB follow a calculation procedure similar to the estimation conducted in the previous section for the vehicle transition measure. Specifically, the annual average VMT of 20,000 miles is assumed (instead of the estimated VMT presented previously in Table 6-8 for heavy duty diesel buses) for a school bus and its corresponding fuel consumption is subsequently used to estimate GHG emissions per 100 school buses; the corresponding electricity use and emissions from 100 ESBs for the same amount of VMT was subsequently calculated; and the GHG reductions from this replacement of 100 diesel school buses were then estimated. The electric vehicle efficiency ratio of ESB is assumed as 5 based on the previous study (California Air Resources Board 2018).

Annual GHG emissions and emission reductions for replacing 100 diesel buses with ESBs were therefore estimated (Table 6-10).

Table 6-10. Estimated annual GHG reductions from replacing 100 diesel buses with ESBs.

	Number of school buses and types	Annual GHG emissions and reductions (MT CO_2-e)
Annual GHG reductions	100 diesel school bus (with 20,000 annual VMT per vehicle)	3140
	100 equivalent ESB (with 2020 electricity generation)	1040
	100 equivalent ESB (with projected 2030 electricity generation)	550
Annual GHG reductions	With 2020 electricity generation	2100
	With projected 2030 electricity generation	2600

6.6.3 Quantification of Cost Range

Cost comparisons of different ESB related programs which may fit within CPRG funding have been conducted by WRI (Table 6-11), serving as a basis to evaluate the associated cost of this measure. Further cost breakdowns for ESB and related infrastructure are subject to some uncertainty and limitations from the existing data and were therefore not conducted for this PCAP.

Table 6-11. Comparisons of associated costs for the ESB-related programs and policies.

Program and Policy	Tier	Grant Ranges
ESB Transition Target New Sales, Full Fleet	Limited, but should be paired with funding	Tier A: $200 million to $500 million
ESB Funding Include a low income and disadvantaged communities %	Tier A, B, C (depending upon size of fleet)	Tier B: $100 million to <$200 million
Infrastructure Funding Include a low income and disadvantaged communities %	Tier A, B, C (depending upon size of fleet)	Tier C: $50 million to <$100 million
ESB Financing	Tier B, C, D – used for initial capitalization	Tier D: $10 million to <$50 million
Workforce Development Drivers/ Mechanics	Tier B, C	Tier E: $2 million to <$ 10 million
State/ Regional Technical Assistance Center Fleet Assessments, Utility Coordination, Infrastructure	Tier D, E	
Municipal Electrification Hubs	Tier B, C	

6.6.4 Timeline of Implementation

This ESB initiative outlines the following timeline for implementing an ESB fleet: 3-6 months for program foundation setting, 12-24 months for infrastructure and operations planning and installation, and continuous training, monitoring, and development afterwards.

6.6.5 Co-benefits to Environment

This reduction measure of implementing an ESB initiative can provide co-benefits of reducing waste, reducing the emissions of co-pollutants from fossil fuel combustion, and helping balance peak electricity demand. ESBs require less maintenance and overall reduced demand in required parts, consequently leading to reduction in the waste stream from the disposal of associated discarded parts and fluids (such as oil). Similar to electrifications of other vehicles, the adoptions of ESB can lead to reductions of other co-pollutants, although the net benefits depend on the emissions from electricity generation and will increase with additional clean energy used for generation of electricity. Additionally, ESB fleets can partner with local utilities to feed power back into the grid when buses are not in use and electricity demand is high, which would reduce strain on the local power grid and reduce costs for school districts.

6.6.6 Workforce Impact

Training will be needed for EV safety, operation, and maintenance. Coordinating a bus program with other workforce development and training programs would help reduce costs and increase opportunities for people who complete the training.

6.6.7 Benefits to Low Income/Disadvantaged Communities

This reduction measure will provide benefits to low income/disadvantaged communities include improved public health from reduction in co-pollutants, creation of high-quality jobs and workforce development opportunities, decreased energy costs and increased energy security, and reduced noise pollution.

6.7 Alternative Fueling Infrastructure

6.7.1 Descriptions of Reduction Measures

By deploying and constructing additional alternative fueling infrastructure (e.g., electric charging stations), this measure aims to serve as another strategy to promote and stimulate the adoption of EV and other alternative vehicles. Adoption of EV, along with other types of vehicles such as H_2 vehicles, faces significant barriers, one of which is the lack of charging/fueling infrastructure. The adoption of EV and deployment of charging stations are also interdependent, i.e., the lack of charging stations leads to slower adoption of EV, which in return affects the development of new charging stations. By developing a priority measure and establishing programs to deploy and speed up the development of new charging/fueling infrastructure, this measure can promote vehicle transition with a positive feedback loop between adoption of EV and other alternative vehicles and deployment of supporting charging/fueling infrastructure.

The Federal Highway Administration approved the Mississippi Electric Vehicle Infrastructure Deployment Plan on September 14, 2022, responding to the National Electric Vehicle Infrastructure Formula Program. The plan's mission is to provide reliable, accessible, and equitable EV charging infrastructure across Mississippi, focusing on main interstates. Additionally, the alternative fueling infrastructure (e.g., level 2 and rapid electric charging stations) will be deployed along east-west and distribution routes and near urban and education hubs such as college campuses to optimize the benefits of this measure.

6.7.2 Quantification of GHG Reduction Per Unit of Measure

While the deployment of charging/fueling infrastructure by itself will not lead to reductions of GHG emissions, such infrastructure will help to facilitate the GHG reductions anticipated from fleet transition (Kelly et al. 2022). The GHG reduction results estimated and presented in previous Section Emission Source for vehicle transition measure can therefore serve as a basis for the assessment of GHG reduction benefits from this reduction measure.

The quantification of GHG reductions from the deployment of alternative fueling infrastructure focuses on the development of electric charging stations and was conducted in this section in a preliminary manner, given the relative complexity from the effect of increasing charging (or other alternative fueling) stations on the sales of EV (or other alternative vehicles). Only increase of battery EV sales from additional charging stations was estimated (i.e., increase on the sales of plugin hybrid EVs was not estimated); these additional EV sales were also assumed to be light duty vehicles, replacing light duty gasoline vehicles.

According to MDOT (2023), a total of 780 battery EV is registered in Mississippi in 2020 and a total of 42 DC fast charge and Level 2 charging stations are available as of 2022.

The effect of increasing charging stations on the increase of EV sales have been studied, which serves as the basis for the subsequent calculation. Li et al. (2017), for example, suggests an elasticity ratio of EV adoption with respect to charging station to be 0.84 (i.e., 1% increase of charging stations leads to 0.84% increase of EV demand), while other studies (Austin 2023) have found lower elasticity ratios (e.g., 0.4). Given that the numbers of charging stations and EVs in Mississippi are small and the number of charging stations per EV is also low (in comparison, there are 30,000 EV and over 6,000 charging stations nationwide in 2013), a higher value of 0.8 was assumed and used as the elasticity ratio of EV demand from charging stations.

A total of 100 new charging stations was used to quantify the GHG reductions per unit measure. 100 new charging stations indicates a 238% increase from the existing number of stations, which subsequently is estimated to result in 200% increase of EV demand (i.e., 1560 EVs). The annual GHG reductions from this replacement of 1560 light duty gasoline vehicles with EVs (based on the calculations presented in Table 6-9) were therefore estimated as 5970 MT CO_2-e (using electricity generation in 2020) or 7990 MT CO_2-e (using the projected electricity generation in 2030).

6.7.3 Quantification of Cost Range

The cost of alternate fueling infrastructure will vary depending on location, type of fueling, number of stations, land ownership, utilization of incentives, loan programs, and grant funding. Several current programs are available in MS including the Alternative Fuel Vehicle (AFV) Revolving Loan Program, the Commercial Electric Vehicle (EV) Charging Station and Off-Road Equipment Rebate from MS Power, EV Charging Station Rebate from TVA, and the EV and EC Charging Station Incentive from Entergy. Additionally, the specific utility responsible for electricity in the location of a new station may have additional funding options. In general, the cost can range from $2,000 for small installations similar to a home charger with no land purchase needed to over $200,000 for larger fast direct current charging stations. There are some additional costs associated with the supply of electricity or fuel which depend on the amount of onsite storage available to offset peak use costs.

6.7.4 Timeline of Implementation

Through the National Electric Vehicle Infrastructure Formula Program, MDOT is considering a 3-year timeline including establishing a steering committing, creating resources and working with coalition states, and addressing issues and monitoring progress.

6.7.5 Co-benefits to Environment

The co-benefits of this measure are mainly provided by the transition of transportation fleet, which is facilitated and supported by this measure of providing, promoting, and improving alternative fueling infrastructure.

6.7.6 Workforce Impact

This measure creates regional jobs related to design, construction, operation, and maintenance of alternative fueling infrastructure. Additional workforce development programs can be implemented to help prevent job loss through cross-training employees in vulnerable positions.

6.7.7 Benefits to Low Income/Disadvantaged Communities

This measure will provide engagement opportunities and reduce air pollution from greater adoption of EV especially in low income/disadvantaged communities. This measure will additionally create job opportunities and provide workforce training programs related the construction and operation of these alternative fueling infrastructure with specific focus on low income and disadvantaged communities.

6.8 Biofuel Use for Transportation or as an Energy Source

6.8.1 Descriptions of Reduction Measures

This measure aims to replace the diesel or other types of fuels used in transportation and other sectors with biodiesel and similar biofuels. The quantification of GHG reductions and related discussions focus on biodiesel in this section (because of the availability of existing information on biodiesel), although similar calculations and programs can be carried out for other types of biofuels. Biodiesel is renewable fuel that can be manufactured from vegetable oils, animal fats, recycled restaurant grease, or other sources such as oil seeds for use in diesel vehicles or any equipment that operates on diesel fuel. Biodiesel's physical properties are similar to those of petroleum diesel. Mississippi currently has a 1.2% market share of biodiesel vehicles, with about 31,600 vehicles registered in 2022 (DOE 2024a). Engines manufactured after 2010 are required to meet the same emissions standards, whether running on biodiesel, petroleum diesel, or any alternative fuel. Selective catalytic reduction technology in diesel vehicles makes this possible.

6.8.2 Quantification of GHG Reduction Per Unit of Measure

Biodiesel is produced entirely from non-fossil sources and has been estimated to reduce GHG emissions by 74% (Huo et al. 2008). A gallon of diesel produces 10.18 kg of CO_2-e emissions (USEPA 2024a). To the extent that a gallon of biodiesel is a substitute for a gallon of regular diesel, the CO_2 emissions avoided are 74% of regular diesel. Total sales of diesel in Mississippi are 867 million gallons (2021 data). If approximately 1% of this fuel is biodiesel (consistent with the market share of biodiesel vehicles), then the avoided CO_2 emissions are 65,300 MT annually or 0.065 million tons annually. As described previously, similar calculations and programs can be carried out for other types of biofuels as well.

6.8.3 Quantification of Cost Range

A 2014 Tennessee State University study (Illukpitiya and de Kof 2014) estimates biodiesel production costs in the vicinity of $4.29 to $5.92/gallon, including feedstock costs and capital costs for equipment. These costs may change if there are subsidies for capital costs or if the feedstock prices are lower. A state program to make biodiesel cost competitive would need to consider subsidies for the capital equipment or the feedstock.

6.8.4 Timeline of Implementation

The technology used to produce biodiesel and other types of biofuels is mature, and individual facilities to produce biodiesel could be developed in 3-5 years. Biodiesel would be a highly distributed source, with production in multiple facilities at different scales.

6.8.5 Co-benefits to the Environment

This reduction measure of promoting biofuels provides multiple co-benefits related to cleaner burning, biodegradability, and waste reduction. For example, some data suggests that biodiesel burns cleaner than petroleum diesel, producing fewer pollutants like particulate matter and carbon monoxide (DOE 2024b), which can lead to improved air quality, especially in urban areas. Biofuels are biodegradable, reducing the environmental impact of spills or leaks compared to petroleum diesel, which have the potential to contaminate soil and water sources. Additionally, biofuels can be produced from various feedstocks, including waste vegetable oils and animal fats, diverting these materials from landfills and reducing waste generation.

6.8.6 Workforce Impact

Biofuel production and its associated supply chain related to feedstock production, refining, and distribution may create new jobs in rural areas. Additional considerations include the need for worker safety training to address handling of flammable substances.

6.8.7 Benefits to Low Income/Disadvantaged Communities

For farmers producing feedstock, biofuels provide an additional revenue source. Biofuel production infrastructure can bring additional investment into rural communities.

6.9 Building Energy Efficiency Improvements

6.9.1 Descriptions of Reduction Measures

As detailed in Section 4.1.5, the combustion of fuels in the residential and commercial buildings sectors account for 2.88 MMT CO_2-e of GHG emissions in Mississippi (around 4%). Furthermore, electricity used in these sectors accounts for an additional 7.70 MMT. Among the end-use sectors (EIA 2021a), residential and commercial buildings contribute to 34% of total energy used in Mississippi. With the shared goal of reducing overall energy use in buildings, energy efficiency measures – including a broad suite of retrofits and construction practices – are therefore proposed and studied in this section as a priority reduction measure. These energy efficiency measures provide proven reduction opportunities with mature technology.

Energy efficiency improvements can be summarized by the following categories:

- Building Envelope: This accounts for the entire boundary which separates conditioned space from the unconditioned environment. A building envelope provides resistance to air leakage and moisture along with the control of heat, light, and noise transfer. The envelope includes building components such as exterior walls, foundations, roof, windows, and doors. A well-constructed building envelope reduces the overall amount of energy needed for space conditioning and aids in the creation of a healthy, controlled indoor environment. Improvements include proper air sealing and insulating during initial construction or through retrofits along with the utilization of energy efficiency windows and doors.

- Lighting: Lighting refers to the system of fixtures, lamps, and controls used to illuminate indoor and outdoor spaces. Energy-efficient lighting involves using LEDs and implementing smart controls to optimize usage. Proper lighting design enhances both aesthetics and energy efficiency in a space.
- HVAC: HVAC systems control temperature, humidity, and air quality in buildings. Energy-efficient HVAC includes well-designed systems, regular maintenance, the use of programmable thermostats or controls, duct sealing, and upgrading newer, high-quality equipment. Proper ventilation is crucial for indoor air quality and occupant comfort.
- Water Heating: Water heating systems provide hot water for domestic use. Energy-efficient water heating involves using efficient heaters, insulating pipes, and practicing water conservation. Heat pump water heaters and solar water heaters are examples of efficient alternatives.
- Appliances: Appliances include household devices like refrigerators, washing machines, and stoves. Energy-efficient appliances carry the ENERGY STAR label and consume less energy. Regular maintenance and mindful usage contribute to the overall efficiency of appliances.
- Power Systems: Power systems are directed more for commercial use where there is high energy consumption. This involves reducing power system losses, installing variable speed motors and pumps, and reducing peak power demand.
- Integrated Controls: Integrated controls involve the use of smart systems to manage and optimize various building functions. Building automation systems integrate controls for lighting, HVAC, and other systems for improved efficiency. Smart sensors and programmable systems enable real-time adjustments based on occupancy to provide energy savings.
- Auditing and benchmarking: Existing homes or commercial building owners can use energy auditing or benchmarking to provide insight on energy use specific to the building(s). This provides a prescriptive approach for implementing energy efficiency upgrades and can indicate anticipated savings and payback.

Mississippi has existing programs to promote energy efficiency upgrades in buildings, including the Weatherization Assistance Program administered through the Mississippi Department of Human Services. There are also Federal programs and incentives to promote energy efficiency such as the Home Efficiency Rebates program and the 25C, 45L, and 179D tax credits.

This priority measure of improving and enhancing building energy efficiency includes the following four major programs:

1. Incentive programs for implementation of end-use energy efficiency measures in existing commercial and industrial buildings.
2. Incentive programs for the purchase of certified energy-efficient lighting in commercial and industrial buildings, as well as streetlights.

3. Incentive programs for the purchase of certified energy-efficient building products to replace inefficient products in residential buildings.
4. Weatherization programs for residential buildings.

6.9.2 Quantification of GHG Reduction Per Unit of Measure

Quantification of GHG reductions per unit measure can be conducted using the energy consumption surveys for commercial (EIA 2023e) and residential (EIA 2023d) buildings from EIA. Specifically, the 2018 Commercial Building Energy Consumption Survey provides the surveyed energy consumption and building characteristic data for commercial buildings in East South Central Census Division, whereas the 2020 Residential Energy Consumption Survey provides the data of energy consumption and building characteristics in Mississippi. Annual average energy consumptions for commercial and residential buildings were subsequently calculated based on these survey data (Table 6-11). Given the various sizes of commercial buildings, the energy consumption for commercial buildings was calculated as BTU per unit floor space (i.e., square foot).

Table 6-12. Annual average energy consumption for electricity and selected fuel use in commercial (2018 survey for East South Central Census Division) and residential buildings (2020 survey for Mississippi).

Energy Source	Commercial[7] (thousand BTU per square foot)	Residential[8] (million BTU per household)
Electricity	41.1 (98%)	48.1 (100%)
Natural gas	23.3 (76%)	17.4 (71%)
Fuel Oil	0.2 (15%)	0.2 (6%)
Propane	-	5.5 (60%)

Based on the energy consumption in Table 6-11, the corresponding GHG emissions and reductions of emissions from the improvement on building energy efficiency can be quantified. As described previously, a range of building retrofitting and weatherization options is available to improve the building energy efficiency. A study conducted by the Edison Foundation in 2010 (Rohmund et al. 2010) suggests that a moderate 30% reduction in whole-building energy use can be achieved from 2010 to 2025, while a further 40-45% reduction can be achieved under an aggressive scenario. Therefore, a 30% reduction of building energy consumption (including both electricity and the fuel use presented in Table 6-11) is assumed as a result of this reduction measure in PCAP. A more comprehensive analysis on the effect of different building efficiency improvement options on energy savings and GHG reductions will be applied for CCAP.

The estimated GHG emission reductions from the improvement of energy efficiency for a commercial and a residential building in Mississippi were calculated (Table 6-13). Because both commercial and residential buildings may or may not use a particular type of energy (e.g., 76% of floor space in commercial buildings uses natural gas as presented in Table 6-11), this estimation

7 Calculated as total energy use divided by all commercial building floor space (or total number of households for residential buildings). Numbers in parentheses present the percentages of floor space (or households) use this energy.

of GHG reductions is based on average energy use calculated in Table 6-11. Additionally, the GHG reductions were only estimated for the four types of energy presented in Table 6-11, while a small portion of energy from other sources may be used. A floor space of 10,000 square feet (with the average energy use per floor space presented in Table 6-11) is used to estimate GHG reductions per unit measure (for comparison, the average floor space of a commercial building in the East South Central Census Division is 15,600 square feet). GHG reductions for 100 residential buildings were estimated in Table 6-13 to consider use of different energy in the 100 households (e.g., 6 out of the 100 buildings use fuel oil).

Table 6-13. Estimated annual average GHG emission reduction from improving energy efficiency for 10,000 ft^2 floor space of commercial buildings and 100 residential building.

	Annual GHG reduction (MT CO_2-e) for 10,000 ft^2 floor space in commercial buildings	Annual GHG reduction (MT CO_2-e) for 100 residential buildings
Electricity	15.3	180
Natural gas	3.7	28
Propane	-	10
Fuel Oil	0.0	0.4
Sum	19.1	220

Additionally, Mississippi coordinated with Tennessee to determine GHG reduction potentials across the TVA service territory. The service territory of TVA for Mississippi generally includes the counties of Alcorn, Attala, Benton, Calhoun, Chickasaw, Choctaw, Clarke, Clay, Grenada, Itawamba, Kemper, Lafayette, Lauderdale, Leake, Lee, Lowndes, Marshall, Monroe, Neshoba, Newton, Noxubee, Oktibbeha, Panola, Pontotoc, Prentiss, Quitman, Rankin, Scott, Tallahatchie, Tate, Tippah, Tishomingo, Union, Webster, Winston, and DeSoto (partial-TVA service area shown on the map, or everything east of I-55), which accounts for about 11% of the overall energy consumption in TVA service territories.

Previously listed four building energy efficiency improvement programs were quantified with their GHG reduction potentials for the Tennessee and Mississippi portions of the TVA service territories. These estimates are based on the USEPA's Global Change Analysis Model Long-term Interactive Multi-Pollutant Scenario Evaluator (GLIMPSE) model. The GLIMPSE model along with scaling factors was used to estimate the electricity total savings from the four building energy efficiency improvement programs, which were subsequently used to estimate the emissions reductions. The results from the GLMPSE model and the use of scaling factors suggest electricity savings of 2,425 GWh from 2025 to 2030 for the TVA service area in Mississippi and a consequently 0.17 MMT CO_2-e of annual GHG reductions.

6.9.3 Quantification of Cost Range

The costs associated for retrofitting buildings and upgrading building appliances for energy efficiency can be found in a number of existing studies and databases, e.g., the National

Residential Efficiency Measures Database from the National Renewable Energy Laboratory (NREL 2023) provides itemized and detailed cost information. Given the various options for improving building energy efficiency as described previously, the cost range of this reduction measure (which is expected to be proportional to the total cost of improving building energy efficiency) was not currently estimated.

6.9.4 Timeline of Implementation

Given the maturity of the technology, it is expected that the upgrading and improvement of building energy efficiency in both commercial and residential buildings can be carried out in a short timeframe. According to the two EIA surveys, there are a total of 1.08 million households in Mississippi and a total of 347,000 commercial buildings in the East South Central Census Division. Energy efficiency improvement programs can potentially be carried out for 1% of households (i.e., 10,800 homes) and for 500 commercial buildings (assuming 10,000-ft^2 of floor space per building) annually. For every 10,800 homes and 500 commercial buildings, the annual emission reductions are therefore 33,000 MT of CO_2-e.

6.9.5 Co-benefits to Environment

Increasing building energy efficiency lead to both reduction of fuel consumption on site at commercial and residential buildings and lower the overall electricity demand. The reduction of fuel consumption decreases the emissions of other related air pollutants at commercial and residential buildings. This reduction of air pollution in commercial and residential buildings thus improves regional air quality and associated negative health impacts. The reduction of electricity demand also results in less power generation and a potential reduction in generation on average and during peak demand events.

Additionally, the reductions of other pollutants (NO_X and SO_2) have been quantified for the regions in Mississippi serviced by TVA, following the coordination between Mississippi and Tennessee as described previously. Based on the results of electricity savings of 2,425 GWh from 2025 to 2030 for the TVA service area in Mississippi, the estimated annual total reductions of NO_X and SO_2 from the four building energy efficiency programs are 2,200 MT and 3,300 MT per year from 2025 to 2030, respectively.

6.9.6 Workforce Impact

The implementation of energy efficiency measures holds significant implications for the workforce. Firstly, it creates job opportunities across various sectors, particularly in construction, engineering, and technology, as skilled labor is required for tasks such as retrofitting buildings and installing energy-efficient systems. Secondly, the focus on energy efficiency stimulates skills development through investment in training programs and educational initiatives. This ensures that the workforce is equipped with the expertise needed in areas such as green building practices, sustainable design, and the latest energy-efficient technologies. Additionally, businesses adopting energy efficiency measures often experience cost savings, enabling them to reinvest in their workforce through increased wages, training programs, and other employee benefits. This not only fosters economic growth but also enhances job security and stability in industries that prioritize energy efficiency. The combination of job creation, skills development, and economic stability positions energy efficiency as a catalyst for positive workforce impacts.

6.9.7 Benefits to Low Income/Disadvantaged Communities

The implementation of energy efficiency measures presents a promising avenue for alleviating the energy burden experienced by low-income and disadvantaged communities. These communities often face a disproportionate share of their income going towards energy bills. By introducing energy-efficient retrofits, such as improved insulation and energy-efficient appliances, households can experience significant cost savings, reducing the financial strain associated with high energy costs. Moreover, targeted training programs ensure that residents have access to job opportunities created by energy efficiency projects, fostering economic empowerment within these communities. Addressing the health implications of substandard housing conditions, particularly in disadvantaged areas, energy efficiency measures contribute to improved indoor air quality. Simultaneously, community resilience is enhanced by initiatives like distributed energy systems, ensuring reliable power sources during outages. With a focus on energy technology parity, programs promoting new technology adoption in low-income areas provide residents with access to clean and affordable energy alternatives, contributing to a more equitable energy landscape. Recognizing environmental justice concerns, energy efficiency measures aim to reduce the environmental impact of energy production and consumption, preventing disproportionate exposure to pollution. Additionally, the health benefits stemming from improved housing conditions contribute to reduced healthcare costs, benefiting both individuals and the community at large. Through a comprehensive approach that addresses the energy burden, economic empowerment, technology parity, resilience, environmental justice, and health outcomes, energy efficiency measures can significantly improve the well-being of low-income and disadvantaged communities.

6.10 Refrigerant Replacement

6.10.1 Description of Reduction Measure

Refrigerants used in residential, commercial, and industrial refrigeration and air-conditioning generally have very high GWPs. These refrigerants include HCFCs, chlorofluorocarbons (CFCs), HFCs, and PFCs. On a per unit mass basis, some of these substances trap thousands of times more heat in the atmosphere than CO_2. Many of these substances are also ozone-depleting substances, and their use is currently being phased out nationally under Title VI of the Clean Air Act. The phaseout of these refrigerants presents a significant environmental challenge, and an effective program could help expedite the replacement or retrofitting of existing systems with cleaner refrigerants that have a lower GWP and lower ozone depletion potential (ODP). A summary of key refrigerants based on their ozone ODP and GWP is shown in Table 6-14 (Dong et al. 2021).

Table 6-14. Refrigerants and their environmental properties (Dong et al. 2021). An ODP of 1 refers to a substance with significant adverse effects on the ozone layer, whereas a value of 0 indicates no impact.

Refrigerant	Properties	Notes on the Current Application
R11 (CFC)	ODP = 1.0; GWP = 4,750	Phased out in 1996 due to severe ozone depletion effects
R12 (CFC)	ODP = 0.82; GWP = 10,900	Phased out in developed countries in 1996 and in developing countries in 2010 according to the Montreal Protocol due to its ozone depletion effects
R22 (HCFC)	ODP = 0.055; GWP = 1,800	Used as an alternative to R11 and R12 due to lower ODP in the cooling and refrigeration sector; phased out according to the Montreal Protocol; production banned or cut significantly in most countries but still has widespread use in equipment that has not yet been retired
R123 (HCFC)	ODP = 0.012; GWP = 76	Used as an alternative to R11 in low-pressure HVAC systems; phased out according to the Montreal Protocol due to ozone depletion effects
R134a (HFC)	ODP = 0; GWP = 1,340	Widely used in commercial refrigeration systems globally and also on refrigerated vehicles in high- and medium-temperature conditions; being phased down according to the Kigali Amendment
R404a (HFC)	ODP = 0; GWP = 3,940	Widely used in industry and commercial refrigeration systems worldwide, as well as refrigerated vehicles in medium- and low-temperature conditions; being phased down according to the Kigali Amendment
R407C (HFC)	ODP = 0; GWP = 1,770	Used as a replacement to R22 in HVAC systems; being phased down according to the Kigali Amendment
R410a (HFC)	ODP = 0; GWP = 2,100	Widely used in building and vehicle HVAC systems as an alternative to R22; being phased down according to the Kigali Amendment
R600a (hydrocarbon)	ODP = 0; GWP = 3	Mainly used in domestic refrigerators in Europe, Asia, the Middle East, and Africa
R717 (NH3)	ODP = 0; GWP = 0	Used in industry refrigeration systems (e.g., refrigerated warehouses, process cooling)
R744 (CO_2)	ODP = 0; GWP = 1	Mainly used in industry and commercial refrigeration systems (e.g., supermarkets) in Northern Europe

6.10.2 Quantification of GHG Reduction Per Unit of Measure

The current estimate of emissions of some of these refrigerants through the SIT is approximately 2 MMT CO_2-e. The magnitude of GHG reduction depends on scale of the program and the number of systems that can be replaced or retrofitted. As an example, the refrigerant GHG contents of a large commercial refrigeration system can be evaluated (). Assuming a program that could support the retrofit of 5 systems statewide each year, the GHG reduction can be estimated to be 7,780 MT CO_2-e per year.

Table 6-15. Refrigerant leak estimate from a commercial refrigeration system (USEPA 2011).

Input	Value
Typical Commercial Refrigerant Used	R-404A
GWP	3,921.6
Commercial Refrigeration Charge Size	3,500 pounds
Annual Commercial Refrigeration Leak Rate	25% per year
Annual Volume of Commercial Refrigerant Leaked	875 pounds per year
Annual CO_2-e of R-404A Leaked	3,431,400 pounds of CO_2-e per year
Annual CO_2-e of R-404A Leaked (metric units)	1,556 MT CO_2-e per year

6.10.3 Quantification of Cost Range

The replacement of HFC refrigerants usually entails the retrofit or replacement of the entire refrigeration system. To be effective, it would be best to focus the effort on large commercial or industrial systems. Costs have not been quantified for this measure.

6.10.4 Timeline of Implementation

The alternative replacement refrigerants are commercially available, and the timeline is limited by the funding support available for developing a program for replacement as well as the workforce needs to perform the equipment changes. As noted above, a statewide program may consider a subsidy for replacement/retrofit for a set number of systems each year that aligns with funding availability and workforce capacity.

6.10.5 Co-benefits to Environment

Many climate-friendly alternatives to HFCs boast superior thermodynamic properties, leading to improved energy efficiency in refrigeration systems. This translates to lower energy bills for businesses and households, contributing to both cost savings and reduced reliance on fossil fuels.

6.10.6 Workforce Impact

The development and deployment of new, climate-friendly refrigeration technologies creates opportunities for job creation in green manufacturing, installation, and maintenance sectors. This can stimulate economic growth, particularly in communities transitioning away from fossil fuel-dependent industries.

6.10.7 Benefits to Low Income/Disadvantaged Communities

The financial implications of a phaseout thus pose a serious obstacle for many businesses, particularly small and independent operators and those within disadvantaged communities. A subsidy would typically be needed to enable such a change. Targeted financial support programs specifically designed for small and independent businesses can significantly reduce the transition burden, ensuring equitable access to climate-friendly technologies. Additionally, collaborative partnerships between government agencies, non-profit organizations, and industry stakeholders can foster knowledge-sharing and develop innovative financing solutions.

6.11 Forest Carbon Management

Forests are continuously sequestering CO_2 through photosynthesis, storing large amounts of carbon in the soil, and emitting a portion of it back to the atmosphere through bacterial decomposition. This process prevents the stored carbon from being emitted to atmosphere as CO_2. The carbon sequestered by forest is 3.67 times the quantity of carbon stored in the forest. As shown in Section 4, carbon sequestered in the land either by forest remaining forest or non-forest land converted to forest land is an important element to balance the net flux of carbon in the state. Mississippi has extensive forest lands (Table 6-15) and the results of GHG inventory in Section 4 indicate the carbon sink in Mississippi has a magnitude nearly equal to emissions from all other sectors. Based on several studies, older forests capture carbon more efficiently and rapidly than younger forests, therefore, conservation and forest management are among the most efficient and cost-efficient measures of increasing GHG sequestration and reducing net emissions.

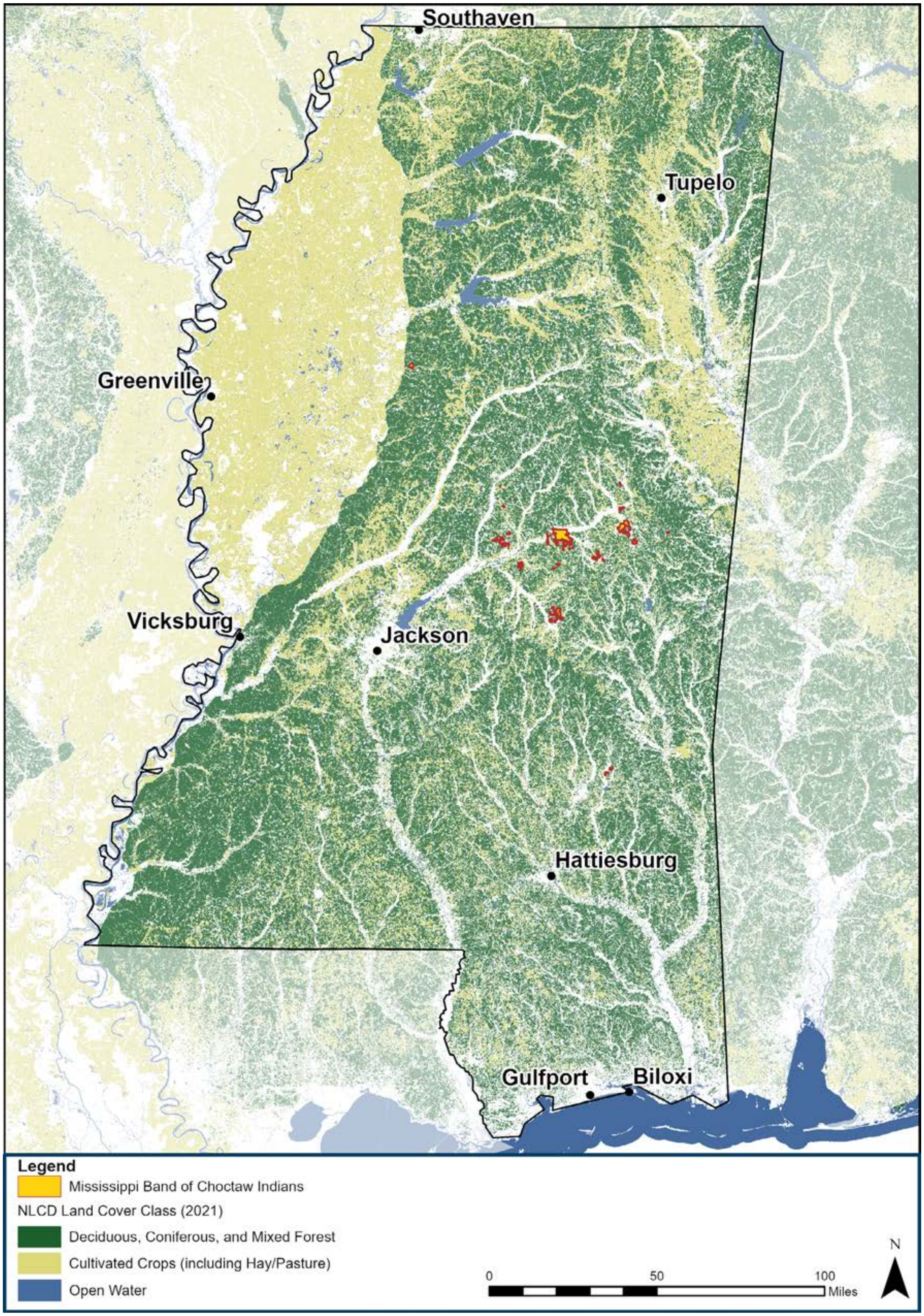

Figure 6-5. Mississippi forested land (conifer, deciduous, and mixed) and cropland (including hay and pasture) from the 2021 National Land Cover Dataset derived from LANDSAT imagery, 30-meter resolution (MRLC 2024).

6.11.1 Description of Carbon Pollution Mitigation Measures

Forest carbon management practices used to mitigate carbon pollution include:

1. **Forest conservation**

Forests conservation means protecting existing forest land. Forests are a vital resource and their conservation does not only bring benefits for carbon sequestration, but also reduces erosion, protects and improves air and water quality, and serves as a habitat for local biodiversity. The implementation of forest conservation can have barriers, e.g., the loss of income from not converting forest land and the lack of awareness on the role of the forest in carbon management. Some examples of forest conservation measures that can be implemented across Mississippi are provided (Table 6-16).

Table 6-16. Summary of potential forest conservation measures, description, considerations, and examples for Mississippi.

Reduction Component	Description, Considerations, and Examples
Support carbon and ecosystem services markets	Carbon and conservation markets, payments for ecosystem services programs
Reduce Land use conversion	Siting of renewable energy infrastructure where it has minimal impact and conversion; state, county, municipal zoning laws; transfers of development rights

2. **Forest management**

Forest management methods improve forest resilience, mitigate forest fires, and increase carbon storage when feasible. Several examples of forest management measures that can be implemented across the state are provided (Table 6-17).

Table 6-17. Summary of potential carbon sequestration measures by forest management, description, considerations and examples for Mississippi.

Reduction Component	Description, Considerations, and Examples
Reforestation and afforestation	Planting on former forestland or previously disturbed land. Increasing forest density in forests that are not at immediate risk for severe drought stress, severe fire or insect outbreaks, and that currently support a density of trees substantially less than what could be supported based upon the site's ecology and climate.
Protect, conserve, and restore, forest, grasslands, shrublands, peatlands, coastlines	Living shorelines, salt marshes, sea grass, protection of migration corridors, identify future inland advancement zones to create storm buffers, committing to no net loss, reestablish hydrological connectivity, riparian buffers, floodplains, rewet hydrologically altered peatlands, restore and reforest peatlands, and enhance soil health and retention
Fire Management Intervention	Reducing density of trees and fuels in forests using methods such as thinning and prescribed burns.

3. **Land converted to forest**

Land converted to forest means conversion of cropland or other lands into forest and it is estimated to have the maximum long term biophysical maximum mitigation potential across the contiguous united states (Fargione et al. 2018). This maximum mitigation potential calculation includes preservation of cropland to safeguard food production (agroforestry is discussed in the subsequent measure for agricultural land).

6.11.2 Quantification of GHG Reduction Per Unit of Measure

As described previously, conservation of forest land is expected to provide the highest potential for carbon sequestration in Mississippi.

The level of carbon sequestration per conserved acre is affected by the age and level of disturbance of the forest and also depends on types of trees in forests and the age of managed forest. The Forest Service's Standard Estimates of Forest Ecosystem Carbon for Forest Types of the United States shows that the South Central States are predominantly loblolly-shortleaf pine, oak-pine, oak-hickory, oak-gum-cypress, and elm-ash-cottonwood. The estimates of carbon stored in managed forests and after afforestation at different years after intervention are provided (Table 6-18 and Table 6-19).

Table 6-18. Carbon stored in different years after forest management in the Southcentral States.

Type of Forest	Carbon Storage from Managed Forest (short tons of carbon per acre)					
	1 year	5 years	10 years	30 years	50 years	90 years
Loblolly-Shortleaf Pine	6.3	9.7	25.9	39.5	46.9	51.1
Oak-Pine	6.3	8.6	18.2	38.5	45	63.1
Oak-Hickory	6.4	4.7	17	40.2	53.1	67.9
Oak-Gum-Cypress	5.1	4.7	8.7	33.5	46.3	56.8
Elm-Ash-Cottonwood	4.2	3.5	9.3	27	35.5	48.7

Table 6-19. Carbon stored in different years after afforestation in the Southcentral states.

Type of Forest	Carbon Storage from Afforestation (short tons of carbon per acre)					
	1 year	5 years	10 years	30 years	50 years	90 years
Loblolly-Shortleaf Pine	0.6	6.4	23.0	37.2	44.8	49.2
Oak-Pine	0.0	4.7	15.0	36.1	42.8	61.2
Oak-Hickory	0	0.9	13.8	37.9	51	66
Oak-Gum-Cypress	0	1.3	5.8	31.3	44.3	55
Elm-Ash-Cottonwood	0	1.1	7.7	26.3	34.9	48.1

As presented in Table 6-18 and Table 6-19, interventions related to forest management in loblolly-shortleaf pine and oak-pine forest yield the largest amounts of sequestered carbon, whereas interventions related to afforestation require longer periods to achieve the amounts of carbon sequestration comparable to the results from managed forest.

Quantification of GHG sequestration with forest management practices (including conservation and afforestation) was conducted in a preliminary manner based on the estimates of annual carbon sequestration from existing forest land. Based on the results from the SIT, a total of 60.69 MMT CO_2-e is sequestered from the forecast land in 2017 in Mississippi (excluding sequestration from harvested wood products and related waste disposal) with around 19.3 million acres (Oswalt 2019). Therefore, approximately 3.1 MT of CO_2-e per acre are sequestered in 2017. This rate of carbon sequestration is comparable to the results of annual changes in carbon stocks presented in Table 6-18 and Table 6-19 (10 years after the intervention) and is subsequently assumed to be achieved for managed forecast practices after 10 years. For every 10,000 acres of forest land (with forest management practices), it is estimated that annual 31,000 MT of CO_2-e can be sequestered.

6.11.3 Quantification of Cost Range

Cost estimates of forest management can be found in the existing literature, which can be used to provide cost quantification of this reduction measure in a preliminary manner. Results from Cook-Patton et al. (2020), for example, suggest an annualized costs of afforestation in the Southeast forests of the US with an average of $136 per hectare ($55 per acre) per year. Fargione et al. (2018) includes a review of existing studies on the costs of reforestation for different forest types and locations, Mississippi bottomland hardwood for example, is estimated to cost around $ 277 per acre in 2022.

6.11.4 Timeline of Implementation

Forest land conservation can be implemented in an immediate timeframe and carbon sequestration will continue to increase as the protected land matures. Table 6-18 and Table 6-19 show that managed forest will start sequestering a high level of carbon from the first year of implementation whereas afforestation will sequester high amounts of carbon after the 5th year.

Additionally, forecast carbon management programs can include the following steps and processes: (a) identification of high opportunity areas for conservation and forest management interventions and identification of high opportunity afforestation strategies; (b) community outreach for forest conservation; (c) creation of workforce development program for forest management; (d) policy development and deployment for protection of public forest; (e) development of coalitions with private forest owners to protect public and private forest with recently developed workforce and high community outreach; and (f) Program evaluation for forest conservation, management, and afforestation interventions.

6.11.5 Co-benefits to Environment

Forest conservation, carbon management, and afforestation have inherent benefits to the environment related to conservation of habitat for endemic species, increased water and air quality, and reduced erosion. In addition, forest conservation integrates tribal perspectives, traditional ecological knowledge, and protects culturally important species and foodways that ensures the needs of both the people and ecosystems.

6.11.6 Workforce Impact

This measure is expected to provide and promote employment opportunities in forestry industry and other related field; additional workforce training programs can be established to further enhance the benefits to local workforce. The investments from forest management programs will create good-paying jobs and positions such as forest technician, ranger, or forest supervisor. Workforce development programs can be established targeting the trainings for vegetation management, low impact timber harvesting equipment, longer timber rotations, thinning, replanting understocked forests, biochar application, and other practices.

6.11.7 Benefits to Low Income/Disadvantaged Communities

Conservation of forests and other undisturbed ecosystems can be designed to provide optimized benefits to low income/disadvantaged communities. Programs specifically designed and implemented for and around low income/disadvantaged communities can increase the local air and water quality, improve environment and quality of life, and create local employment opportunities related to forest management, providing important benefits to these communities.

6.12 BMPs for Agricultural Land

6.12.1 Description of Reduction Measures

According to the GHG inventory results presented previously in Section 4, the emissions from the agricultural sector represent around 9% of the total GHG emitted by the state. It should be noted that, as also discussed in Section 4, the estimation of GHG emissions from the agriculture sector is subject to uncertainty from the data and the methodology used (as agricultural practices, land conversion rates and GHG emissions differ at the climate and ecological region, farm, county, and regional level). Consequently, the reduction potential of GHG emissions from the agricultural sector also varies, and reduction measures should be tailored to meet local needs and conditions. Existing studies of reducing emissions from agriculture are showing positive results, although large uncertainty is associated with the different agricultural systems in Mississippi (Hu et al. 2023). Stakeholders interested in reduction measures therefore should prioritize opportunities that have the least uncertainty on GHG reductions.

Some key reduction measures associated with agricultural activities and land use conversion have been reported to result in the greatest reductions in GHG emissions by the Natural Resource Conservation Service (Table 6-19).

Table 6-20. Agricultural BMPs ranked to have the highest GHG emission reductions.

Practice Standard	Beneficial Attributes
Conservation Cover	Establishing perennial vegetation on land retired from agriculture production increases soil carbon and increases biomass carbon stocks.
Residue and Tillage Management, No Till/Strip Till/Direct Seed	Limiting soil-disturbing activities improves soil carbon retention and minimizes carbon emissions from soils.

Practice Standard	Beneficial Attributes
Anaerobic Digester	Biogas capture reduces CH_4 emissions to the atmosphere and provides a viable gas stream that is used for electricity generation or as a natural gas energy stream.
Roofs and Covers	Capture of biogas from waste management facilities reduces CH_4 emissions to the atmosphere and captures biogas for energy production. CH_4 management reduces direct GHG emissions.
Multi-Story Cropping	Establishing trees and shrubs that are managed as an overstory to crops increases net carbon storage in woody biomass and soils. Harvested biomass can serve as a renewable fuel and feedstock.
Windbreak/Shelterbelt Establishment	Establishing linear plantings of woody plants increases biomass carbon stocks and enhances soil carbon.
Forage and Biomass Planting	Deep-rooted perennial biomass sequesters carbon and may have slight soil carbon benefits. Harvested biomass can serve as a renewable fuel and feedstock.
Nutrient Management	Precisely managing the amount, source, timing, placement, and form of nutrient and soil amendments to ensure ample nitrogen availability and avoid excess nitrogen application reduces N_2O emissions to the atmosphere.
Feed Management	Diets and feed management strategies can be prescribed to minimize enteric CH_4 emissions from ruminants.

The Comet-Planner tool by the Natural Resource Conservation Service from the USDA and Colorado State University (USDA 2024) allows calculation of GHG emissions for each measure at the state and county level across the United States.

A summary of the mitigation measures transformed into policies and programs that can specifically be tailored for the state of Mississippi is provided (Table 6-21).

Table 6-21. Summary of potential mitigation measures, description, considerations, and examples for the state of Mississippi.

Mitigation Measure	Description, Considerations, and Examples
Reduce Land use conversion	Siting of renewable energy infrastructure where it has minimal impact and conversion; state, county, municipal zoning laws; transfers of development rights
Support carbon and ecosystem services markets	Carbon and conservation markets, payments for ecosystem services programs
Expand biomass to energy production	Biomass from livestock manure, poultry litter, forest residuals, capture of waste heat
Include climate-related and emission-reduction criteria in project design and implementation	Broad-based policy

Mitigation Measure	Description, Considerations, and Examples
Promote climate-smart livestock management practices	Alternative manure management, precision feed/forage, herd management, feed mixes/additives, managed grazing
Protect, conserve, and restore forests	Keep forests as forests policies, land acquisition, and conservation easements
Reforestation and afforestation	Planting on former forestland or previously disturbed land
Quantify and monitor coastal blue carbon	Net carbon flux of wetland habitat (fresh, intermediate/brackish, saline, submerged aquatic vegetation, open water habitats)
Improve water management and use, water quality	Demand side water conservation and reuse, water-rights options that protect fish and wildlife, improve ground/drinking water, watershed planning

In addition to mitigation measures presented in Table 6-21 (which represent the larger opportunity for the state to reduce GHG emissions while maintaining the current carbon capturing ecosystem), other mitigation measures with lower GHG reduction potential but higher community impacts include (a) support local food systems through community gardens, urban agriculture, local-product markets etc. to supply resources for underserved communities; (b) expand the peer support networks farmer to farmer, rancher to rancher, land owner to land owner; (c) invest in Education and workforce development for urban forestry and agriculture, climate smart land management practices, especially in underserved communities.

6.12.2 Quantification of GHG Reduction Per Unit of Measure

6.12.2.1 Enteric fermentation

Opportunities exist for enteric fermentation and manure management to reduce GHG through feeding additives and other livestock management measures. Researched additives around the world have shown reductions in enteric emissions by 32% in dairy (Feng and Kebreab 2020) and 22% in beef. Other additives less researched can achieve up to 20% (16% from 2005) enteric emission reductions per cattle herd (Searchinger et al., 2021). This is combined to a 10% reduction in GHG emissions from enteric fermentation when combining improvements in animal health, reduced mortality, better reproductive management and faster weight gain per cattle herd. The additives are in the process to get approved by the United States Food and Drugs Administration (FDA) but the timing for their approval is still uncertain.

6.12.2.2 Crop Management

Producing nitrogen fertilizers from green ammonia using renewable energy can reduce GHG emissions by 91% compared with conventionally produced ammonia (Kwon et al. 2021; Liu et al. 2020). Peer-reviewed research syntheses and reports provide a wide range of possible N_2O emission reductions (2%–50%) with improved nitrogen management on cropland (Ahmed et al. 2020; Eagle and Olander 2012; Fargione et al. 2018; Pape et al. 2016; Winiwarter et al. 2018).

According to the Comet-Planner Tool, the following average reductions can be achieved per 1,000 managed acres across the state for each BMP (Table 6-22). However, the diversity of crops across the state makes these strategies vary in total reduction across the state.

Table 6-22. Average GHG reductions for each BMP considered in the Comet-planner for the state of Mississippi.

Best Management Practice	GHG reduction (MT CO_2-e per 10,000 acres)
Cover Crop	6,870
Multiple Conservation Practices	12,880
Nutrient Management	2,800
Residue and Tillage Management - No-Till	3,960
Residue and Tillage Management – Reduced Till	2,010
Strip-cropping	2,390

6.12.3 Quantification of Cost Range

Cost of implementation of these reduction measures is expected to vary depending on farm/location and the practice. According to literature the average cost for implementation of Till or Reduce Till is $16.67 per acre per year, ranging from $8.17 to $23.75 per acre per year. For cover crops, the average cost of implementation is $44.84 per acre per year, ranging from $21.51 to $69.11 per acre per year. The Nutrient Management has the largest uncertainty related to cost estimates.

6.12.4 Timeline of Implementation

A program focused on GHG reduction in agriculture can be implemented over five years:

- 1st year – Identification of specific geographic areas of opportunity for BMP and livestock mitigation measures. Community outreach for strategic deployment. Development and Deployment of workforce development program.
- 2nd year – Deployment of livestock emissions mitigation strategies related to feeding additives. Workforce development and educational program for livestock and agricultural soil BMPs.
- 3rd year – Deployment of livestock and agricultural soil BMPs.
- 4th year – Livestock feeding additives program evaluation and expansion of program to other farms.
- 5th year – Livestock and agricultural lands program evaluation and expansion of program to other farms.

6.12.5 Co-benefits to Environment

The various BMPs described previously have various benefits to the environment. These benefits include: (a) lower runoff of nutrients to water bodies such as rivers, creeks, and lakes, preventing eutrophication; (b) improved overall soil health by reducing soil disturbance and erosion; (c) reduced windblown dust from cover crop and better soil health; (d) reduced evaporation of nitrogen and other gaseous contaminants from better soil health and decreased nutrient runoff prevents; and (e) improved air and water quality water quality by preventing further nitrogen deposition.

6.12.6 Workforce Impact

This measure can be implemented with additional workforce development to optimize the benefits to local workforce and provide employment opportunities. This measure can also be collaborated with several institutions that have developed programs specific for workforce development in the agricultural sector such as MSU Extension and the National Institute of Food and Agriculture.

6.12.7 Benefits to Low Income/Disadvantaged Communities

The agriculture BMPs can provide and facilitate low income and disadvantaged communities with technical assistance and training for agricultural practices, more affordable healthy food, and the strengthening of communities around farms.

Investing and implementing agricultural BMPs also represent a great opportunity to benefit low income/disadvantaged communities, given historical discrimination in the agriculture sector. Examples of historical discrimination include the lack of land security from minority-owned land that has been passed among generations without will or without an estate planning strategy, lack of access to financial and supportive resources due to racial discrimination, exclusion and mistreatment of minority owners or the limited representation of minority owned land in the development of public policy related to the agricultural sector. The BMP strategies considered and described previously represent an opportunity to overcome such barriers. Some of the efforts will require prioritizing the financing of low income, small landowners that have been historically disadvantaged when accessing agribusiness, technology for smart agriculture or additives for livestock feeding and manure management, and technical support for BMPs and for agroforestry and land use conservation.

Additional opportunities to benefit low income and disadvantaged communities exist during the public policy development processes. Involving low income and disadvantaged communities during the public design and execution of policy increases ownership, participation, and trust. The continuous engagement and trust overtime will result in benefits to low and disadvantaged communities. Additionally, because of the lack of access to financing of agribusiness and technology, low income and disadvantaged communities have been pioneering alternative farming practices, some of which have been proven to have a positive impact in reducing pollution. Along with these alternative practices, the public policy process can also integrate the tribal perspectives of farming, traditional ecological knowledge, and culturally important species and foodways.

6.13 Landfill Methane Capture

Landfill gas (LFG) is a natural byproduct of the decomposition of organic material in landfills. LFG is composed of roughly 50 percent CH_4, 50 percent CO_2, and a small amount of non- CH_4 organic compounds. Instead of escaping into the air, LFG can be captured, converted, and used as a renewable energy resource. Using LFG helps to reduce odors and other hazards associated with LFG emissions and prevents CH_4 from contributing to GHG emissions. The focus of these calculations from waste is on the GHGs added to the atmosphere as a result of human activity, and this quantity excludes biogenic CO_2. CO_2 derived from products formed from recent (<100 year) atmospheric CO_2, such as food products or forestry products, is considered of biogenic origin, and is considered to be carbon neutral with respect to the atmosphere. For the solid waste sector, and also the wastewater sector in the following section, the direct biogenic CO_2 emissions are not counted; however CH_4 and N_2O emissions do count, because these are a consequence of the activity, and have a different and much greater warming impact than CO_2. Of these gases, CH_4 is a particular focus for this measure because it has a GWP of 28 (as used in the SIT) and can be used as a fuel source through combustion and converted to CO_2. This CO_2 is not counted as part of the emission inventory because it is biogenic in origin.

The state of Mississippi has been a part of EPA's Landfill Methane Outreach Program (LMOP) since 2001 (USEPA, 2007). The LMOP maintains a state-by-state database of landfills, with the caveat that the database may not include every MSW landfill in the United States. For the state of Mississippi, the LMOP database contains 27 landfills, of which 6 have operational LFG projects as of July 2023 (USEPA 2024b).

6.13.1 Description of Reduction Measures

6.13.1.1 Convert LFG into Energy

This measure aims to collect, treat, and utilize LFG for various applications as a renewable energy source while reduce emissions of CH_4. LFG energy projects can generally be grouped into three broad categories (1) electricity generation, (2) direct use of medium-BTU gas, and (3) renewable natural gas (USEPA 2024b). For electricity generation, a variety of technologies, including reciprocating internal combustion engines, turbines, microturbines and fuel cells, can be used to generate electricity for onsite use and/or sale to the grid. For direct use of medium-BTU gas, LFG can be used directly in a boiler, dryer, kiln, greenhouse or other thermal application. In these projects, the gas is piped directly to a nearby customer for use in combustion equipment as a replacement or supplementary fuel. LFG can be upgraded to renewable natural gas (RNG), a high-BTU gas, through treatment processes by increasing its CH_4 content and, conversely, reducing its CO_2, nitrogen and oxygen contents. RNG can be used in place of fossil natural gas, as pipeline-quality gas, compressed natural gas, or liquefied natural gas (LNG).

Figure 6-6 presents a schematic of an LFG energy project, showing different examples of CH_4 uses (pipeline gas, vehicle fuel, industry, trade, and electricity). Other alternative technologies and projects of treating and using LFG can also be implemented.

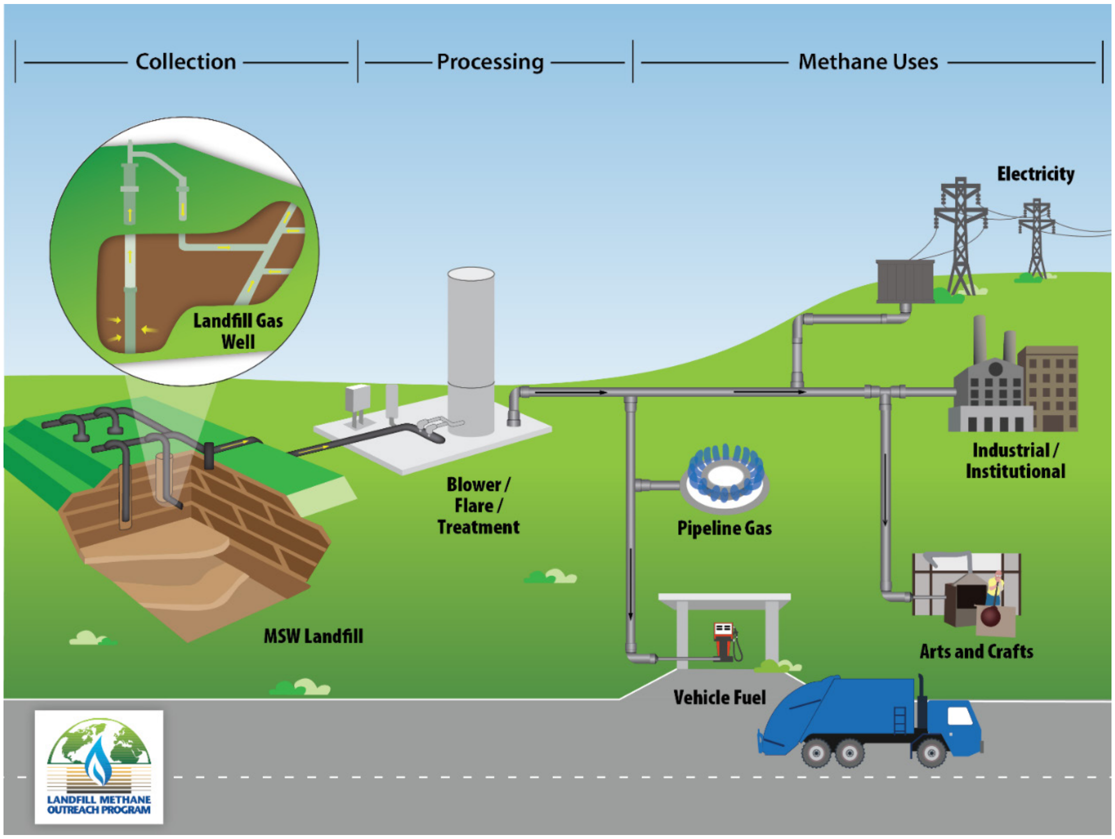

Figure 6-6. Schematic of landfill gas collection, processing and use as a fuel for heating and for electricity generation (USEPA 2024b).

6.13.2 Quantification of GHG Reduction Per Unit of Measure

EPA's Landfill Gas Energy Benefits Calculator, provided on EPA's website as part of LMOP, can be used to quantify GHG reduction from CH_4 capture programs (USEPA 2024b). Table 6-23 provides the data and calculations used in the tool to calculate the total equivalent emissions reduced. The example value of landfill gas used for the calculation is the median amount of LFG collected from landfills with LFG projects in Mississippi's LMOP database (values range from 0.082 to 2.22 million standard cubic feet per day).

Table 6-23. GHG reduction estimates using EPA's Landfill Gas Energy Benefits Calculator.

Calculator parameter	Value	Notes
Landfill gas produced (million standard cubic feet per day)	0.908	Median amount of LFG collected from Mississippi's LMOP database
Direct Equivalent Emissions Reduced (MMT CO_2-e/yr)	0.0890	Reduction of CH4 emitted directly from the landfill
Avoided Equivalent Emissions Reduced (MMT CO_2-e/yr)	0.0078	Offset of CO2 from avoiding the use of fossil fuels
Total Equivalent Emissions Reduced (MMT CO_2-e/yr)	0.0969	Total = Direct + Avoided

During the implementation phase of the planning grant, a more detailed model such as EPA's Waste Reduction Model can be used to quantify the potential GHG reduction from specific landfills in Mississippi. Beyond quantifying GHG emission reductions, the Waste Reduction Model can calculate energy savings and economic impacts of different waste management practices, such as source reduction, composting, anaerobic digestion, and landfilling.

6.13.3 Quantification of Cost Range

EPA's Landfill Gas Energy Cost Model is a spreadsheet tool that provides an initial economic feasibility analysis for developing a LFG energy project (USEPA 2024b). Table 6-24 provides a summary of estimated costs associated with different LFG electricity project technologies.

Table 6-24. LFG Electricity Project Technologies Estimated Cost Summary.

Technology	Optimal Project Size Range	Typical Capital Costs ($/kW)	Typical Annual O&M Costs ($/kW)
Microturbine	1 MW or less	$3,400	$340
Small internal combustion engine	799 kW or less	$2,900	$320
Large internal combustion engine	800 kW or greater	$2,000	$300
Gas turbine	3 MW or greater	$1,700	$190

Reproduced from USEPA (2024c)

6.13.4 Timeline of Implementation

Because the technology to develop and implement LFG energy projects is well established, it is expected that most LFG energy projects could be implemented within a timeframe of approximately 5 years.

6.13.5 Co-benefits to Environment

GHG reduction measures that reduce CH_4 emissions can improve public health outcomes by reducing emissions of co-pollutants, such as volatile organic compounds and hazardous air pollutants.

6.13.6 Workforce Impact

LFG energy projects have a positive workforce impact by creating jobs for engineers, construction firms, equipment vendors, and utilities or end users of the power produced. Much of this cost is spent locally for drilling, piping, construction, and operational personnel, providing additional economic benefits to the community through increased employment and local sales.

6.13.7 Benefits to Low Income/Disadvantaged Communities

Implementation of LFG energy projects will benefit communities in the vicinity of a project landfill, including low income/disadvantaged communities. Several existing tools such as EPA's

Environmental Justice Screening and Mapping Tool and the Climate and Economic Justice Screening Tool from the Council on Environmental Quality can be used to identify target landfills that will directly benefit low income and disadvantaged communities.

6.14 Wastewater Methane Capture

6.14.1 Description of Reduction Measure

The wastewater sector is responsible for GHG emissions from wastewater collection/conveyance, treatment, and discharge. A portion of the emissions is due to energy generation required for various processes, such as pumping water towards or away from a treatment facility, while others result from biochemical reactions and are not directly associated with energy use. The broad emission categories for wastewater treatment are shown in schematic form in Figure 6-7 (Tetra Tech 2018). CH_4 and N_2O are the primary GHG emissions from non-energy related wastewater processes. CH_4 is produced by microorganisms under anaerobic conditions when they biodegrade organic matter in the wastewater or sludge. For systems with sludge processing, digester gas, with a high fraction of CH_4, is a byproduct. Digester gas can be flared or be captured as a fuel source, resulting in the eventual release of carbon as CO_2. There is a GHG benefit to capturing and combusting CH_4 in wastewater systems because if it is released directly into the atmosphere it has a GWP of 28 (as used in the SIT) compared to CO_2. CH_4 that is captured or flared, and the resulting CO_2 emissions, need not be included in the GHG emissions total since the carbon is part of the short-term carbon cycle (or biogenic carbon). The energy recouped from using CH_4 as a fuel reduces the energy requirements either at the wastewater treatment site or elsewhere.

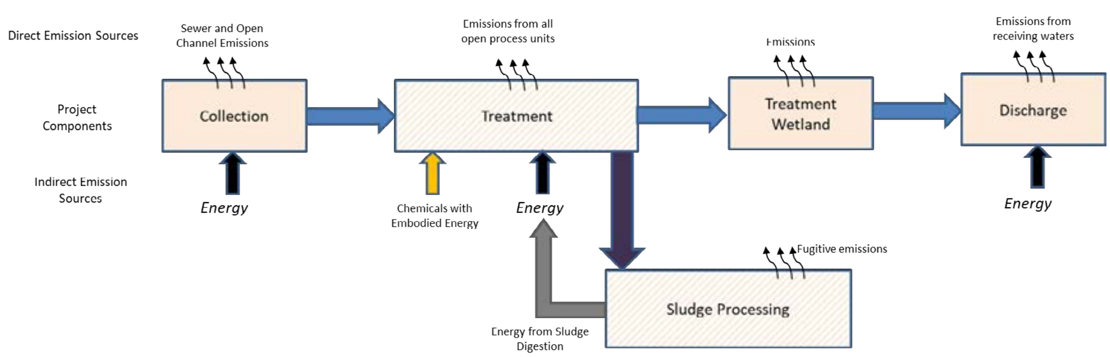

Figure 6-7. Schematic of wastewater collection and treatment system. Methane is produced during sludge processing and can be captured and used as a source of energy in the treatment plant or returned to the electricity grid.

6.14.2 Quantification of GHG Reduction Per Unit of Measure

The rate at which CH_4 is generated is dependent on the amount of degradable organic material, the temperature, and the type of treatment (IPCC 2006). The amount of degradable organic material present in wastewater is quantified using either BOD (typically for aerobically treated domestic wastewater) or Chemical Oxygen Demand (typically for industrial wastewater) which measures the amount of oxygen required for the organic material in the wastewater to be degraded by biological organisms or a chemical oxidizing agent, respectively, over some period of time.

An existing tool for water sector GHG emissions developed for the World Bank (Tetra Tech 2018) was used to estimate the CH_4 production and GHG emission reductions through capture and/or electricity production. The tool includes default values of key parameters which are reported below. The estimates are shown in Table 6-25. For a wastewater plant serving 10,000 people, CH_4 capture and combustion is expected to reduce GHG emissions by 620 MT/year, with the potential of generating 1,238 MWh of electricity if the gas is connected to a combustion engine, similar to that used for landfill gas.

Table 6-25. Methane emission estimates for a wastewater plant serving 10,000 people.

Assumption	Quantity
Population served by wastewater plant	10,000 people
BOD per capita	0.04 kg/day
Volume of digester gas produced	140 m3/day
Fraction of digester gas that is CH4	0.65
Available energy density of CH4 in digester gas (energy/volume)	default = 1028 Btu/ft^3
CH_4 emissions if sludge processing is open to air	22 MT/year
CO_2-e of CH_4 emissions if sludge processing is open to air	620 MT/year
CO_2-e of CH_4 emissions if combusted	0.3 MT/year
Electricity generated	120 MWh/year

6.14.3 Quantification of Cost Range

The cost estimates of implementing a CH_4 capture system in an existing wastewater treatment plant would be site specific and are not provided here. However, the sale of CH_4 or of electricity produced would recoup the costs of the system.

6.14.4 Timeline of Implementation

The technology embodied in this emission reduction measure is mature and can be deployed at one or more sites in Mississippi where wastewater treatment plant modifications are possible. The changes do require major engineering design and construction at existing facilities and are expected to require 3-5 years or longer for implementation.

6.14.5 Co-benefits to Environment

GHG reduction measures that capture CH_4 emissions can improve public health outcomes by reducing emissions of co-pollutants that occur in the source gases, such as volatile organic compounds and hazardous air pollutants.

6.14.6 Workforce Considerations

This reduction measure will need qualified engineering and construction personnel for implementation, although, given the location-specific nature of this work, overall workforce impacts, although positive, are expected to be small.

6.14.7 Benefits to Low Income/Disadvantaged Communities

The potential location of this emission measure is tied to the presence of wastewater treatment plants that are of reasonable size and where modifications are possible. The environmental co-benefits of this measure may benefit low income/disadvantaged communities where such communities happen to be near selected treatment plants.

7 Summary

This document is the initial report on priority measures planned for the State of Mississippi to reduce GHG net emissions and other air pollutants in the state. Following submission of this PCAP to EPA by March 1, 2024, implementation grant applications will be developed and submitted that seek to implement one or more of these priority actions. These implementation grants may be submitted by MDEQ, or by other state, local, and regional agencies that are best suited to lead a particular type of implementation action. A subsequent planning document, the Mississippi CCAP, will be prepared by mid-2025, expanding on the work in the PCAP with a more detailed assessment of emission sources and mitigation measures to provide a pathway to deliver cleaner air and lower energy costs for Mississippi.

An initial estimate of GHG emissions for Mississippi was developed using the SIT. Emissions for the year 2017 are used as the baseline year in this analysis, because this is a year for which alternative data sources for comparison were available, and this was before the period when Covid-19 had wide-ranging economic impacts (specifically 2020). The total emissions for Mississippi are 74.5 MMT CO_2-e with power generation (32%), transportation (30.8%), industry (20%), and agriculture (8.9%) being the four largest sectors. Most of the emissions are in the form of CO_2 (83%), with the rest being CH_4 (7.6%), N_2O (6.6%) and other gases (2.7%). A notable observation from the inventory calculation is the finding that the extensive forested areas of Mississippi served as a sink of magnitude similar to GHG emissions from all other sectors (minus 79 MMT CO_2-e). On a net basis, therefore, consideration of the forest carbon sink suggests that Mississippi's GHG emissions are zero or slightly negative. Even so, it should be understood that implementation of emissions reduction measures will contribute to minimizing both the harmful "nearfield" effects on low income and disadvantaged communities as well as broader regional ambitions for GHG reductions.

The independent review of GHG emissions for selected sectors revealed only minor differences and the SIT was considered appropriate for the present application. However, review indicates areas that could be the focus of further refinement in future phases of CPRG implementation.

There are multiple facets for evaluating GHG reduction measures, quantitative factors such as the magnitude of reduction, cost, and timeline, as well as broader considerations such as workforce impacts and benefits to low income and disadvantaged communities. For the 14 measures that were evaluated, we provide a summary of the approximate GHG reduction benefit assuming a typical scale of application in Table 7-1 below. These are not specific programs, but the magnitude of GHG reductions can help identify and then scale programs to better achieve statewide GHG targets.

Table 7-1. GHG reduction measures and magnitude of reduction for a planned scale of implementation

Proposed Reduction Measure	Planned Scale of Implementation	Annual GHG Reduction (CO_2-e)
Residential and commercial distributed solar generation and storage	Install 1% of residential buildings and 500 commercial buildings with small scale solar systems annually	94,570 MT
Utility solar generation and storage	Deploy 20 large-scale solar power plants (with average 50 MWAC capacity each) annually	949,400 MT
Electricity transmission and distribution upgrades	A 5% reduction on annual electricity transmission and distribution losses	59,000 MT
Cargo transportation to rail	Transit the transport of 2,600 containers over 3,000 miles from trucking to rail	12,200 MT
Vehicle Transition	Replace 4000 light duty and 2000 heavy duty vehicles to EV [8]	96,200 MT
School bus electrification	Replace 100 school buses to ESB[9]	2,600 MT
Alternative Fueling infrastructure	Deploy 100 new electric charging stations (and increase 1560 EV as a result)[9]	7,990 MT
Biofuel use for transportation or as an energy source	Replacement of 1% of annual diesel fuel sales in Mississippi	65,300 MT
Building efficiency improvements	Implementation of efficiency measures reducing total energy use by 30% in 1% of residential buildings and 500 commercial buildings annually	33,000 MT
Refrigerant replacement	Assumes a replacement or retrofit of 5 commercial-scale systems each year	7,780 MT
Forest carbon management	Program application over 10,000 acres	31,000 MT
BMPs for agricultural land	Representative application of multiple conservation practices over 10,000 acres	12,880 MT
Landfill CH_4 capture/electrification	Based on emissions data from a median landfill in Mississippi	89,000 MT
Wastewater CH_4 capture/electrification	Single wastewater plant serving a community of 10,000 people	620 MT

[8] Assuming 2030 electricity generation

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