

NEW JERSEY'S

PRIORITY CLIMATE ACTION PLAN

MARCH 2024



ACKNOWLEDGEMENTS

The New Jersey Priority Climate Action Plan is the first deliverable for the U.S. Environmental Protection Agency's Climate Pollution Reduction Grant program and serves to guide future federal investments in the State's emission reduction efforts. This plan is issued with special thanks to Governor Phil Murphy and the Department of Environmental Protection Commissioner Shawn M. LaTourette. It would not have been possible without the tireless work of state agency leadership, staff and other professionals dedicated to meaningful climate action.

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EXECUTIVE SUMMARY

New Jersey is warming faster than the rest of the Northeast region and the world (NJDEP, 2020). Its citizens are already experiencing the effects of climate change, from chronic heat to intense flooding and rising sea levels. Recognizing the need for immediate action, in 2021, Governor Murphy signed Executive Order 274 (EO 274), establishing an interim greenhouse gas reduction target of 50% by 2030. This new target, coupled with the State's previously adopted goal of an 80% reduction by 2050, will require significant near-term investments and comprehensive policy reform. The funding associated with the United States Environmental Protection Agency's (USEPA) Climate Pollution Reduction Grant program (CPRG) offers a historic opportunity to make substantial progress towards achieving these goals.

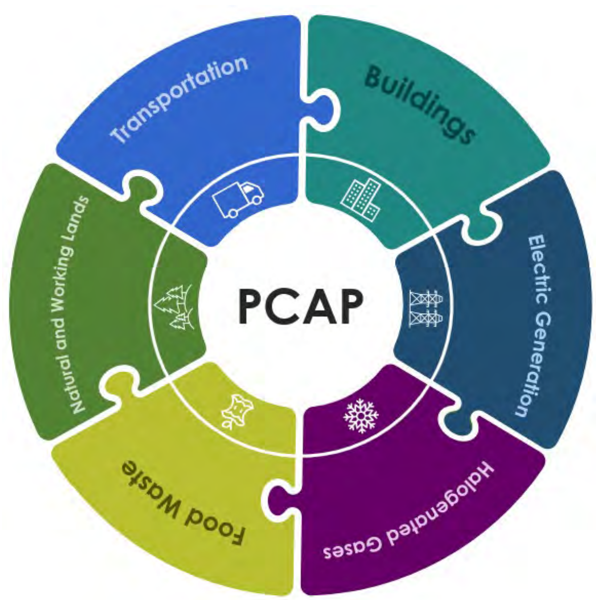
About CPRG

The CPRG program is a nationwide, two-phase USEPA grant funded by the Inflation Reduction Act (IRA). Phase 1 provided $250 million in noncompetitive planning grants to states and other entities to develop climate action plans for reducing greenhouse gas emissions and other harmful air pollutants. Phase 2 provides $4.6 billion in competitive grants to implement priority measures included in Priority Climate Action Plans (PCAP).

New Jersey's Priorities

The State of New Jersey developed this Priority Climate Action Plan (PCAP), as part of the Phase 1 CPRG grant. This plan builds on the State's 2019 Energy Master Plan and 2020 Global Warming Response Act 80x50 report to outline a near term roadmap for statewide emission reductions. Six focus areas are identified in this plan: 1) Transportation, 2) Residential and Commercial Buildings, 3) Electric Generation, 4) Food Waste, 5) Halogenated Gases, and 6) Natural and Working Lands (Figure ES 1). These sectors contribute the most to greenhouse gas emissions in New Jersey, or have the potential to significantly sequester carbon, and were identified in prior climate planning efforts as key areas on which to focus reduction efforts.

Figure ES. 1 *New Jersey's PCAP Priority Focus Areas*



As part of this PCAP, New Jersey also released an updated Greenhouse Gas Inventory Report, covering statewide emissions from 2006-2021. Similar to preceding years, emissions from the transportation sector were the largest source, totaling 37.3 million metrics tons of carbon dioxide equivalent (MMT CO_2e) (GWP_{100}). Residential and commercial buildings accounted for 14.9 and 9.9 MMT CO_2e in 2021 respectively, while emissions from the electric generation sector were 19.1 MMT CO_2e. Emissions from the State's waste management sector, which includes food waste, were 6.6 MMT CO_2e and hydrofluorocarbons (HFCs) which are commonly used halogenated gases, accounted for 5.2 MMT CO_2e in 2021. Finally, approximately 8.1 MMT of New Jersey's 2021 GHG emissions were removed via carbon sequestration from the State's natural and working lands, such as forests and wetlands, resulting in a net statewide emission total of 97.6 MMT CO_2e in 2021.

State agencies identified 12 priority measures and 68 enabling actions within these sectors (Table ES.1). These measures were developed with extensive stakeholder input and intergovernmental collaboration, reflecting the voices of communities and their leaders. Further, each measure was evaluated for its potential to reduce greenhouse gas emissions and benefit low-income and disadvantaged communities (See Chapter 4 and Appendix 7.4). New Jersey also conducted a workforce planning analysis to understand workforce needs related to successful implementation of the priority measures (See Chapter 5 and Appendix 7.5). This PCAP will serve as a guiding document for State and local agencies to secure federal funding to reduce greenhouse gas emissions.

***Table ES.1** New Jersey's PCAP Priority Measures and Estimated GHG Reductions*

PRIORITY MEASURE	EST. CUMULATIVE GHG REDUCTION BY 2030 (MMT CO_2e)	EST. CUMULATIVE GHG REDUCTION BY 2050 (MMT CO_2e)
TRANSPORTATION		
01 Achieve 30% zero-emission medium- and heavy-duty vehicle sales by 2030 and 100% by 2050	1.2	53.4
02 Achieve light duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c. 362)	9.6	268.2
03 Reduce emissions in and around ports	0.4	8.2
04 Reduce vehicle miles travelled	4.2	25.9
BUILDINGS		
05 Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties	9.5	63.8
06 Make at least 10% of all low-to-moderate income properties electrification-ready by the year 2030	0.0	6.5
ELECTRIC GENERATION		
07 Achieve 12.2 GW of solar in-state by 2030	15.2	107.3
08 Facilitate the integration of clean distributed energy resources into the grid[1]	0.0	0.0

[1] Emissions were not calculated for this measure directly; rather this measure enables emission reductions from other measures.

09 Support the development of 11.0 GW of offshore wind by 2040	6.4	276.6
FOOD WASTE 10 Achieve a 50% reduction in food waste by 2030	2.1	16.0
HALOGENATED GASES 11 Reduce halogenated gas emissions from refrigeration equipment	0.7	8.8
NATURAL AND WORKING LANDS 12 Maintain, protect and enhance New Jersey's natural carbon sinks[2]	0.01	0.2

Note on GHG estimates: *Readers are cautioned not to simply add the estimated reductions from each of these sectors to arrive at a total state-wide reduction because the measures interact with one other. For example, to gain the full benefits of electrified transportation and buildings, clean energy must be built in tandem with electrification to avoid reliance on fossil electricity. Timing will determine effectiveness.*

[2] Near term sequestration estimate only includes carbon that will be sequestered from street/shade tree planting actions due to data limitations. Also note, that carbon accrues on longer timescales in these systems and will take years to be realized.

Works Cited

Exec. Order No. 274. (2021). *New Interim Greenhouse Gas Reduction Goal and $33 Million Investment in Clean Transportation Projects.* Retrieved from https://nj.gov/infobank/eo/056murphy/pdf/EO-274.pdf

NJDEP. (2020) *New Jersey Scientific Report on Climate Change: At-A-Glance*. New Jersey Department of Environmental Protection. Retrieved from https://www.nj.gov/dep/climatechange/pdf/scientific-report-on-climate-change-at-a-glance.pdf

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ABBREVIATIONS

ACC II	Advanced Clean Cars II regulation
ACEEE	American Council for an Energy Efficient Economy
ACES	Alliance for Competitive Energy Services
ACT	Advanced Clean Trucks regulation
AD	Anaerobic Digestion
ADI	Administratively Determined Incentive
AIOBC	Adversely Impacted Overburdened Community
AMI	Area Median Income
BAU	Business-as-usual
BEB	Battery Electric Buses
BEV	Battery Electric Vehicle
CARB	California Air Resources Board
CBES	Commercial Building Energy Survey
CBO	Community-Based Organization
CCAP	Comprehensive Climate Action Plan
CCRC	Rutgers University Climate Change Research Center
CCSP	Conservation Cost Share Program
CEJST	White House's Climate and Economic Justice Screening Tool
CEPG	Community Energy Planning Grant
CEPI	Community Energy Plan Implementation
CESA	Clean Energy States Alliance
CFC	Chlorofluorocarbons
CFI	Charging and Fueling Infrastructure Grant Program
CHS	Clean Heat Standard
CNG	Compressed Natural Gas
CO_2e	Carbon Dioxide equivalent emissions
CPRG	Climate Pollution Reduction Grant
CSI	Competitive Solicitation Incentive
CST	Combined Stressor Total
DAC	Disadvantaged Community
DCFC	Direct Current Fast Charger
DER	Distributed Energy Resources
DERA	Distributed Energy Resource Aggregators
DVRPC	Delaware Valley Regional Planning Commission
E.O.	Executive Order
EGU	Electric Generating Utility
EJ	Environmental Justice
EJMAP	New Jersey's Environmental Justice Mapping, Assessment and Protection Tool
EMP	Energy Master Plan
EQIP	Environmental Quality Incentives Program
EVs	Electric Vehicles
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GHG	Greenhouse Gas
GHGMRR	Greenhouse Gas Monitoring and Reporting Rule
GLGE	Gasoline Powered Lawn and Garden Equipment
GPC	Geographic Point of Comparison
GSHP	Ground Source Heat Pump
GVWR	Gross Vehicle Weight Rating
GW	Gigawatt
GWP	Global Warming Potential
GWP_{100}	100-Year Global Warming Potential
GWRA	Global Warming Response Act
HEEHR	Home Electrification and Appliance Rebates
HFC	Hydrofluorocarbon (refrigerants)
HOMES	Home Efficiency Rebate
IECC	International Energy Conservation Code
IIJA	Infrastructure Investment and Jobs Act
IRA	Inflation Reduction Act
ITC	Investment Tax Credit
LDV	Light-Duty Vehicles

LEUP	Large Energy User Program
LIDAC	Low-Income/Disadvantaged Communities
LMI	Low-to Moderate-Income
LVPC	Lehigh Valley Planning Commission
MHDV	Medium- and Heavy-Duty Vehicles
MMT	Million Metric Tons (weight/mass)
MOU	Memorandum of Understanding
MOVES	Motor Vehicle Emission Simulator
MPO	Metropolitan Planning Organization
MSA	Metropolitan Statistical Area
MUD	Multi-unit Dwelling
MW	Megawatt
NCS	Natural Climate Solutions Grant Program
NESCAUM	Northeast States for Coordinated Air Use Management
NEVI	National Electric Vehicle Infrastructure Program
NJ SIP	New Jersey Energy Storage Incentive Program
NJ TRANSIT	North Jersey Transit Corporation
NJ ZIP	New Jersey Zero-emission Incentive Program
NJAC	New Jersey Administrative Code
NJBPU	New Jersey Board of Public Utilities
NJCAT	New Jersey Corporation for Advanced Technology
NJCEP	New Jersey Clean Energy Program
NJCEP	New Jersey Clean Energy Program
NJDA	New Jersey Department of Agriculture
NJDCA	New Jersey Department of Community Affairs
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJDPMC	New Jersey Division of Property Management and Construction
NJEDA	New Jersey Economic Development Authority
NJTPA	North Jersey Transportation Planning Authority
NJTPA	North Jersey Transportation Planning Authority
NJWP	New Jersey Wind Port
NWL	Natural and Working Lands
OBC	New Jersey Overburdened Community
OREC	Offshore Wind Renewable Energy Certificate
PANYNJ	Port Authority of New York and New Jersey
PASTA	Physical Activity through Sustainable Transport Approaches
PCAP	Priority Climate Action Plan
PHEV	Plug-in Hybrid Electric Vehicle
PNNL	Pacific Northwest National Laboratory
PTC	Production Tax Credit
PV	Photovoltaic
PVSC	Passaic Valley Sewerage Commission
REA	Recycling Enhancement Act
RECS	Residential Energy Consumption Survey
RFI	Request for Information
RGGI	Regional Greenhouse Gas Initiative
RMP	Refrigerant Management Program
SF_6	Sulfur hexafluoride
SSA	State Agreement Approach
SUV	Sports Utility Vehicle
SWIFR	Solid Waste Infrastructure for Recycling
UCC	Uniform Construction Code
UCF	Urban and Community Forestry
USCA	United States Climate Alliance
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
V2B	Vehicle-to-building electric charging/supply system
V2G	Vehicle-to-grid electric charging/supply system
V2S	Vehicle-to-storage electric charging/supply system
VMT	Vehicle Miles Travelled
VOC	Volatile Organic Compound
2019 EV Law	P.L. 2019, c352

INTRODUCTION

Overview

The State of New Jersey's Priority Climate Action Plan (PCAP) was developed as part of the United States Environmental Protection Agency's (USEPA) Climate Pollution Reduction Grant Program (CPRG) Phase 1 Planning Grant which requires the State to identify priority measures that state agencies or CPRG implementation grant-eligible entities can implement in the near term (by 2030) to achieve quantifiable greenhouse gas emissions reductions. It is intended to act as a resource and guide for applicants seeking CPRG Phase 2 Implementation Grants. This PCAP outlines many of the key actions that state and local government can take between now and 2030 to achieve the ambitious interim goal of halving statewide greenhouse gas emissions by 2030 with a particular focus on actions that can benefit the State's most vulnerable populations. A measure's inclusion in this PCAP is a prerequisite for state agencies and local governments to compete for Phase 2 implementation grant funding. Accordingly, the measures included in this PCAP are designed to be broad enough to support a variety of funding applications. This PCAP builds upon the goals, strategies, and actions of the 2019 Energy Master Plan and the 2020 Global Warming Response Act 80x50 Report but is not a comprehensive list of policy and program recommendations for New Jersey. Avoiding the worst impacts of climate change will require decisive action from the state, local governments, community organizations, businesses, and residents; every entity and individual must make choices to reduce our greenhouse gas emissions in the fight against climate change.

CPRG Overview

The CPRG program is a nationwide, two-phase USEPA grant funded by the Inflation Reduction Act (IRA). Phase 1 provided $250 million in noncompetitive planning grants to states, local governments, tribes, and territories to develop and implement climate action plans for reducing greenhouse gas emissions and other harmful air pollution. This phase involves the creation of the PCAP, a Comprehensive Climate Action Plan (CCAP) due in 2025, and a status update report due in 2027.

Phase 2 provides $4.6 billion in competitive grants for recipients of the Phase 1 grants as well as other eligible entities such as local governments, tribes, and air pollution control agencies to implement priority measures included in a PCAP.

PCAP Overview

The PCAP is the first of three deliverables that New Jersey is required to submit to the USEPA. PCAPs must include four major elements: a greenhouse gas inventory, quantified greenhouse gas reduction measures, low-income and disadvantaged communities benefit analysis and a review of authority to implement. New Jersey's PCAP also includes optional components: a plan for leveraging federal and other funding sources to implement each measure and a workforce planning analysis.

The core of the New Jersey's PCAP is the focused list of near-term, high priority, implementation ready measures to reduce greenhouse gas emissions that can be found in Section 3.0 of this plan. These priority measures and several key actions to enable them, are informed by extensive stakeholder engagement and coordination led by the New Jersey Department of Environmental Protection (NJDEP or the Department) beginning in June 2023 until publication of this plan in March 2024. The PCAP identifies emissions reduction and sequestration measures in six priority areas: Transportation, Buildings, Electric Generation, Food Waste, Halogenated Gases, and Natural and Working Lands which serve as carbon sinks. The CCAP, which is the second USEPA deliverable, will consider other measures and address all greenhouse gas emissions sectors in New Jersey.

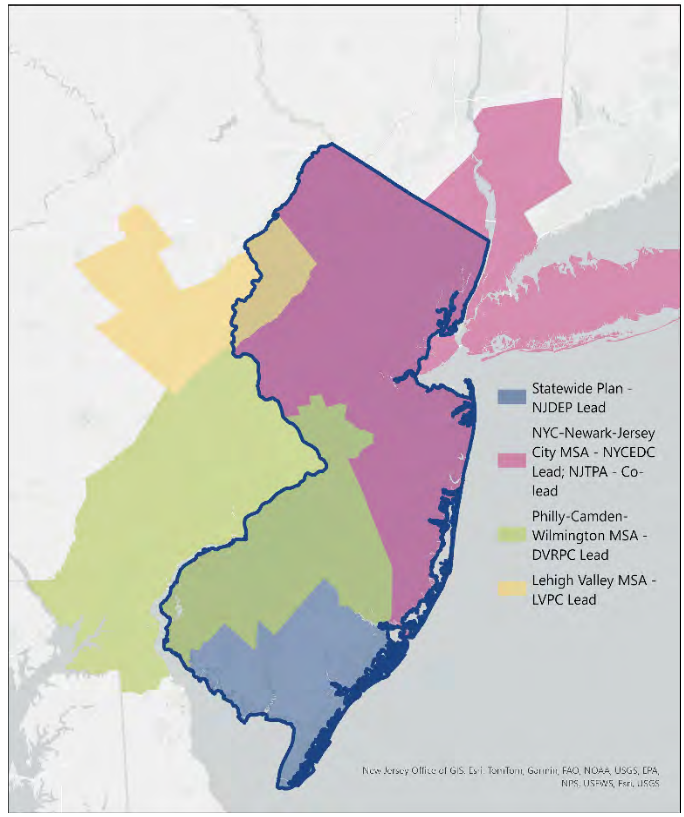
Scope of New Jersey's PCAP

New Jersey's PCAP covers the entire state, ensuring any eligible entity seeking a CPRG Phase 2 Implementation Grant is adequately covered.

There are four discrete CPRG Phase 1 planning grants that cover various portions of the State (Figure 1.1).

The NJDEP received a grant to develop a statewide plan [shown in blue outline on the map]. Three Metropolitan Statistical Areas (MSAs) all received grants covering portions of New Jersey. The New York City Economic Development Corporation (NYCEDC) in partnership with the North Jersey Transportation Planning Authority (NJTPA) received a planning grant covering 12 counties in New Jersey stretching from Sussex to Ocean [shown in pink on the map].[1] The Lehigh Valley Planning Commission (LVPC) in Pennsylvania received a planning grant that covers a portion of Warren County [shown in yellow on the map]. And the Delaware Valley Regional Planning Commission (DVRPC) received a planning grant that covers portions of 5 counties in New Jersey [shown in green on the map].[2] Each of these entities will produce climate action plans for their respective areas of New Jersey.

Figure 1.1. *CPRG workplan areas within New Jersey*



State and MSA Context

This statewide PCAP covers all municipalities, counties and metropolitan planning organizations that are eligible for CPRG implementation grant funds. To coordinate implementation of priority measures that may have been identified in the Philadelphia-Camden-Wilmington MSA PCAP, the NY-NJ MSA PCAP, and the Lehigh Valley MSA PCAP, that may not have been expressly identified in New Jersey's statewide PCAP, New Jersey formally adopts these plans by reference.

Approach to Developing the PCAP

This PCAP builds upon New Jersey's ongoing leadership in climate planning and policy. It was informed by the State's two foundational climate action plans:

- 2019 Energy Master Plan[3]
- 2020 Global Warming Response Act 80x50 Report

Further it expands upon and thematically connects to the priorities and outputs of:

- New Jersey's Clean Buildings Working Group
- New Jersey's Regional Greenhouse Gas Initiative (RGGI) Strategic Funding Plans
- New Jersey Council on the Green Economy's Green Jobs for a Sustainable Future Report
- Food Waste Reduction Plan
- Natural and Working Lands Strategy
- Electric Vehicle Law (P.L. 2019, c.362, 2019)

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[1] New Jersey counties covered by NJTPA & NYEDC PCAP: Essex, Hunterdon, Morris, Sussex, Union, Middlesex, Monmouth, Ocean Somerset, Bergen, Hudson, Passaic.

[2] New Jersey counties covered by DVRPC PCAP: Burlington, Camden, Gloucester, Mercer, Salem

[3] New Jersey is in the process of updating the 2019 Energy Master Plan and intends to release a new version in 2025.

- Transportation rules (Advanced Clean Cars II and the Advanced Clean Truck Rule)

NJDEP actively collaborated with government officials at various levels - state, regional, and local - throughout the PCAP development process. The NJDEP team also collaborated and sought input from non-governmental stakeholders including non-profit organizations, business leaders, and residents throughout the State. These interactions served multiple purposes: information exchange, identifying potential partners for implementation grants, and in some cases, working together to engage stakeholders and coordinate measures in PCAPs.

By fostering this multi-level, collaborative approach, New Jersey's PCAP lays the groundwork for enduring climate action. This cross-pollination of ideas, resources, and strategies empowers state, regional, and local entities to leverage each other's strengths and address challenges collectively. Ultimately, this type of coordination is not just important, it's essential to achieve the State's ambitious climate goals. It ensures efficient implementation, maximizes impact, and sends a clear message: New Jersey stands united in building a more sustainable future for all.

Intergovernmental Coordination

Interstate Coordination

NJDEP proactively collaborated with regional partners by leading monthly meetings with the three MSAs receiving CPRG funds and the neighboring states of New York, Delaware, and Pennsylvania. The result is a unified regional approach to PCAP development. NJDEP also participated in DVRPC's PCAP steering committee, attending regular meetings, and providing insight into priorities and partnership opportunities.

Intrastate Coordination

Reducing greenhouse gas emissions calls for a whole-of-government approach. NJDEP utilized the opportunity presented by the CPRG to continue to dialogue with other State departments and agencies about how to optimize greenhouse gas reduction efforts and pool resources. Overall, the Department held over 20 meetings with other State departments and agencies.

Local Government Coordination

Many of the actions proposed in this PCAP require engagement and action by the State's local governments thus NJDEP hosted meetings with local government officials to identify priority actions for inclusion in the PCAP. NJDEP also collected feedback from county officials.

Stakeholder Engagement

Recognizing that a robust participatory process is crucial for achieving effective change, NJDEP established four overarching goals for PCAP stakeholder engagement:

- Raise awareness of the CPRG program among eligible entities and community leaders;
- Establish and/or deepen relationships to drive greenhouse gas reduction efforts across the State;
- Ensure meaningful engagement of overburdened communities; and
- Document priorities for climate action to inform State planning documents.

The Department collected feedback through various public stakeholder engagement activities, which included:

- Offering five sector-specific workshops;
- Hosting two local government meetings;
- Holding a dedicated in-person community dialogue with environmental justice stakeholders;
- Arranging two halogenated gases industry dialogues; and
- Collecting written comments via the online comment form and the Department's NJClimate email address.

A full stakeholder engagement report summarizing the findings from the engagement process is included in Appendix 7.3 of this report.

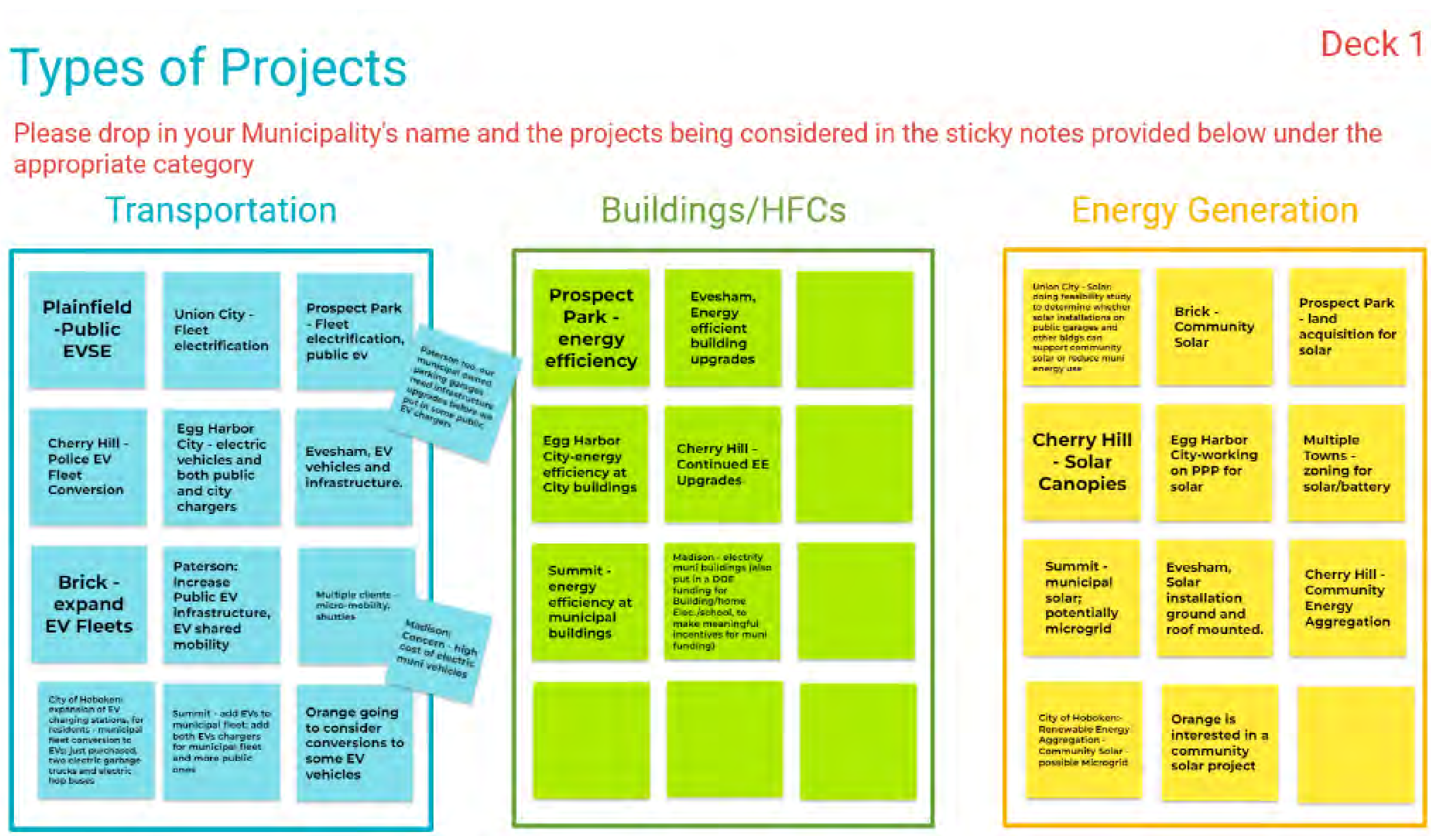
Sector-specific Workshops

NJDEP partnered with Rutgers University to host five sector-specific workshops. The two-hour sessions, available in English and Spanish, addressed Buildings and Electric Generation, Food Waste, Halogenated Gases, Natural and Working Lands, and Transportation. Recordings and materials were made readily accessible on the NJDEP CPRG website, fostering transparency and ongoing engagement. Over 260 attendees participated in these events.

Local Government Meetings

Recognizing the pivotal role municipal and county government play, NJDEP partnered with Sustainable Jersey and the NJBPU to cohost two meetings with cohorts of local governments. Attendees, including awardees of NJBPU's Community Energy Plan grants, shared insights into their greenhouse gas reduction priorities (Figure 1.2). Key themes emerged, highlighting the need for initiatives like building electrification, electric vehicle charging infrastructure, and community solar projects. Participants openly shared concerns regarding upfront costs, space limitations, and navigating procurement processes.

Figure 1.2. *Urban Sustainability Hub Meeting Jamboard Identifying Local Government Priorities.*



Environmental Justice Community Engagement

Voices from New Jersey's environmental justice communities were prioritized throughout the development of the PCAP. The NJDEP Environmental Justice Advisory Committee was periodically consulted about the PCAP development process and in December of 2023, NJDEP held an in-person community dialogue with key environmental justice community members to hear their climate action priorities. This is the first of ongoing dialogues planned throughout the CPRG grant period. Over twenty Newark residents participated, representing diverse groups and perspectives. The discussion centered around four key themes:

> **Workforce development:** Residents advocated for better training opportunities in renewable energy, including solar panel and technology programs. They emphasized the importance of union eligibility, language accessibility, and inclusivity for undocumented and formerly incarcerated individuals.

Place-based climate action: Support emerged for creating "eco-villages" as pilot projects. These could focus on different aspects of climate resilience, like building community eco-plans and providing local workforce training. Residents also suggested establishing an environmental task force for youth to participate in monitoring and implementing climate action.

Organic waste: Participants called for removing barriers to community composting and encouraging urban farming initiatives in collaboration with schools and seniors.

Air pollution: Residents highlighted the urgency of regulating toxic pollutants alongside greenhouse gases. They recommended establishing zero-emission zones around ports and an advisory committee with stipends for longshoremen. Concerns were raised regarding expanding the NJ Turnpike, purchasing diesel buses, and utilizing fossil-fueled power plants.

Industry Dialogues

Due to low turnout for the halogenated gases webinar, Rutgers University Climate Change Resource Center performed phone surveys of two large refrigerant users in the State. Their feedback further complemented comments received during the webinar and NJDEP's rule comment period for its Greenhouse Gas Monitoring and Reporting Rule regarding halogenated gases, adopted in 2022.

Webpage, Online Comment Form and Emails

NJDEP published a CPRG webpage in August of 2023, providing a general overview of the grant, a timeline for each phase, meeting presentations and recordings (in both English and Spanish), and a feedback form to collect public comments. Over 40 comments were received.

Figure 1.3 *New Jersey's PCAP Engagement Timeline.*

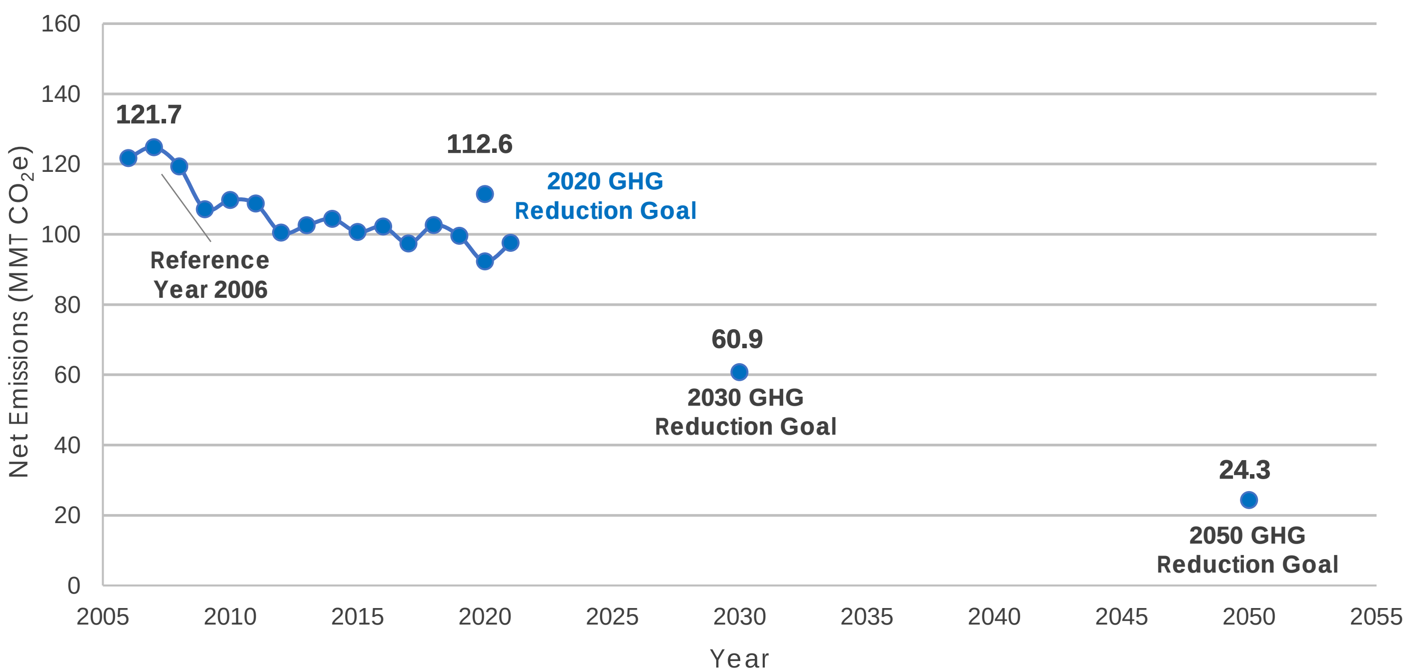
2023								2024
May	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**January**
Interstate/Inter-agency coordination meetings	EJ Meeting	General Outreach/ Outreach Events	Interstate/Inter-agency coordination meeting	General Outreach/ Outreach Events	General Outreach/ Outreach Events | **5**	General Outreach/ Outreach Events | **2**	EJ Meetings | **2**	Interstate/Inter-agency coordination meetings | **2**
		Interstate/Inter-agency coordination meetings | **2**	Meetings with NJ Governor's Office	EJ Meeting	EJ Meeting	EJ Meeting	Interstate/Inter-agency coordination meetings | **5**	Other inter-agency coordination meetings | **3**
		Other inter-agency coordination meetings | **5**	Other inter-agency coordination meetings | **6**	Meetings with NJ Governor's Office	Interstate/Inter agency coordination meetings | **2**	Interstate/Inter agency coordination meetings | **4**	Meetings with NJ Governor's Office | **2**	Sector Specific Outreach/ Workshops | **3**
				Other Inter-agency coordination meetings | **2**	Meetings with NJ Governor's Office	National Interstate Coordination | **3**	National Interstate Coordination | **11**	
					National Interstate Coordination | **3**	Other Federal-agency coordination meetings	Other Federal-agency coordination meetings	
					Other Federal-agency Coordination meetings	Other inter-agency coordination meetings | **4**	Other inter-agency coordination meetings | **4**	
					Other inter-agency coordination meetings | **14**	Sector Specific Outreach/ Workshops | **6**	Sector Specific Outreach/ Workshop	
					Sector Specific Outreach/ Workshops			

GREENHOUSE GAS INVENTORY

Overview

The New Jersey Global Warming Response Act (GWRA, P.L. 2007, c.112, as amended 2019) calls for an annual compilation of statewide greenhouse gas emissions data. Periodic inventory updates provide vital information for assessing the State's progress towards meeting its greenhouse gas reduction goals (Figure 2.1). Specifically, the GWRA calls for the State, no later than January 1, 2020, to reduce greenhouse gas emissions to, or below, the level of emissions in 1990. Based on the assessment presented here, the State achieved that goal more than a decade early. The GWRA also requires the State to reduce its statewide greenhouse gas emissions to at least 80% below 2006 levels by January 1, 2050. More recently, Governor Phil Murphy's Executive Order 274 established an interim target of reducing total greenhouse gas emissions to 50% of 2006 levels by 2030.

Figure 2.1: *New Jersey Emissions and Greenhouse Gas Reduction Goals*



Inventory Structure and Process

New Jersey uses an inventory scope and framework consistent with international and national greenhouse gas inventory practices. This inventory provides estimates of anthropogenic greenhouse gas emissions within New Jersey, and those associated with imported electricity and exported waste. Biogenic (natural) sources are not included in the inventory. The inventory includes estimates for:

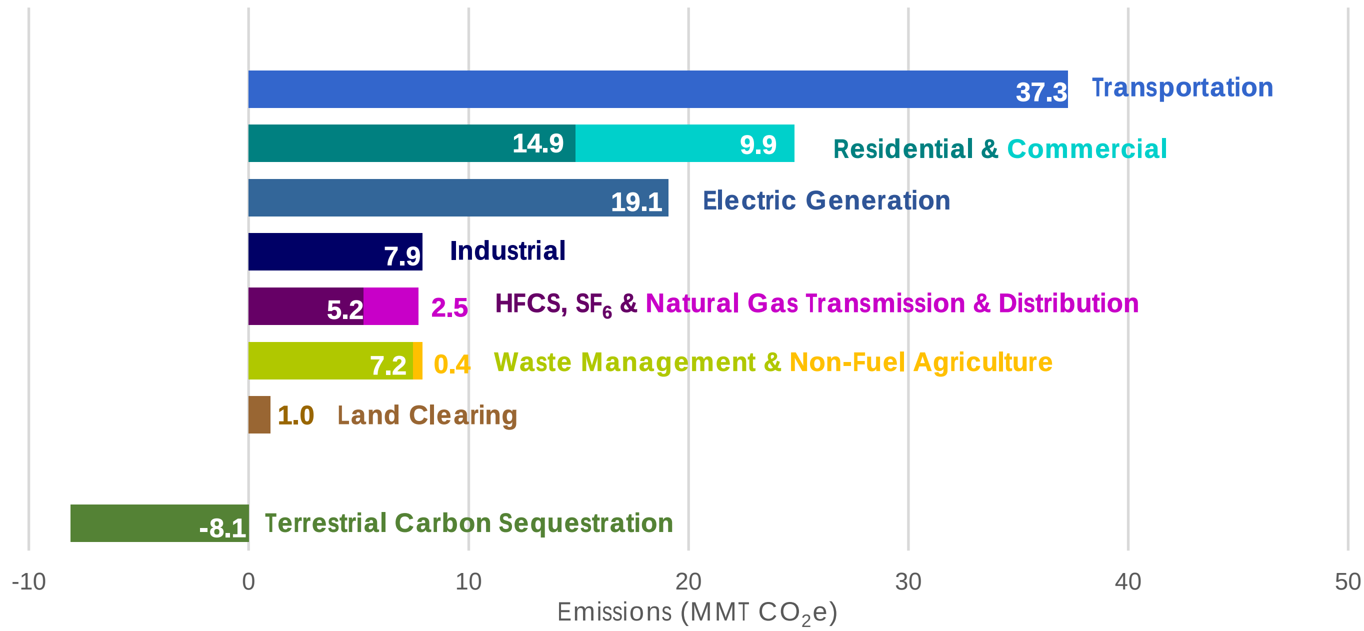
- Carbon Dioxide (CO_2);
- Methane (CH_4);
- Nitrous Oxide (N_2O);
- Fluorinated gases with high global warming potentials (High-GWP) which includes hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF_6); and
- Estimates of Carbon Sequestration from natural and working lands.

Emission estimates are recalculated annually for all years to maintain a consistent time-series following the Intergovernmental Panel on Climate Change recommendations for developing greenhouse gas inventories. Thus, emissions levels in this report may differ from those in previous inventory editions. The full Greenhouse Gas Inventory report and the methods applied is available in Appendix 7.6.

2021 Emissions

In 2021, statewide gross emissions were 105.7 million metrics tons of carbon dioxide equivalent (MMT CO_2e) (GWP_{100}) (Figure 2.2). Energy consuming sectors were the largest sources of emissions (89%), resulting from fossil fuel combustion from transportation, electric generation, residential and commercial, and fuel-consuming industrial activities. Non-energy emissions accounted for the remaining 11% of emissions and are associated with a variety of processes such as the release of greenhouse gases from sectors using or producing halogenated gases, sulfur hexafluoride, natural gas transmission and distribution, waste management and other industrial processes. Approximately 8% of 2021 emissions were removed via carbon sequestration from New Jersey's natural and working lands, such as forests and wetlands, resulting in a net emission total of 97.6 MMT CO_2e.

Figure 2.2: *New Jersey 2021 GHG Emissions (GWP_{100})*



New Jersey's net emissions have dropped 13% from 112.6 MMT CO_2e in 1990 to 97.6 MMT CO_2e in 2021. The general pattern of annual decreases seen since 2005 continued in 2021, with a small 1.9 MMT CO_2e reduction from the pre-pandemic year of 2019. However, between 2020 and 2021 there was a rebound increase of 5.4 MMT CO_2e as the State's economy recovered and traditional patterns of commerce and travel resumed. This series of events is instructive in that it demonstrates the combined roles of technical and social processes in determining greenhouse gas emissions. Looking across the thirty-year period, many reductions can be traced to the adoption of new technologies with inherent environmental benefits. For example, aging coal-fired power plants in New Jersey have been entirely phased out and replaced by less-polluting combined-cycle natural gas systems and a burgeoning supply of renewable energy. Similarly, improvements in the fuel efficiency of passenger vehicles over the past 30 years have contributed to overall emission reductions; however, much of these improvements have been offset by increased consumer demand for larger trucks and sport utility vehicles. Most notably, changes to travel patterns and purchasing behaviors during the pandemic demonstrated how social actions can directly reduce climate emissions.

PRIORITY SECTORS AND REDUCTION MEASURES

New Jersey identified six sectors for greenhouse gas reduction within this Priority Climate Action Plan (PCAP). Collectively, these sectors account for the vast majority of emissions in the State. This PCAP dedicates a chapter to each sector, providing an overview of the sector, its emissions profile, the State's progress to date in abating emissions and the measures and enabling actions necessary to realize New Jersey's climate mitigation goals. A full list of priority measures and enabling actions can also be found in Appendix 7.1.

Measure Development

To develop the measures included in this PCAP, NJDEP used the 2020 Global Warming Response Act 80x50 report as a foundational document then gathered all existing climate planning documents, evaluated implementation progress, and performed a gaps analysis to tease out cross cutting, near term priorities. This analysis guided plans for partner coordination and public stakeholder efforts. Following stakeholder engagement efforts, a comprehensive list of measures was developed.

These measures are considered "priority measures" for the purposes of:

- Setting the State on a path towards its goal of reducing greenhouse gases 50% by 2030.
- Setting the State on a path towards achieving its goal of reducing greenhouse gas emission 80% by 2050.
- Providing an opportunity for states, local governments, metropolitan planning organizations, and eligible institutions to pursue federal funding through the Infrastructure Investment and Jobs Act, the Inflation Reduction Act of 2022 (IRA), and specifically the Climate Pollution Reduction Grant (CPRG) implementation grants (IRA Section 60114).

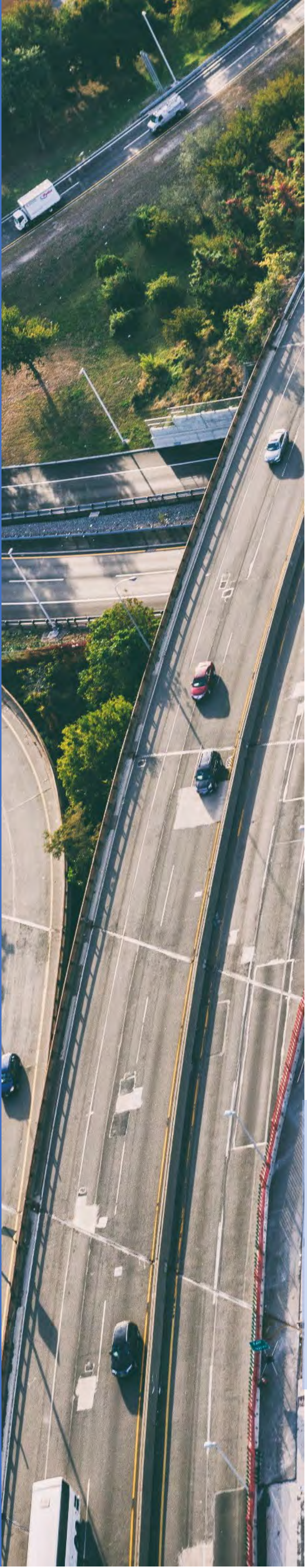
The PCAP is not exhaustive and does not represent all the priorities of the State or all the measures that can be implemented to achieve reductions. Additionally, most of the measures are contingent on receiving adequate State and/or federal funding to develop and implement. While focused primarily on near-term, capital investments that directly reduce greenhouse gas emissions, it is worth noting that "non-capital investments" or "soft" approaches are an integral part of implementing these measures. NJDEP therefore considers all indirect, "soft" approaches including but not limited to staffing, project planning, design, educational outreach, and workshops that may be necessary for successful implementation of a measure or enabling action as eligible activities for funding under this PCAP. Eligible CPRG applicants may cite this section and the aligned measure(s) or action(s) where appropriate in their implementation grant proposals.

Bundling Measures for Holistic Decarbonization

Throughout the PCAP engagement process, stakeholders consistently expressed that taking a cross-sector approach to implementation is critical to achieving meaningful emissions reductions. As eligible New Jersey entities prepare applications for the USEPA's CPRG implementation grants, the NJDEP supports the bundling of enabling actions across various sectors to demonstrate holistic, place-based decarbonization and encourages citation of specific page(s) or section(s) of this PCAP that align with grantees' proposals.

Greenhouse Gas Reduction Estimates

The following chapters include estimated reductions from priority measures in each of the priority sectors. Cumulative estimates count reductions occurring in 2025 and in subsequent years through 2030 and 2050. When considering these benefits in the broader context of the entire economy, it is not appropriate to directly sum these reductions to arrive at a total statewide number due to interactions between the sectors. Specifically, the estimated reductions from the electric generation sector were calculated with the assumption that new renewables generation would avoid the need to build new natural gas fired power plants to meet the growing demand from electrification of transportation and buildings. However, in the short run, demand from electrification could grow more rapidly than renewable energy is built, leading to continued gas consumption until sufficient clean energy is brought online. This in turn would at least temporarily offset some of the potential emissions reductions from electrification. To the degree that electricity production rapidly shifts to clean, renewable sources of power, this offsetting factor will diminish, and greater reductions will be realized.



TRANSPORTATION

Overview

New Jersey's transportation sector generates the largest share of greenhouse gases in the State. In 2021, the sector contributed 37.3 million metric tons of carbon dioxide equivalent (MMT CO_2e) (GWP_{100}), or 38% of total net statewide emissions. The primary source of emissions is from the combustion of fossil-fuels to power on-road vehicles, aviation, marine, and rail. Of these, the on-road transportation segment makes up 92.3% of the sector's emissions while aviation, marine, and rail make up 2.7%, 4.0%, and 0.9% respectively (NJDEP, 2024) (Figure 3.1.1). The State's 2020 Global Warming Response Act 80x50 Report (2020 GWRA 80x50 Report) set 5.4 MMT CO_2e as the emissions goal to be achieved by 2050 for the overall sector. To achieve this goal, 88% of new light-duty vehicle sales (passenger cars, sports utility vehicles, and light-duty trucks) need to be electric or hydrogen-powered by 2030, rising to 100% of sales by 2035 (NJDEP, 2020). A significant share of medium- and heavy-duty vehicle (MHDV) sales must also be based on technologies that do not emit carbon dioxide.

37.3 MMT CO_2e

2021 Combined Emissions

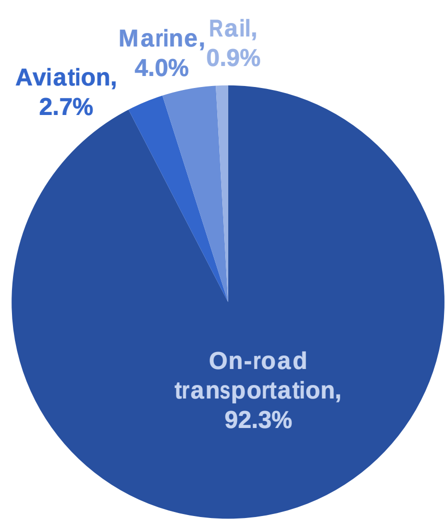
38%

of Total State Emissions

5.4 MMT CO_2e

2050 Reduction Goal

Figure 3.1.1. *2021 NJ Greenhouse Gas Emissions from Transportation (Percent of 37.3 MMT CO_2e)*

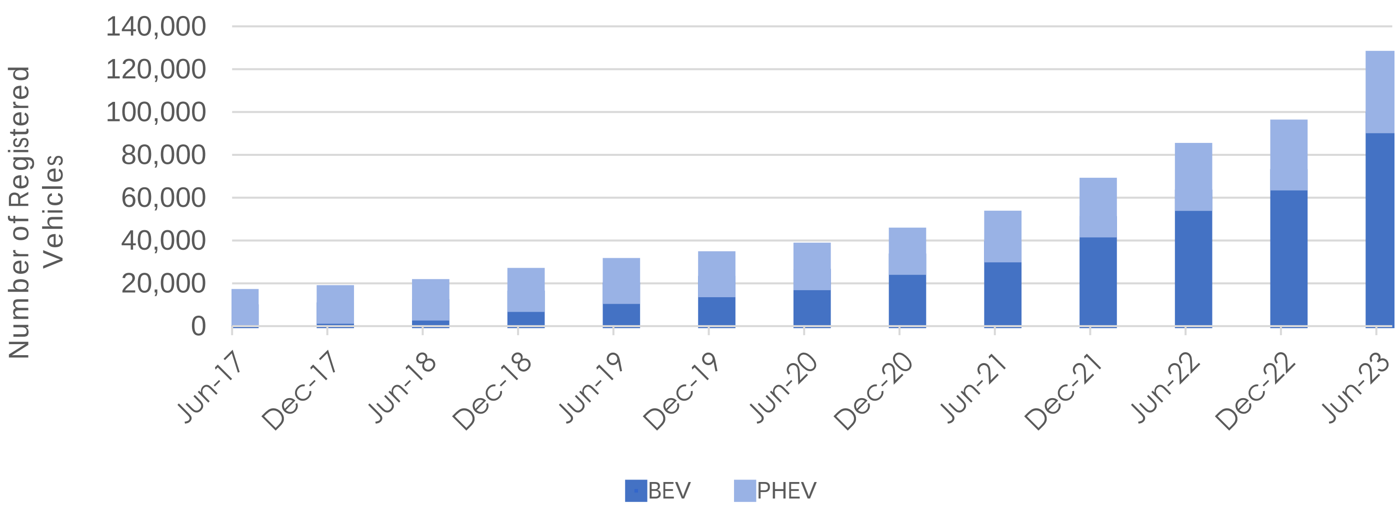


New Jersey's vast number of gasoline- and diesel-fueled on-road vehicles need to rapidly shift to clean alternatives. New Jersey has nearly 7 million registered on-road vehicles including 6.5 million light-duty vehicles, 405,058 medium-duty vehicles, and 108,385 heavy-duty vehicles.[1] Light-duty vehicles account for the largest percentage of on-road vehicle emissions at 73.9%, followed by medium- and heavy-duty trucks and vocational vehicles at 18.1%, light commercial trucks at 6.0%, and buses at 2.0%.[2] Due to the complexities of the different types of vehicles and their use cases, decarbonizing the transportation sector will require multiple strategies and resources to achieve meaningful emissions reductions.

Progress to Date

New Jersey has begun to make progress in decarbonizing on-road transportation. The number of light-duty plug-in electric vehicles (including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) is growing each year, reaching 123,551 registered vehicles in June 2023. BEVs and PHEVs now account for 1.3% of registered light-duty vehicles in the State and 12% of the new vehicle market share (Figure 3.1.2). For the MHDV population, New Jersey has experienced an increase in registrations of compressed natural gas vehicles, reaching 0.8% of registered vehicles as of July 2023. Zero-emission vehicles are relatively newer, having reached just 0.3% of registered vehicles as of July 2023.

Figure 3.1.2. *Semi-annual Electric Vehicle Registrations in New Jersey (all vehicle classes)*



To support these vehicles, a network of over 2,240 public Level 2 charging ports and 1,010 public direct current fast charging (DCFC) ports are available (Atlas Public Policy, 2024). This expansion has exceeded the goals set out in New Jersey's Electric Vehicle Law (2019 EV Law) P.L. 2019, c.362, 2019) which called for the deployment of at least 400 DC fast charging stations and at least 1,000 publicly available Level 2 charging stations across the State by 2025. The network of charging stations spans all New Jersey counties and continues to grow.

Zero-emission vehicle registrations in New Jersey will increase significantly due to the 2019 EV Law and the 2021 Advanced Clean Trucks regulation (N.J.A.C. 7:27-31). Adopted in November 2023, the Advanced Clean Cars II (ACC II) (N.J.A.C. 7:27-29A) regulation requires manufacturers to sell increasing percentages of zero-emission vehicles each year, ramping up to 100% of new vehicle sales being zero emission by 2035. ACC II is anticipated to drive significant transportation sector emissions reductions. These policies are supported by a series of programs incentivizing light-, medium-, and heavy-duty zero-emission vehicle purchases (Table 3.1.1).

[1] Light-duty vehicles include cars, light-duty trucks, and motorcycles (i.e., Federal Highway Administration (FHWA) Vehicle Classes 1-2a). Medium- (i.e., FHWA Classes 2b-6) and heavy-duty vehicles (i.e., FHWA Classes 7-8) include trucks, vocational vehicles (including motor homes, short-haul, long-haul, and refuse trucks), and buses (including school, transit, and other buses).

[2] Note that this does not include the millions of vehicles, in particular medium-and heavy-duty vehicles going to and from the State's ports, that traverse New Jersey's roadways each year that are not registered in the State.

Table 3.1.1. *New Jersey Transportation Electrification Programs*

Name	Focus	Application
Charge Up New Jersey	Vehicles	Light-duty vehicles
eMobility grants	Vehicles and charging infrastructure	All classes
NJ ZIP	Vehicles	Medium- and heavy-duty vehicles
Diesel Fleet Modernization	Vehicles and charging infrastructure	Medium- and heavy-duty vehicles
Electric School Bus Program	Vehicles and charging infrastructure	Medium- and heavy-duty school buses
Clean Fleet Electric Vehicle Incentive Program	Vehicles and charging infrastructure	All classes
It Pay$ to Plug-in	Charging Infrastructure	Light-duty vehicles
EV Charging grants for MUDs and Tourist Attractions	Charging Infrastructure	Light-duty vehicles
Medium- and Heavy-Duty Electric Vehicle Charging Program	Charging Infrastructure	Medium- and heavy-duty vehicles
National Electric Vehicle Infrastructure	Charging Infrastructure	All classes

Community Driven Solutions

Stakeholders identified six broad priorities for reducing greenhouse gas emissions from New Jersey's transportation sector during the public comment and engagement period including: expanding current incentives for electric vehicle adoption; expanding current electric vehicle charging infrastructure; expanding resources for reducing travel demand and vehicles miles travelled; expanding zero- and low-carbon transit and eMobility options; supporting local transportation planning efforts that lead to measurable greenhouse gas emission reductions; and supporting deployment of strategic education programs aimed at both the general public as well as school districts and municipalities in underserved communities. Stakeholders stressed that current financial incentive programs for transportation electrification are insufficient to meet demand and recommended investing more funds in these programs with a focus on overburdened communities. Stakeholders also emphasized that since funding for smart growth-type, transit-oriented development, and other land use related projects that reduce emissions from transportation has been insufficient, there is a need now to strategically fund technical assistance for local agencies and governments to move conceived projects to "shovel-ready" and to support them in applying for implementation funding.

"Active transportation infrastructure, like sidewalks, bike lanes, and well-connected mixed-use trails, provides further potential for reducing greenhouse gas emissions and transitioning away from car travel. Well-connected active transportation networks allow people to get to and from their destination of choice reliably by foot, bike, or scooter. When good infrastructure and compact densities allow for safe, convenient travel by foot, bike, or scooter, lower-income people benefit by not having to drive everywhere."

– NJ Environmental Advocacy Non-profit

"Pre-proposal, or early proposal expert consultation would be helpful, [including] standard guidance on similar use cases of electric vehicle fleet conversion and charger installation."

– NJ Local Government

01

Achieve 30% zero-emission medium- and heavy-duty vehicle sales by 2030 and 100% by 2050

In July 2020, New Jersey signed onto a multi-state Memorandum of Understanding (MOU), committing to work collaboratively to advance and accelerate the market for MHDVs (NESCAUM, 2022). This MOU establishes a target for 30% of new MHDV sales being zero-emission by 2030 and 100% of all new MHDV sales being zero-emission by 2050. Signatory states agreed to coordinate with partner manufacturers, charging and fueling providers, community and environmental advocates, utilities, corporate fleet owners, financial institutions, clean cities coordinators, and others to support the commercialization of zero-emission MHDVs and maximize the use of renewable energy at charging and fueling stations. In line with the stated objective of this MOU, New Jersey is making zero-emission MHDV sales a priority measure with a near term goal of reaching a 30% zero-emission market share by 2030. Six enabling actions were identified to support this measure. Achievement of this measure will provide a total cumulative greenhouse gas reduction of 1.2 MMT CO_2e by 2030 and 53.4 CO_2e by 2050 (Table 3.1.2).

Table 3.1.2 *Priority Measure 1 Greenhouse Gas Reduction Estimates*

	Near Term by 2030	Long Term by 2050
	Cumulative Reduction	Cumulative Reduction
Estimated GHG reductions (MMT CO_2e, GWP_{100})	1.2	53.4

Purchase zero emission buses and modify and build depots in the NJ TRANSIT system to achieve Electric Vehicle Law goals

NJ TRANSIT will continue to seek funding to transform its bus fleet to achieve the zero emissions statutory requirements in the 2019 EV Law. To date, NJ TRANSIT has received roughly $105.9 million under the Federal Transit Administration's Low- and No-Emission and Grants for Buses and Bus Facilities programs to purchase battery electric buses and upgrade two NJ TRANSIT depots to support these buses. NJ TRANSIT also received funding under the federal Ride and Drive Electric grant program for a 20-year resilience plan for its electric bus fleet. The agency has a deep need for additional funding for depot charging and solar canopy projects to support the transition to battery electric buses.

Implement the Advanced Clean Truck Rule

In November 2021, the State took a significant step towards this goal by adopting the Advanced Clean Trucks (ACT) (N.J.A.C. 7:27-31) regulation, which requires manufacturers of medium- and heavy-duty vehicles to deliver an increasing percentage of zero-emission vehicles. The annual sales requirements, shown in Table 3.1.3, takes effect in 2025 and increases annually through 2035, at which point 55% of Class 2b to 3 vehicles, 75% of Class 4 to 8 straight trucks, and 40% of Class 7 and 8 tractor trailers must be zero-emission.

Table 3.1.3. *Advanced Clean Trucks regulation annual sales requirements*

Model Year	Class 2b-3	Class 4-8	Class 7-8 Tractors
2025	7%	11%	7%
2026	10%	13%	10%
2027	15%	20%	15%
2028	20%	30%	20%

2029	25%	40%	25%
2030	30%	50%	30%
2031	35%	55%	35%
2032	40%	60%	40%
2033	45%	65%	40%
2034	50%	70%	40%
2035 and beyond	55%	75%	40%

Implement technical assistance program(s) to help fleet owners transition to electric vehicles and provide workforce training programs

Beyond the financial components of zero-emission vehicle purchases, New Jersey is working to address the significant challenges fleets face in transitioning to zero-emission vehicles due to gaps in knowledge, lack of time to evaluate new technologies, and difficulties engaging entities such as utilities, manufacturers, and local permitting authorities. To address these uncertainties, the State is developing a zero-emission fleet technical assistance program designed to spur zero-emission vehicle adoption by assisting fleet owners in transitioning to zero-emission vehicles. The State will also work to develop pathways to train the workforce on electric vehicle supply equipment installation and maintenance along with electric vehicle repair. These training programs would largely target low-and-moderate income community members and provide good paying jobs.

Electrify NJ TRANSIT Access Link paratransit service, local service and rail

NJ TRANSIT's paratransit program, known as Access Link, was established to provide public transportation to people with disabilities who are unable to use the fixed route NJ TRANSIT system. NJ TRANSIT will seek funding to expand its efforts to electrify its paratransit service. This began with the fall 2023 purchase of EV paratransit vans for use by Access Link and county community transit providers, and planning assistance to these organizations to pilot the implementation of these vehicles. This work was funded by Coronavirus Response and Relief Supplemental Appropriations Act flex funds from the North Jersey Transportation Planning Authority (NJTPA). Funding is needed for vehicles and charging infrastructure, along with technical assistance and training for staff managing these routes.

NJ TRANSIT will also seek funding to electrify its diesel fuel-powered engines. Diesel engines are less efficient in providing power to trains and have greater carbon emissions compared to electric traction power. For portions of the rail system that do not support catenary wires, NJ TRANSIT is studying how to convert a Dual Power Diesel-Electric locomotive into one that can be propelled by electrical energy stored in a high-capacity battery, also known as a battery electric locomotive. NJ TRANSIT conducted a feasibility study to convert an existing USEPA Tier III ALP-45 dual-power locomotive to a battery electric locomotive. The study considered NJ TRANSIT lines which necessitate the need for a dual-power locomotive because they traverse both electrified and non-electrified territories. The study concluded that it is feasible to operate a converted battery ALP-45 dual-power locomotive on several of NJ TRANSIT's existing routes. Specifically, the North Jersey Coast Line route from Bay Head to Long Branch was found to be an ideal location to pilot this technology.

Incentivize replacement of diesel medium-and heavy-duty vehicles, including school buses, with battery electric vehicles or green hydrogen fuel cell electric vehicles

The State offers financial assistance for the purchase of zero-emission MHDVs and associated charging infrastructure through programs such as NJ ZIP, the Diesel Fleet Modernization program, the Electric School Bus Program, and the Medium- and Heavy-Duty Electric Vehicle Charging Program (Table 3.1.1). These programs have been successful in helping local governments, schools, and private fleets transition to zero-emission MHDVs, with funding requests exceeding available funding. The State will continue to seek grants in order to reach more organizations and more vehicle applications.

Expand medium- and heavy-duty charging infrastructure

Charging and fueling infrastructure is vital to supporting the transition to zero-emission MHDVs in New Jersey. While many of the same considerations that apply to light-duty BEV charging apply to electric MHDV charging, additional considerations like parking space size and power demands differ. Vehicles in Class 4 and above are often too large to fit into typical light-duty vehicle parking spaces and require higher power levels to recharge quickly. It is anticipated that most public charging stations for heavy-duty trucks will require power levels of 350kW or more per port, paired with pull-through charging stalls and ample clearance. The State will seek funding to support zero-emission charging and fueling infrastructure for MHDVs at public and depot locations including potential collaboration with other northeast states to deploy charging infrastructure that would enable zero-emission freight trucks along the I-95 corridor from Connecticut to Maryland. The regional approach would be guided by two U.S. Department of Energy-funded analyses to identify key sites for Zero Emission Vehicle (ZEV) charging and fueling infrastructure in the region: the Northeast Freight Corridors Charging Plan and the East Coast Commercial ZEV Corridor. The Parties would work together to assess sites along and near the I-95 corridor and select priority initial sites for investment.

Table 3.1.4. *Priority Measure 1 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Purchase zero emission buses and modify and build depots in the NJ TRANSIT system to achieve Electric Vehicle Law goals	10% of purchases by 2024 50% of purchases by 2026 100% of purchases by 2032	NJ TRANSIT
Implement Advanced Clean Trucks rule	2024 – Ongoing	NJDEP
Implement technical assistance program(s) to help fleet owners transition to electric vehicles and provide workforce training programs	2024 – Ongoing	NJDEP, NJEDA and Labor
Electrify NJ TRANSIT Access Link Paratransit, local service and rail	Ongoing until 2030	NJ TRANSIT
Incentivize replacement of diesel medium- and heavy-duty vehicles, including school buses, with battery electric vehicles or green hydrogen fuel cell electric vehicles	Ongoing until 2030	NJDEP, NJBPU, NJEDA, Local Governments
Expand medium- and heavy-duty charging infrastructure	Ongoing until 2030	NJDEP, NJBPU

Table 3.1.5. *Priority Measure 1 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey has made significant, ongoing investments to support the transition to zero-emission medium-and heavy-duty vehicles and charging infrastructure, via four primary grant programs:

- NJ ZIP
- Diesel Fleet Modernization Program
- Electric School Bus Grant Program
- Medium- and Heavy-Duty Electric Vehicle Charging Program

These programs have largely relied on funding from the Volkswagen Mitigation Trust and auction proceeds from New Jersey's participation in the Regional Greenhouse Gas Initiative (RGGI). Since 2021, NJ ZIP has allocated $90 million across two rounds of funding to support commercial, industrial, and institutional organizations in purchasing zero-emission MHDVs. The program has received over $120 million in requests, indicating significant additional demand. The Diesel Fleet Modernization program has allocated over $180 million for electric MHDVs and continues to be oversubscribed, indicating additional funding is needed. To date, collectively, New Jersey's electric vehicle programs have allocated nearly $373 million, including funding for 246 electric light duty vehicles (LDV) for local government, 546 electric trucks and cargo vans, 201 electric school buses, and 251 electric buses and shuttle buses.

NJ TRANSIT was awarded $38 million from the FHWA in September 2023 to support its bus depot electrification efforts, along with $105.9 million from the Federal Transit Administration's Low- and No-Emission and Grants for Buses and Bus Facilities programs to purchase battery electric buses and upgrade two NJ TRANSIT depots. The agency has also secured funding to via the federal Ride and Drive Electric grant program for a 20-year resilience plan for its electric bus fleet.

Funding Gaps and Opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts quicker and on a wider scale, achieving deeper decarbonization.

Federal funding opportunities that could be leveraged to expand and continue the New Jersey grant programs include:

- Clean School Bus rebate and grant programs
- Clean Heavy-Duty Vehicle
- Clean Ports Programs
- Low- and No-Emission and Grants for Buses and Bus Facilities
- Section 5310 Enhance Mobility for Seniors and Persons with Disabilities
- Congestion Mitigation and Air Quality

New Jersey will continue to pursue federal funding opportunities as they become available.

Geographic Scope

Statewide. Interstate collaboration may be needed.

Authority to Implement

NJDEP has broad authority to implement policies and programs to prevent, control, and prohibit air pollution throughout the State, including air contaminants from motor vehicles pursuant to N.J.S.A. 13:1D-9, 26:2C-1 et seq. Further, NJDEP has existing authority to conduct Statewide programs of education pursuant to N.J.S.A. 13:1D-9.

In addition to its broad authority to implement the measures described in this chapter, NJDEP has adopted the ACT rule at N.J.A.C. 7:27-31 and will continue implementing the program. Further, NJDEP has existing authority to implement an Electric School Bus Program (N.J.S.A. 236:2Cc-8.58), while NJ TRANSIT has existing authority to purchase zero emission vehicles (P.L. 2019, c.362).

Incentive programs for the electrification of medium- and heavy-duty vehicles and/or charging infrastructure could be implemented under the existing authority of NJDEP, NJBPU, and NJEDA. Municipalities shall promote the installation of EV charging stations. See N.J.S.A. 40:55D-28, 40:55D-89 and 40A:12A-7.

Metrics for Tracking Progress

Progress towards this measure will be tracked through MHDV registration data. Vehicles funded through State-run programs will be equipped with on-board telematics devices that provide data to evaluate usage and project emissions reductions associated with these programs. The deployment of charging stations is also tracked via a public dashboard EValuateNJ.

NJ TRANSIT will track progress as it adds new zero emission buses and prepares its depots for the coming transition. For actions to electrify services subrecipients of any grant funding would track usage of fossil vehicles up until point of replacement and compare usage of electric vehicles in service through submission of quarterly maintenance reports.

02 Achieve light-duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c. 362)

On January 17, 2020, Governor Murphy signed New Jersey's 2019 EV Law (P.L. 2019, c.362, 2019) which established a goal of having 330,000 registered light-duty electric vehicles in the State by 2025, increasing to 2 million by 2035. Additionally, the law calls for 85% of all light-duty vehicles sold or leased in the State to be electric by 2040. For State-owned vehicles, 25% of non-emergency light-duty vehicles must be plug-in electric by the end of 2025, increasing to 100% by the end of 2035. To support this rapid transition, the 2019 EV Law calls for the development of 400 DCFC stations at 200 locations along major highways and communities by December 2025. Further, at least 1,000 publicly available Level 2 charging stations must be available across the State by December 2025. Four enabling actions were identified to support this measure. Achievement of this measure will provide a total cumulative greenhouse gas reduction of 9.6 MMT CO_2e by 2030 and 268.2 MMT CO_2e by 2050 (Table 3.1.6).

Table 3.1.6. *Priority Measure 2 Greenhouse Gas Reduction estimates*

	Near Term by 2030	Long Term by 2050
	Cumulative Reduction	Cumulative Reduction
Estimated GHG reductions *(MMT CO_2e, GWP_{100})*	9.6	268.2

Implement Advanced Clean Cars II Rule

New Jersey reaffirmed its commitment to light-duty vehicle electrification by adopting the Advanced Clean Cars II (ACC II) regulation (N.J.A.C. 7:27-29A)**.** This regulation, if USEPA grants California's waiver request, takes effect starting with model year 2027 vehicles and increases annually through 2035, at which point 100% of new light-duty vehicle sales must be zero-emission (Table 3.1.7).

Table 3.1.7. *Advanced Clean Carts II annual sales requirements*

Model Year	Percentage Requirement
2027	43%
2028	51%
2029	59%
2030	68%
2031	76%
2032	82%
2033	88%
2034	94%
2035 and later	100%

Electrify State and local government fleets to achieve Electric Vehicle Law goals

State and local government fleets will need to transition to electric technologies to achieve the scale of vehicle electrification required for attaining the State's greenhouse gas reduction goals. The 2019 EV Law calls for 25% of state-owned non-emergency light-duty vehicles to be plug-in electric vehicles by December 31, 2025, and 100% by December 31, 2035. Local governments need to follow suit and begin to shift purchasing to acquire electric vehicles. The State's Clean Fleet Electric Vehicle Incentive Program offers funding for local and State governments to purchase electric vehicles and charging stations. Additionally, the State will soon award a term contract for electric vehicle charging stations which will make it easier for government to procure charging infrastructure.

Ensure low- and moderate-income residents have access to clean transportation by expanding eMobility programs that provide electric ride sharing, ride hailing and similar services

Another key pillar of the State's light-duty electric vehicle strategy is the development of eMobility programs**.** These programs are designed to ensure that all New Jersey residents receive the benefits of clean transportation, regardless of whether they own their own vehicle. eMobility covers a wide variety of shared-use electric vehicle programs, including community carshare and electric ridesharing programs. To date, nine eMobility projects totaling $15.6 million have been awarded in communities across the State. Each award has been tailored to the needs of the community served. The State is looking to expand on the success of these programs by bringing eMobility projects to additional communities.

Expand publicly available electric vehicle charging infrastructure with a specific focus on charging for multi-unit dwellings

To meet the requirements of both the 2019 EV Law and ACC II, the State will dedicate significant resources to supporting zero-emission vehicle adoption for light-duty vehicles. Currently, programs such as Charge Up New Jersey provide rebates for residents to purchase or lease an electric vehicle and home charging station. For governments with light-duty vehicles, the State's Clean Fleet Electric Vehicle Incentive Program offers funding for local and State governments to purchase electric vehicles and charging stations. As electric vehicles become more prevalent in the State, the demand for charging infrastructure will also increase. To address this, the State has created programs to incentivize the installation of charging stations at multi-unit dwellings, tourism destinations, workplaces, and in public. These programs utilize a combination of state, federal, utility, and private funds to maximize charging station deployment.

Table 3.1.8. *Priority Measure 2 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Implement Advanced Clean Cars II Rule	Beginning in 2026	NJDEP
Electrify State and local government fleets to achieve EV Law goals	25% of state-owned non-emergency light-duty vehicles are plug-in electric vehicles by 2025 100% of state-owned non-emergency light duty vehicles are plug-in electric vehicles by 2035	All State agencies
Ensure low- and moderate-income residents have access to clean transportation by expanding eMobility programs that provide electric ride sharing, ride hailing, and similar services	Ongoing	NJDEP, Local Governments
Expand publicly available electric vehicle charging infrastructure with specific focus on charging for multi-unit dwellings	15% of all multi-family residential properties in the State are equipped for electric vehicle charging by 2025 30% of all multi-family properties are equipped for electric vehicle charging by 2030	NJDEP, NJBPU, Local Governments

Table 3.1.9. *Priority Measure 2 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey has made significant, ongoing investments in light-duty vehicle electrification via four grant programs:

- Charge Up New Jersey
- eMobility Grants
- It Pay$ to Plug-in
- EV Charging grants for MUDs and Tourist Attractions

These programs have relied on funding from the Volkswagen Mitigation Trust, auction proceeds from New Jersey's participation in the Regional Greenhouse Gas Initiative (RGGI), Clean Energy Funds, and environmental mitigation settlements. To date, New Jersey has allocated $90 million for residents to purchase electric vehicles and charging infrastructure via the Charge Up New Jersey program. Each year, the number of applications for this program exceeds the amount of funding available, indicating a strong, consistent demand for this program. The State has also allocated $15.6 M in RGGI funding for eMobility projects, which has been used to fund nine projects in overburdened communities. More recently, under the Federal Charging and Fueling Infrastructure competition, New Jersey was awarded $10 million to support the deployment of public charging infrastructure near MUDs.

NJ TRANSIT is one State agency that has received State Transportation Trust Fund funding and a $1.15 million BPU grant for electrifying its non-revenue fleet, but more funding is required.

Funding Gaps and Opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts quicker and on a wider scale, achieving deeper decarbonization.

Existing federal funding opportunities that could be leveraged to expand and continue these programs include:

- Charging and Fueling Infrastructure Program

New Jersey will continue to pursue federal funding opportunities as they become available.

Geographic Scope

Statewide

Authority to Implement

NJDEP has broad authority to implement policies and programs to prevent, control, and prohibit air pollution throughout the State, including air contaminants from motor vehicles pursuant to N.J.S.A. 13:1D-9, 26:2C-1 et seq. Further, NJDEP has existing authority to conduct Statewide programs of education pursuant to N.J.S.A. 13:1D-9.

In addition to its broad authority to implement the measures described in this chapter, NJDEP has adopted the ACC II rules at N.J.A.C. 7:27-29A and will implement and enforce the program so long as California's waiver request is granted. NJDEP's rules are supported by legislation that sets a minimum electric vehicle ownership requirement for the State-owned fleet of light-duty vehicles. See P.L. 2019, c.362. Further, NJBPU has authority to implement light duty plug-in electric vehicle incentive programs and charging programs See N.J.S.A. 48:25-4, N.J.S.A. 48:25-6.

Incentive programs for light-duty charging infrastructure could be implemented under the existing authority of NJDEP, NJBPU, and NJEDA. All municipalities are required to promote the installation of EV charging stations as part of their master plan preparations. See N.J.S.A. 40:55D-28, 40:55D-89 and 40A:12A-7. and 7:27A-3.

Metrics for Tracking Progress

Progress towards this measure will be tracked through light-duty vehicle registration data. The deployment of charging stations is also tracked via a public dashboard EValuateNJ.

03 *Reduce emissions in and around ports*

Emissions from activities in and around New Jersey's airports and seaports disproportionately impact residents of surrounding communities. New Jersey is a prominent shipping hub for the northeastern United States, hosting the Port Authority of New York and New Jersey (PANYNJ) as well as the South Jersey Port Corporation. In total, the State is home to three airports and 14 seaports, the largest of which is the Port of Newark. Achieving emissions reductions in New Jersey's ports is vital not only to the State's greenhouse gas reduction goals, but also to improving air quality in surrounding communities. Three enabling actions were identified to support this measure. Achievement of this measure will provide a total cumulative greenhouse gas reduction of 0.4 MMT CO_2e by 2030 and 8.1 MMT CO_2e by 2050 (Table 3.1.10).[3]

Table 3.1.10. *Priority Measure 3 Greenhouse Gas Reduction estimates*

	Near Term by 2030	Long Term by 2050
	Cumulative Reduction	Cumulative Reduction
Estimated GHG reductions ($MMT\ CO_2e$, GWP_{100})	0.4	8.2

Electrify drayage trucks

Drayage trucks are large semi-trailers used to transfer shipping containers or bulk freight from ports to different shipping facilities. As of June 2023, approximately 27,400 trucks are registered to enter the Port of Newark making an estimated 70,000 trips per week (PANYNJ 2023c, PANYNJ 2023d). The Port Authority of New York and New Jersey can serve as a case study for other ports in New Jersey. PANYNJ launched a truck replacement program for operators who frequently service the ports. While the current program is to modernize the diesel fleet, additional funding could be used to transition to electric.

Electrify cargo handling equipment

On February 6, 2023, the State adopted the Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards (N.J.A.C. 7:27-34) regulation which will modernize the oldest diesel-powered equipment at port and intermodal rail yards. Ports in New Jersey should seek to convert port equipment to electric as technology advances.

Decarbonize marine vessels and ferries

Marine vessels bring cargo from across the world to New Jersey ports and are also used to transport passengers in and around the New Jersey's harbors. New Jersey will continue to pilot decarbonization technologies for these vessels and ferries and continue to explore the feasibility of providing electrical hookups when ships are docked.

Table 3.1.11. *Priority Measure 3 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Electrify drayage trucks	Ongoing	NJDEP, Port authority/corporation
Electrify cargo handling equipment	Ongoing	NJDEP, Port authority/corporation
Electrify marine vessels and ferries	Ongoing	NJDEP, Port authority/corporation

[3] Port projections were based on facilities operated by the Port Authority of New York and New Jersey (PANYNJ) and located in New Jersey. Ports outside PANYNJ control represent additional opportunities for emissions reductions and were not included in these totals. DEP estimates of MHDV emissions reduction benefits for the NJ PANYNJ facilities were based on Class 8 emissions reductions from NESCAUM (2022). Projections for cargo handling equipment, harbor craft and ocean-going vessels were based on the overall reduction goals in PANYNJ (2023a) and data from PANYNJ (2023b). Some emissions reductions may be outside the scope of PANYNJ (2023a). Estimates do not include potential emissions reductions associated with rail transportation servicing the port facilities.

Table 3.1.12. *Priority Measure 3 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey has made ongoing investments decarbonizing port equipment and ferries via one program:

- Diesel Fleet Modernization Program

This program has largely relied on funding from the Volkswagen Mitigation Trust and auction proceeds from New Jersey's participation in the Regional Greenhouse Gas Initiative (RGGI). The Diesel Fleet Modernization Program has funded replacing older diesel engines in ferries and off-road equipment with newer, more efficient engines. Recent modernization projects include hybrid electric straddle carriers, all-electric yard tractors and forklifts.

Funding Gaps and Opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts quicker and on a wider scale, achieving deeper decarbonization.

Existing federal funding opportunities that could be leveraged to expand and continue these programs include:

- Clean Ports Program
- Clean Heavy-Duty Vehicle Grant
- DERA
- Port Infrastructure Development Program
- Marine Highway Planning Grant

New Jersey will continue to pursue federal funding opportunities as they become available.

Geographic Scope

Statewide at New Jersey's three airports, 14 seaports, and port-adjacent communities.

Authority to Implement

NJDEP has broad authority to implement policies and programs to prevent, control, and prohibit air pollution throughout the State. See N.J.S.A. 13:1D-9, 26:2C-1 et seq.

Metrics for Tracking Progress

The State will work with its ports authorities to track progress on electrification of drayage trucks, cargo handling equipment, marine vessels, and ferries. Further, NJDEP, via the Cargo Handling Equipment at Ports and Intermodal Rail Yards Rule (N.J.A.C. 7:27-34) requires all regulated businesses at ports and railyards to submit a cargo handling equipment Inventory. This data will serve as a baseline.

04 Reduce vehicles miles travelled

Vehicles miles travelled (VMT) is a measure of the amount of travel for all vehicles in a geographic region over a given period of time. Reducing the mileage that people drive can improve air quality while shifting travel to other transportation options that promote physical activity can improve public health. VMT reduction can be encouraged in a multitude of ways, from the expansion of protected bike lanes and walking paths to better land use planning that links residential and commercial properties with public transit. Three enabling actions were identified to support this measure. Achievement of this measure will provide a total cumulative greenhouse gas reduction of 4.2 MMT CO_2e by 2030 and 25.9 MMT CO_2e by 2050 (Table 3.1.13).

Table 3.1.13. *Priority Measure 4 Greenhouse Gas Reduction estimates*

	Near Term by 2030	Long Term by 2050
	Cumulative Reduction	Cumulative Reduction
Estimated GHG reductions (MMT CO_2e, GWP_{100})	4.2	25.9

Expand active transportation infrastructure and complete streets

Active transportation refers to human-powered modes of transportation, such as walking or bicycling. Improving active transportation infrastructure through bike routes, multi-use trails, and by constructing complete streets can shift people out of cars, reducing greenhouse gas emissions. Complete streets refer to streets that are designed for all users, for all modes of transportation and ability levels. Complete streets consider the needs of drivers, pedestrians, bicyclists, transit riders, emergency responders, and goods movement based on the local context. Every town in New Jersey should work towards becoming a safe, active community, where it is easy to navigate to your destination. Even a moderate amount of daily exercise can improve both physical and mental health, and it provides people who cannot drive more options for getting around independently. The New Jesey Department of Transportation provides funding to communities to support these efforts via federally funded programs like Safe Route to School Grants and the Transportation Alternatives Set-Aside Program and State Funded programs like Municipal Aid, Transit Village, Bikeways and Safe Streets to Transit. Additional funding is needed for communities to fully plan, design, and implement active transportation projects. Expanding funding for existing NJ program and initiatives that provide planning assistance for active transportation projects like NJ TRANSIT's Transit Friendly Planning Program, NJDOT Local Bicycle/Pedestrian Planning Assistance Program, and NJTPA's Complete Streets Technical Assistance, Emerging Centers, and Transit Hubs could help bridge the gap between funding available for planning and design and funding for construction.

Increase NJ TRANSIT ridership and expand development of transit villages

NJ TRANSIT is the nation's third largest provider of bus, rail, and light rail transit, linking major points in New Jersey, New York, and Philadelphia. According to NJT2030 –A 10-Year Strategic Plan, the agency will seek to increase the percentage of the New Jersey population that has access to high-frequency service from 27% to 40% by 2030 (NJ Transit, 2020). Shifting passengers out of cars and into New Jersey's public transit system provides an opportunity to reduce greenhouse gas emissions. Secure and predictable operating support for public transit is a foundational need to offer frequent and attractive services that reduces the need for the use of personal automobiles and related pollution. NJ TRANSIT has prepared plans for innovative and attractive bus service reconfigurations, pending additional financial resources to implement the plans. Service enhancements is one key tool to enhance transit ridership. NJ TRANSIT's NewBus Newark proposal, which redesign's the City's bus routes, will result in a 73% increase in people with access to 15+ minute all-day service and 18% of riders will have access to 5-minute all-day service. This type of strategic planning should be done throughout the State to maximize ridership. Additional funding for other studies and operational support is needed.

Furthering the expansion of existing transit villages facilitates the use of transit services and reduces the use of personal vehicles. The term *transit village* is an official designation of districts within a half-mile radius around a transit station that also has multiple transit-oriented development projects planned for the area. These projects create dense, walkable, and mixed-use communities where people live, work, and play in one area which helps reduce the need for vehicle ownership and use. The New Jersey Department of Transportation provides funding to support transit villages, in partnership with NJ TRANSIT. Additional funding would allow the State to expand the program beyond the 35 municipalities currently participating.

Expand work-from-home and ridesharing programs

Greenhouse gas emission reductions can also be achieved through the expansion of work-from-home programs which reduce the need for workers to commute. As evidenced by the Covid-19 pandemic, people who work remotely lower their environmental impact, while simultaneously reducing the need for energy intensive offices. Ride sharing and van pooling reduce VMT and can help in the fight against climate change.

Table 3.1.14. *Priority Measure 4 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Expand active transportation infrastructure and complete streets	Ongoing	Metropolitan Planning Organizations, NJDOT, Local Governments
Increase NJ TRANSIT ridership and expand development of transit villages	Ongoing	NJ TRANSIT, NJDOT, Local Governments
Expand work-from-home and ridesharing programs	Ongoing	NJDEP, Local Governments

Table 3.1.15. *Priority Measure 4 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey has made ongoing investments in VMT reduction through the following programs:

- Transit Village Program
- Bikeways Program

These programs have largely been funded via state appropriations.

Funding Gaps and Opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts quicker and on a wider scale, achieving deeper decarbonization.

Existing funding opportunities that could be leveraged to expand and continue these programs include:

- Rebuilding American Infrastructure with Sustainability and Equity
- Reconnecting Communities and Neighborhoods
- Pilot Program for Transit Oriented Development
- Pilot Program for Enhanced Mobility

New Jersey will continue to pursue federal funding opportunities as they become available.

Geographic Scope

Statewide

Authority to Implement

NJDEP has broad authority to implement policies and programs to prevent, control, and prohibit air pollution throughout the State, including programs of education. See N.J.S.A. 13:1D-9, 26:2C-1.

Metrics for Tracking Progress

NJDOT tracks VMT annually.

Works Cited

Atlas Public Policy. (2024). *EValuateNJ*. Atlas Public Policy. Retrieved from https://atlaspolicy.com/evaluatenj/

NESCAUM. (2022). *Multi-state Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding*. Retrieved from https://www.nescaum.org/documents/mhdv-zev-mou-20220329.pdf

N.J.A.C. 7:27-31. Advanced Clean Truck Rule. Retrieved from https://dep.nj.gov/wp-content/uploads/aqm/sub31.pdf

N.J.A.C. 7:27-29A. Advanced Clean Cars II Program. Retrieved from https://dep.nj.gov/wp-content/uploads/aqm/sub29a.pdf.

NJDEP. (2020). *New Jersey's Global Warming Response Act 80X50 Report*. Retrieved from https://www.nj.gov/dep/climatechange/docs/nj-gwra-80x50-report-2020.pdf

NJDEP. (2024). *New Jersey's Greenhouse Gas Emissions Inventory Report Years 1990-2021*

NJTRANSIT. (2020). *NJT2030: A 10-Year Strategic Plan.* Retrieved from https://content.njtransit.com/sites/default/files/njtplans/NJT_2030-A_10-YearStrategicPlan.pdf

PANYNJ. (2023a). *Net Zero Roadmap*. Port Authority of New York & New Jersey. Retrieved from https://www.panynj.gov/port-authority/en/about/Environmental-Initiatives.html

PANYNJ. (2023b). *2022 Multi-Facility Emissions Inventory*. Retrieved from https://www.panynj.gov/content/dam/port/our-port/air-emissions-inventory-reports/PANYNJ-2022-Multi-Facility-EI-Report.pdf

PANYNJ. (2023c). *PortTruckPass Reports*. Port Authority of New York & New Jersey. Retrieved from https://www.panynj.gov/port/en/shipping/truck/port-truck-pass-reports.html

PANYNJ. (2023d). *Port Authority of New York & New Jersey*. Retrieved from https://www.panynj.gov/port/en/shipping/truck/port-truck-pass-reports.html

P.L. 2019, c.362, (2019). Retrieved from https://pub.njleg.gov/bills/2018/PL19/362_.HTM

Residential and Commercial Buildings

Overview

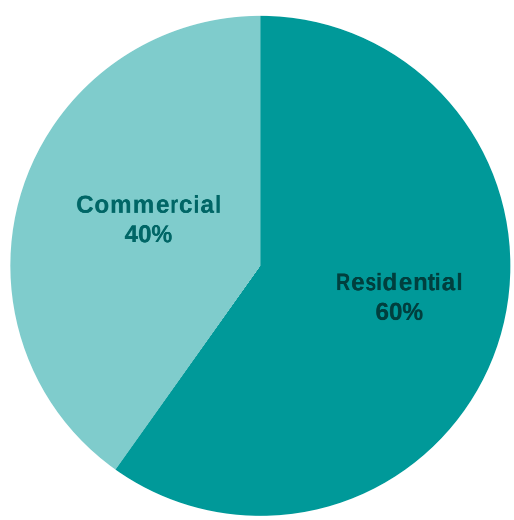
New Jersey's residential and commercial building sector is the second largest contributor to global warming in the State. In 2021, New Jersey's residential and commercial buildings contributed 24.8 million metric tons of carbon dioxide equivalent (MMT CO_2e) (GWP_{100}), or 25% of total net statewide emissions. Of this, residential sources emitted 14.9 MMT CO_2e, or 60% of the combined residential and commercial total (Figure 3.2.1). Emissions from buildings largely stem from the combustion of natural gas for space and water heating. In 2021, natural gas use in commercial and residential buildings comprised 83% and 86% of those subsectors' total emissions, respectively, with propane, motor gasoline, distillate fuel, and residual fuel contributing the remaining amounts (USEIA, 2023a: USEIA, 2023b).[1]

24.8 MMT CO_2e
2021 Combined Emissions

25%
of Total State Emissions

2.7 MMT CO_2e
2050 Reduction Goal

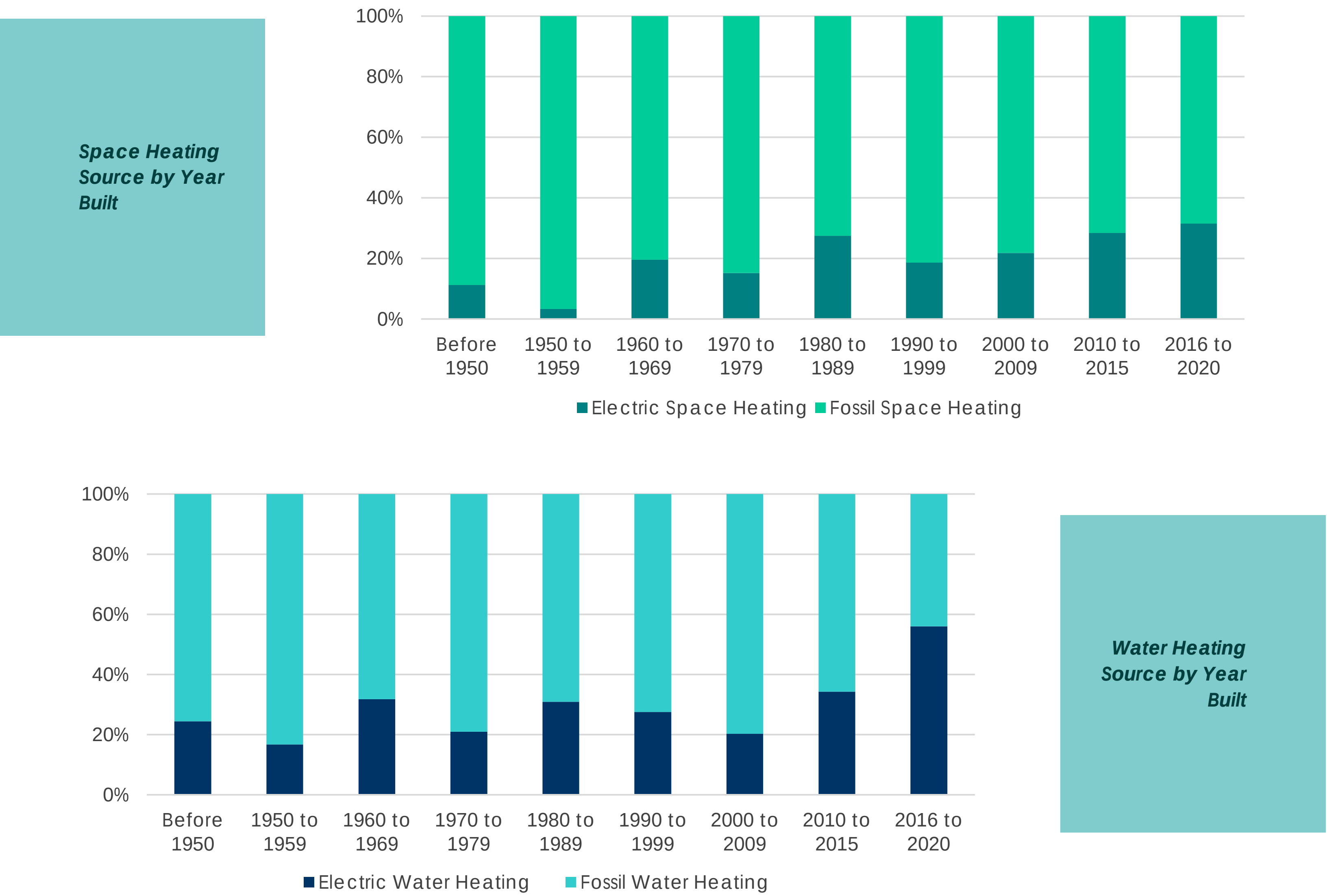
Figure 3.2.1. *2021 NJ Greenhouse Gas Emissions from Buildings (Percent of 24.8 MMT CO_2e).*



[1] Based on USEPA AR5 emissions factors.

The 2020 Global Warming Response Act 80x50 Report (2020 GWRA 80x50 Report) set an emissions goal of 2.7 MMT CO_2e (GWP_{100}) by 2050 for the State's residential and commercial buildings, primarily focusing on electrifying space and water heating and maximizing energy efficiency in existing buildings as the priority pathways to achieving this goal (NJDEP, 2020). Moreover, the 2020 GWRA 80x50 Report and 2019 Energy Master Plan (2019 EMP) determined that the State would need to convert 90% of buildings to 100% clean energy systems, with accelerated conversion beginning in 2030, to reach its 80% reduction in greenhouse gas emissions by 2050 (NJBPU, 2019; NJDEP, 2020). Achieving this level of decarbonization will be a significant undertaking, as New Jersey has approximately 3.4 million residential homes (USEIA, 2023a) and about 114,100 commercial buildings[2] (USEIA, 2023b). In 2020, single family homes comprised the largest share of residential buildings in the State (63%), with apartments and mobile homes making up the remaining 36% and 1%, (USEIA, 2023a). Moreover, 23% of homes were rented and 65% were owned in 2020 (USEIA, 2023a). In 2020, more than half of New Jersey's homes were built before 1970 (54%) and almost 90% built before the 2000's (USIEA, 2023a). Most of the houses built during this timeframe use fossil fuels for space and water heating, with an increasing percentage of homes built after the 2000's using electricity for both space and water heating (Figure 3.2.2). The variety of ages and use cases in the residential sector alone speaks to the inherent complexity of achieving emissions reductions with this sector.

Figure 3.2.2. *Percent of New Jersey Home Constructions with Electric and Fossil Fuel Space and Water Heating Based on Year Built as of 2020 (USEIA, 2023a)*



[2] The estimated number of commercial buildings in New Jersey was based on the Mid-Atlantic total from USEIA (2023b), prorated to New Jersey by 2021 population share (US Census Bureau, 2021).

Progress to Date

Assessing New Jersey's progress in decarbonizing its buildings is limited by the scale of readily available data. Evaluating total energy consumption within the building sector serves as one proxy for tracking decarbonization. As decarbonization is achieved, fossil fuel consumption will be outpaced by growth in electricity. However, in the near term this progress may be confounded due to energy efficiency gains and the pace of adoption. To date, fossil fuel energy consumption in New Jersey remains relatively unchanged within both the commercial and residential sector (Figure 3.2.3). Historical fluctuations in energy consumption within the State are correlated with heating degree days (Figure 3.2.4).

Figure 3.2.3 *New Jersey Residential and Commercial Building Energy Consumption (1990-2021)*

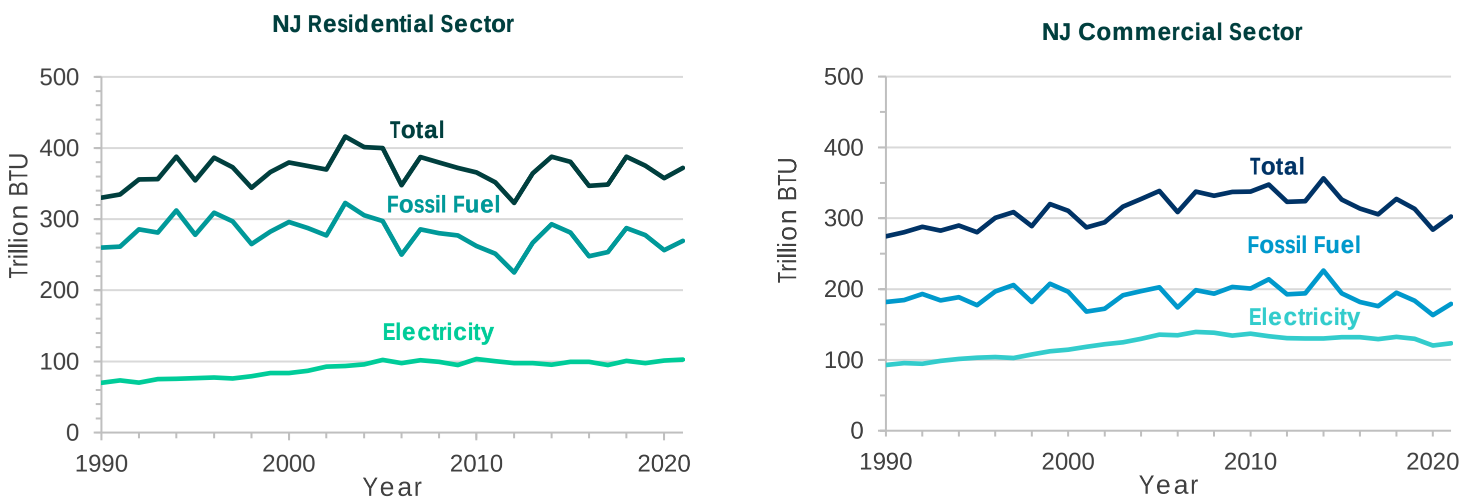
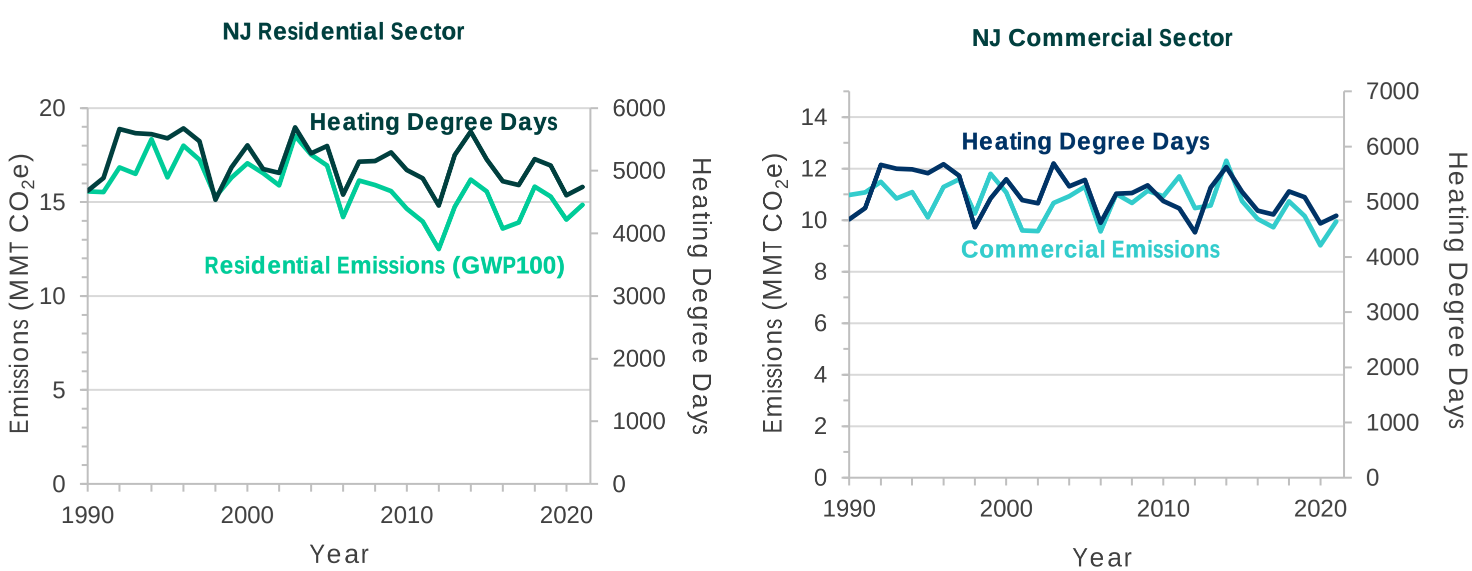


Figure 3.2.4 *New Jersey Residential and Commercial Building Emissions and Heating Degree Days (1990-2021)*



Further, New Jersey has not yet established a method for tracking emissions from individual source categories, like home heating versus cooking. However, the United States Energy Information Agency (USEIA) periodically issues surveys which shed some light on building status. Out of the State's residential buildings in 2020, 11% of homes are all electric, 3% use heat pumps for primary heating, and 16% use electricity for primary space heating (USEIA, 2023a). With respect to commercial buildings, a profile of structures in the Mid-Atlantic region (New Jersey, New York and Pennsylvania), only 13%

were all-electric (USEIA, 2023b). These fully electrified commercial buildings also tended to be small, with fewer than half exceeding 5,000 square feet of floor space. Of all commercial buildings, 17% used electricity as their primary heating source, 51% used natural gas, 15% fuel oil, and 11% were unheated. Another key metric to gauge progress is equipment sales. According to the United States Environmental Protection Agency's (USEPA) Energy Star Unit Shipment and Market Penetration Reports from 2018 to 2022, the Energy Star[3] certified geothermal and air source heat pump market across the United States has been variable from 2018 to 2022 with declines in 2020 sales likely due to the COVID-19 pandemic, yet both heat pump technologies have shown increases in sales since (Figure 3.2.5). Given that heat pumps play an important role in decarbonizing buildings and recent policy and commitments in New Jersey are pushing their adoption forward, the State can expect to see a continued increase in heat pump sales in the near future.

Figure 3.2.5. *United States Energy Star Geothermal and Air Source Heat Pump Market (USEPA, 2018-2022)*

In recent years, New Jersey passed significant legislation invigorating the State's efforts to reduce emissions in the building sector and drive the adoption of clean technology. The Clean Energy Act of 2018 (P.L. 2018 c.17) established various programs supporting renewable energy, energy efficiency, and energy storage, and also set a requirement for the State to implement a benchmarking program. Established in 2022 and effective December 2023, the Energy and Water Benchmarking Program requires commercial and public buildings over 25,000 square feet to benchmark their energy and water usage with continued tracking of performance over time (NJBPU, 2022). Effective 2023, the State's Appliance Standards Law (P.L. 2021 c.464) furthered energy and emissions savings in buildings by setting minimum energy and water

[3] Energy Star is a program under the United States Environmental Protection Agency that certifies energy efficient appliances and products.

efficiency requirements for appliances sold in New Jersey. The State also updated its building codes, to incorporate greater energy efficiency and conservation requirements for both new residential and commercial buildings, adopting the 2021 International Energy Conservation Code (IECC) (N.J.S.A. 5:23-3.18) and ASHRAE Standard 90.1-2019 (N.J.S.A. 5:23-3.16). To further reduce greenhouse gas emissions before a building is built, the State has enacted laws that provide tax credits to builders using low carbon concrete in new constructions (P.L. 2021 c.278) and requires warehouses larger than 100,000 square feet to be solar-ready (P.L. 2021 c.290).

In 2021, Governor Phil Murphy established the Garden State Commercial Property Assessed Clean Energy Program (P.L. 2021 c. 201), which provides financing to commercial building owners seeking to implement renewable energy and energy efficiency projects. The State also enacted the School and Small Business Energy Efficiency Stimulus Program Fund (P.L. 2021 c. 200), which provides financial support to school districts and small businesses to evaluate their buildings' energy efficiency and make appropriate upgrades and installations. In 2023, the NJBPU established the Higher Education Building Decarbonization Pilot Program, which provides funding to public and private higher education schools to expand energy efficiency measures in their buildings and includes solar and electric vehicle charging stations installments, along with other decarbonization actions (NJBPU, 2023a).

Beyond legislation and regulatory development, the State established additional goals for the building sector. Through Executive Order 316 (EO 316), signed by Governor Murphy in 2023, the State aims to electrify 400,000 homes and 20,000 commercial properties by 2030, with 10% of all low-and-moderate income properties electrification ready by 2030. Moreover, EO 316 directed the Governor's Office to publish a Strategic Building Decarbonization Roadmap by March 2024, with the goal of highlighting key developments in electrifying and reducing emissions in the State's building stock. Additionally, New Jersey recently signed two memorandums of understanding (MOU) to accelerate the heat pump market throughout the State. First, the 2023 United States Climate Alliance (USCA) MOU set a target to install 20 million heat pumps across participating states by 2030, where 40% of the benefits go to low-income households (USCA, 2023). The Northeast States for Coordinated Air Use Management (NESCAUM) MOU involves the transitioning of 65% of residential heating and cooling equipment to zero emission heat pumps across signatory states by 2030 and 90% by 2040, with 40% of the investments for incentives or technical guidance directed to low-income households (NESCAUM, 2024). Through Executive Order 317 (EO 317), the State aims to reduce emissions through its natural gas utilities, where the NJBPU will evaluate and plan for natural gas' future in the State. Both the USCA (2023) commitment and EO 317 direct the State to analyze and consider the potential for a Clean Heat Standard. These policies are supported by a series of programs incentivizing energy efficiency and building decarbonization efforts (Table 3.2.1).

Table 3.2.1 *Key New Jersey Building Decarbonization Programs*

Name	Focus	Building Sector
Energy and Water Benchmarking	Energy auditing	Commercial & Industrial
Triennium 2 Building Decarbonization and Demand Response	Building decarbonization, energy efficiency	Utilities
Higher Education Building Decarbonization Pilot Program	Building electrification, energy efficiency, EV chargers, energy storage, renewable energy	Commercial (Higher education campuses and universities)
Energy Efficient Products	Energy efficiency	Residential (homeowners)
Moderate Income Weatherization	Energy auditing, energy efficiency, health & safety	Residential (homeowners and renters)
Multi-Family	Energy auditing, energy efficiency	Residential (multifamily)
Quick Home Energy Check-Up (QHEC)	Energy auditing, energy efficiency	Residential (homeowners and renters)
Combined Heat & Power & Fuel Cells	Renewable energy	Commercial & Industrial
Community Solar	Renewable energy	Residential, Commercial & Industrial
Energy Savings Improvement Program (ESIP)	Energy auditing, renewable energy, energy efficiency, building electrification	Government entities

Large Energy Users	Energy auditing, energy efficiency	Commercial & Industrial
Local Government Energy Audit	Energy auditing, energy efficiency	Local government, colleges, universities, and non-profit agencies
Pay for Performance	Energy efficiency	Commercial, Industrial, & Institutional
SmartStart	Energy efficiency	Commercial & Industrial
New Construction	Energy efficiency	Residential (new construction)
New Jersey Comfort Partners	Energy efficiency, health & safety	Residential
NJ Cool Pilot	Building electrification, energy efficiency, energy storage, renewable energy	Commercial

Community Driven Solutions

Public stakeholders provided comments related to State priority measures for the building sector through the online comment form, during the public webinars, and in-person at the Newark community listening session with environmental justice stakeholders. Overall, stakeholders stressed the need to expand incentive programs and increase State incentives for energy efficiency, whole house upgrades and zero-carbon emission space heating and cooling systems in a way that does not pass costs on to low-income households or residents in affordable housing. Stakeholders emphasized a desire for streamlining communication, outreach, and guidance for navigating all the existing building decarbonization and energy efficiency incentives particularly through the development of a "one-stop-shop" repository for consumers to understand all the opportunities and eligibility. Other comments suggested the development of a local volunteer community-based energy coaching program, similar to New York Energy Coaches, Mass HeatSmart Alliance, that would work with residents to recommend energy audit, weatherization, heat and water upgrades tailored to their unique situation. Municipal stakeholders broadly supported including incentives for implementing municipal building electrification and energy efficiency improvements in the PCAP. Stakeholders across many participant affiliation types supported including project-scale planning, development, feasibility studies and capital costs explicitly as eligible costs in building decarbonization incentive programs; and urged the State to pursue and incentivize holistic, cross-sector approaches and demonstration projects.

"People want energy-efficient homes and heat pumps that keep them warm in the winter. It's important to institutionalize these changes before leadership changes in the governor's office."

– Comment heard at EJ Community Dialogue for CPRG in Newark

"In NJ, we currently are influencing the installation of maybe 50 heat pumps per year. On our current trajectory, we can expect to influence perhaps a few hundred per year next year and increasing numbers in years ahead. But our best projections are FAR from the tens of thousands of annual heat pumps that NJ will need to meet the 50% NJ GHG reduction by 2030. That jump in NJ resident awareness and action will only happen with strong NJ action to boost this type of activity."

– NJ Environmental Advocacy Group

Priority Measures

05 *Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties*

New Jersey's commitment to installing zero-carbon emission space heating and cooling systems in residential and commercial properties can have a substantial impact on this sector's greenhouse gas emissions. Specifically, installing these systems would result in cumulative reductions of 9.5 MMT CO_2e in 2030 and 63.8 MMT CO_2e in 2050. To aid in these efforts and reach the State's goals, New Jersey will pursue the 15 enabling actions outlined below, ranging from demonstration projects and siting and mapping tools to building codes and training grants.

Table 3.2.2. *Priority Measure 5 Greenhouse Gas Reduction Estimates for residential and commercial buildings.*

	Near Term by 2030	**Long Term by 2050**
	Cumulative Reduction	**Cumulative Reduction**
Estimated GHG reductions (MMT CO_2e, GWP_{100})	9.5	63.8

Launch a digital "One Stop Shop" summarizing Federal and State energy rebate funding [4]

Launching a one stop shop online platform would improve the New Jersey customer experience for accessing federal and state energy efficiency funding. A one stop shop would provide targeted rebate information for different categories of customers, including but not limited to households of differing income levels, homeownership status, and geographic location. As a result, the online platform would make finding funds for building-related efficiency and electrification upgrades seamless and efficient for customers. This initiative could be run via the New Jersey Board of Public Utilities (NJBPU) Clean Energy Program (NJCEP)[5]. Additionally, a multi-state collaborative could be formed with a third-party program administrator that coordinates building incentive program design, outreach and delivery to maximize greenhouse gas reductions, equity, and consumer experience among the states. The third-party administrator could focus on low-and-moderate income properties, support upstream markets and expand workforce development opportunities.

Offer training grants for residential energy contractors

With the growing deployment of zero emission space heating and cooling systems, there is an increasing need for qualified, trained contractors to be aware of and install more efficient technologies. The NJBPU has dedicated funding towards offering training grants for residential energy contractors to help transition buildings toward energy efficiency and electrification. However, the State can expand this program to further prepare the workforce for the building decarbonization path ahead.

Work with utilities to launch building decarbonization start-up programs

As a condition under the Clean Energy Act of 2018 (P.L. 2018 c. 17), the NJBPU Triennium 2 building decarbonization framework required the State's energy utilities to submit energy efficiency and peak demand reduction plans by December 2023. Under these plans, utilities will have set goals and targets for energy efficiency and provide incentives to customers

[4] This enabling action could be developed together for both commercial and residential building zero-carbon emission space heating and cooling.

[5] New Jersey's Clean Energy Program is a statewide program that offers incentives, programs, and services that benefit New Jersey residents, businesses, educational and non-profit entities, and government entities to help them save energy, money, and the environment. https://www.njcleanenergy.com/main/about-njcep/about-njcep

that would be funded by ratepayers. Utilities could benefit from additional funds to expand the program beyond the project's three-year period and potentially reach a broader customer base.

Develop a renewable heating and cooling web calculator tool for New Jersey

The Clean Energy States Alliance (CESA) is currently developing a Clean Heating and Cooling Calculator that provides details about potential cost savings and greenhouse gas emissions reductions associated with switching a customer's fossil-fueled heating and cooling technology to cleaner sources, such as an air source heat pump, ground source heat pump, or a hybrid water heater or solar hot water (CESA, n.d.). The current calculator developed by CESA is specific to Connecticut and New York and does not apply to New Jersey. NJBPU is seeking to expand the tool to cover the State of New Jersey.

Develop a ground source heat pump siting tool for New Jersey stakeholders

NJDEP, in partnership with NJBPU, will develop a ground source heat (GSHP) pump siting tool for New Jersey stakeholders (NJBPU, 2023b). This tool will help contractors and customers when deciding on optimal locations and cost savings for installing GSHP systems.

Adopt the 2024 International Energy Conservation Code for Residential Buildings and ASHRAE 90.1-2022 for commercial buildings

One major instrument to increase building electrification and energy efficiency across the State is the timely adoption of building energy codes, such as the IECC and ASHRAE 90.1. Building energy codes serve as key climate mitigation tools, working to reduce building-level energy use, energy related costs and greenhouse gas emissions (Schwarz et al., 2020). They establish minimum standards for energy efficiency across various aspects of building design and technologies, encompassing the building envelope, HVAC systems, lighting, and water heating. New Jersey can continue to show leadership in building codes by adopting the 2024 IECC for residential new construction and ASHRAE 90.1-2022 for commercial new construction as the next base codes for the State. These model codes will provide a significant boost towards improved efficiency of the built environment. According to estimates from the Pacific Northwest National Laboratory (PNNL), the 2024 IECC alone could reduce energy use intensity, energy costs, and emissions, each by an average of 8% compared to the 2021 IECC (PNNL, n.d.).

Explore the adoption of a stretch code to maximize energy efficiency in new construction

A stretch code is a non-mandatory alternative compliance path that is more aggressive than the base code, allowing self-identified communities to accelerate greenhouse gas reductions and energy efficiency from new construction. Building upon the work of the Clean Buildings Work Group and the New Jersey Energy Code Collaborative, New Jersey will seek funding to explore the adoption of an optional Statewide stretch code and consider pairing the rollout with incentives to encourage municipal and builder adoption.

Implement the Appliance Standards Law and develop the Appliance Standards Recommendations Report

The NJDEP is actively implementing the Appliance Standards Law (P.L. 2021 c. 464) and will develop an Appliance Standards Recommendation Report by January 18, 2025. The report will include an evaluation of other products that can be included in future standards, as well as the potential for updated, and more stringent standards for existing regulated sources.

Pilot community/campus/neighborhood scale district geothermal system decarbonization demonstration projects [6]

NJDEP, in partnership with NJBPU, will seek to pilot community, campus and/or neighborhood scale district geothermal systems throughout the State (NJBPU, 2023b). These systems present an opportunity for city blocks, or even discrete communities and campuses with multiple buildings to transition wholesale away from fossil fueled heating systems, achieving economies of scale for decarbonization.

Explore the adoption of a Clean Heat Standard

Through EO 317 (2023), the NJBPU was directed to consider a Clean Heat Standard (CHS) regulation, which would target emission reductions directly from heating energy utilities by requiring them to replace oil, natural gas, and propane with clean heat over time. An energy utility can purchase credits or implement clean heat, with the expectation of heating

[6] This enabling action will be developed together for both commercial and residential building zero-carbon emission space heating and cooling GHG priority actions.

suppliers to convert to various measures aimed at accelerating energy efficiency, decreasing peak demand, and boosting building electrification. Although a CHS policy does not currently exist in New Jersey, other States have either implemented or are undergoing development of a CHS, including Massachusetts, Vermont, Colorado, and Maryland (Commonwealth of Massachusetts, 2022; Regulatory Assistance Project, n.d.; SB21-264, 2021; Vermont Public Utility Commission, 2024).

Continue energy benchmarking efforts and explore building performance standards

New Jersey's Energy and Water Benchmarking Program requires commercial and public buildings over 25,000 square feet to benchmark their energy and water usage (NJBPU, 2022). The State will continue these benchmarking efforts, and explore the development of building performance standards, which would require these buildings to achieve a specified performance level involving water, energy usage and greenhouse emissions.

Develop building decarbonization resources for local government lead by example efforts

Building off the United States Department of Energy's (USDOE) Building Decarbonization Blueprint (expected release in early 2024) and New Jersey's Strategic Building Decarbonization Roadmap (expected release in March 2024), the State will develop supplemental building decarbonization resources to assist local governments (NJ Council on the Green Economy, 2022; USDOE, n.d.). Resources may take the form of either a guidance report, scorecard, or New Jersey specific mapping tool. Specifics will be dictated by future stakeholdering on the needs of local governments.

Pilot building decarbonization efforts at State facilities and at local government facilities

Decarbonizing State facilities and local government facilities is essential for showcasing that combating climate change is attainable and a priority Statewide. Government facilities and operations present a unique opportunity to incorporate energy efficiency and building decarbonization technology, such as heat pumps. Further, decarbonizing the public sector saves money for taxpayers, supports economic development, and conveys to decision makers and the public the vital message that State and local agencies must work towards implementing energy efficient technologies and transitioning buildings off fossil fuels.

Seek grants and funding to pilot beneficial reuse of wastewater for building electrification at wastewater treatment facilities

Wastewater can serve as a renewable heat source and help decarbonize wastewater treatment plant operations. Wastewater treatment plants could explore utilizing the relative constant temperature of effluent to power heat pumps, which in turn provide heating and cooling to onsite buildings. Heat pump systems transfer heat from the effluent to heat the buildings in the winter, and in the summer the heat is transferred into the water to provide building cooling. New Jersey has 243 wastewater treatment facilities, and at least 99 of these could consider the viability of this type of technology for reducing emissions from their operations.[7]

Seek grants and funding to implement NJBPU's Higher Education Decarbonization Pilot Program

In 2023, the NJBPU commenced its Higher Education Decarbonization Pilot Program which evolves the State's Large Energy User Program (NJCEP, 2024), targets existing colleges and universities with multi-building campuses and assists them to reach their clean energy goals (NJBPU, 2023a). The pilot program runs from December 2023 to June 2024 and provides incentives to campuses seeking to develop a decarbonization plan and invest in renewable energy, energy efficiency, electric vehicles and associated charging stations, energy storage, and combined heat and power, to name a few. The State will evaluate the success of the Higher Education Decarbonization Pilot Program and, thereafter, determine the potential future buildout of the program with a broader Statewide mandate.

[7] According to the NJDEP DataMiner there are 243 active permits for facilities that discharge sludge, broken into categories 1-4 with 4 being the largest and 1 being the smallest. According to the Division of Water Quality within NJDEP, only those facilities in Category 3 (57 facilities) or Category 4 (42) facilities would be large enough to have this type of project.

Table 3.2.3. *Priority Measure 5 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Launch a digital "One Stop Shop" summarizing federal and State energy rebate funding	2025	NJBPU
Offer training grants for residential energy contractors	2025	NJBPU
Work with utilities to launch building decarbonization start-up programs	2024 – Ongoing	NJBPU, Energy Utilities
Develop a renewable heating and cooling web calculator tool for New Jersey	2024	NJBPU
Develop a ground source heat pump siting tool for New Jersey stakeholders	2025	NJDEP, NJBPU
Adopt the 2024 International Energy Conservation Code for residential buildings and ASHRAE 90.1-2022 for commercial buildings	Fall 2025	NJDCA
Explore the adoption of a stretch code to maximize energy efficiency in new construction	Ongoing	NJDCA, NJBPU, Local Governments
Implement the Appliance Standards law and develop the Appliance Standards Recommendations Report	Ongoing	NJDEP
Pilot community/campus/neighborhood scale district geothermal system decarbonization demonstration projects	2025 – Ongoing	NJBPU, NJDEP
Explore the adoption of a Clean Heat Standard	2025	NJBPU
Continue energy benchmarking efforts and explore building performance standards	Ongoing	NJBPU
Develop building decarbonization resources for local government lead by example efforts	2025 – Ongoing	NJDEP
Pilot building decarbonization efforts at State facilities and at local government facilities	2025 – Ongoing	NJBPU, Treasury, Local Governments
Seek grants and funding to pilot beneficial use of wastewater for building electrification at wastewater treatment facilities	Ongoing	Local Governments, Sewerage Authorities
Seek grants and funding to implement NJBPU's Higher Education Decarbonization Pilot Program	Ongoing	NJBPU, Local Governments

Table 3.2.4. *Priority Measure 5 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey will continue to support building decarbonization efforts through its existing ratepayer funded pools of money such as the societal benefit charge (SBC), state appropriations, regional greenhouse gas initiative proceeds, and via targeting federal grants. New Jersey has secured the following funds towards partial implementation of this measure and its enabling actions:

- IRA HOMES administration funds towards building a One Stop Shop for federal rebates for New Jersey.
- State-Based Home Energy Efficiency Contractor Training Grant funds to develop a contractor training program.
- Resilient & Efficient Codes Implementation Grant funds under two applications by ACEEE and ASHRAE/IECC to support code related enabling actions.

- NJBPU has dedicated state funding to develop the clean heating and cooling tool, geothermal demonstration projects and a ground source heat pump siting tool, and the Higher Education Decarbonization Pilot Program, Community Energy Plan Grant (CEPG) and Community Energy Plan Implementation (CEPI) Grant programs.
- NJBPU, NJDEP and NJDCA have committed staff resources towards the continuation of the benchmarking program, the development of a building decarbonization mapping tool, the release of an appliance standards report, and ensuring the ongoing adoption of the latest IECC and ASHRAE building codes.
- State agencies and local governments dedicate portions of their modest capital budgets to building decarbonization efforts.

All of these actions are considered partially funded and would benefit from additional funding.

Funding gaps + opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement all enabling actions on a wider scale, achieving deeper decarbonization. The State has applied to or intends on applying to several federal grants to support its ongoing building decarbonization efforts, including, but not limited to the:

- State Energy Program
- Energy Efficiency and Conservation Block
- Solar for All
- IRA Home Electrification and Appliance Rebates Program
- IRA Home Efficiency Rebates Program
- CPRG funding

New Jersey will continue to pursue federal funding opportunities as they become available to build upon these efforts.

Geographic Scope

Statewide

Authority to Implement

NJBPU and energy utilities have existing authority to implement building decarbonization programs. See P.L. 2018, c.17.

NJDEP has broad authority to implement policies and programs to prevent, control, and prohibit air pollution throughout the State, including programs of education. See N.J.S.A. 13:1D-9, 26:2C-1.

NJDCA is authorized to adopt the latest edition of the national model code every three years as the statewide standard; see N.J.S.A. 52:27D-119. This process provides predictability in what to expect in the industry as the minimum standard but does not provide for the ability to supersede this standard. A stretch code enabling action remains an option for those seeking an incentive at the local level.

The NJTreasury, along with its client agencies, have existing authority to implement pilot projects at State-owned facilities pursuant to N.J.S.A. 52:18A-3, which provides central procurement authority for client agencies, as well as the responsibility for the operation and maintenance for many State-owned facilities throughout the State. Likewise, local authorities that own facilities have the existing authority to undertake the pilot projects described in this measure.

Metrics for Tracking Progress

New Jersey will continue to track total energy consumption within the building sector as one metric for evaluating the success of implementing this measure. Additionally, as documented in EO 316, the NJBPU is required to track and annually report on Statewide building decarbonization efforts. NJBPU intends to set up a process for the Statewide tracking of disbursement of federal funds for building decarbonization. Other State agencies will be required to report back to the NJBPU for this effort. Further, NJDCA was directed to develop a system to track building rehabilitation and new construction projects that incorporate electric building space heating and cooling and water heating systems and provide the information to the NJBPU.

06 Make at least 10% of all low-to-moderate income properties electrification-ready by the year 2030

Building decarbonization must consider the effects on individuals who are experiencing an energy burden, those located in overburdened communities, and those who are of lower income. New Jersey's goal of making at least 10% of low-to-moderate income properties electrification-ready by 2030 seeks to ensure that lower resourced communities are not left behind in the clean building transition. No emissions are realized in the near term, as the goal is merely for making properties electrification ready. It is assumed that full electrification of these buildings is subsequently completed over the years between 2030 and 2050, and a cumulative total reduction of 6.5 MMT CO_2e will be realized by the end of the period (Table 3.2.5). The State will achieve this priority measure by considering the three enabling actions outlined below.

Table 3.2.5. *Priority Measure 6 Greenhouse Gas Reduction Estimates for 2050 under two completion scenarios.*

	Near Term by 2030	Long Term by 2050
	Cumulative Reduction	Cumulative Reduction
Cumulative GHG reductions (MMT CO_2e, GWP_{100})	0	6.5

Expand NJBPU's Whole House Pilot Program to enable energy efficiency for low-and moderate-income residential buildings

New Jersey will seek to expand its Whole House pilot program to provide coordinated weatherization, health, safety, and energy efficiency interventions (Green & Healthy Homes Initiative, 2022). 'Whole House' refers to a holistic approach to healthy housing, incorporating, and coordinating energy efficiency improvements while remediating health and safety hazards that pose a threat to human health and too often cause efficiency upgrade work to be deferred or delayed. These hazards include water intrusion, mold, asthma triggers, asbestos, radon, slip-and-fall risks, pests, electrical deficiencies, lead-based paint, lead service lines, and other existing toxins and contaminants. To date the State is piloting the Whole House program in Trenton, New Jersey, with partners including PSE&G, CMC (PSE&G's Comfort Partners implementer), Isles Inc., and Habitat for Humanity. NJBPU is pursuing enrollment of 100 homes in the pilot program and looking for 20-30 candidates for electrification.

Expand electrification and efficiency programs for low-and moderate-income residential buildings

The NJBPU's current Comfort Partners Program provides financial assistance to income-eligible customers by reducing their utility bills through the implementation of energy efficient products and upgrading the safety and performance of their homes (NJBPU, n.d.). The State will consider expanding this program so that more customers can electrify their homes and participate in energy efficiency programs, which is essential for the State to electrify 10% of its low-and-moderate income households by 2030.

Expand NJBPU's multifamily pilot program which offers energy audits and installation of energy efficiency measures at multifamily properties

The State is interested in expanding its multifamily pilot program which currently provides multifamily properties with free home assessments and rebates up to $1,500 per unit for installing suggested energy efficient measures (NJCEP, n.d.). The State will seek funding to explore the potential expansion of this program to include the underserved multifamily affordable housing sector, new incentive structures designed to achieve optimal emission reductions while considering the needs of the multifamily building stock, and accompanying challenges.

Table 3.2.6. *Priority Measure 6 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Expand NJBPU's Whole House Pilot Program to enable energy efficiency for low- and moderate-income residential buildings	2026	NJBPU
Expand electrification and efficiency programs for low- and moderate-income residential buildings	2024 – Ongoing	NJBPU
Expand NJBPU's multifamily pilot program which offers energy audits and installation of energy efficiency measures at multifamily properties	2024 – Ongoing	NJBPU

Table 3.2.7. *Priority Measure 6 Implementation Approach*

Plan to Leverage Funds

Secured Funding

Bringing building decarbonization efforts to scale within LMI communities will require significant, ongoing investment. The NJBPU has dedicated $665,717 to the Trenton Whole House Pilot program and may leverage NJ RGGI proceeds to finance future rounds of this program. The NJBPU plans to integrate its secured IRA HOMES/HEEHR funding with low-income programs, including a minimum of 10% towards LMI multifamily housing.

Funding gaps + opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts quicker and on a wider scale, achieving deeper decarbonization.

Existing funding opportunities that could be leveraged to expand and continue these programs include:

- Green and Resilient Retrofit Program
- Bipartisan Infrastructure Law: Energy Improvement in Rural or Remote Areas
- Clean Communities Investment Accelerator
- National Clean Investment Fund
- Energy Efficiency and Conservation Block
- IRA Home Efficiency Rebates Program
- IRA Home Electrification and Appliance Rebates Program
- Environmental Justice Government-to-Government Program
- Building Codes Implementation for Efficiency and Resilience
- Energy Future Grants
- State Energy Program
- CPRG funding

New Jersey will continue to pursue federal funding opportunities as they become available to build upon these efforts.

Geographic Scope

Statewide

Authority to Implement

NJBPU and energy utilities have the authority to implement building decarbonization programs. See P.L. 2018, c.17.

Metrics for Tracking Progress

Tracking the progress of these three enabling actions would include the number of applicants and participants in the programs, number of energy efficient technologies and products installed, energy savings, cost savings, and GHG emissions.

Works Cited

A.O.-2023-13. (2023). *New Jersey Department of Environmental Protection Lead By Example.* Retrieved from https://dep.nj.gov/wp-content/uploads/dep-ao-2023-13-climate-mitigation-lead-by-example-initiative.pdf

CESA (n.d.). *Clean Heating and Cooling (CH&C) Calculator.* Retrieved from https://www.cesa.org/projects/building-decarbonization-and-clean-heating-cooling/chc-calculator/

Commonwealth of Massachusetts (2022). *Massachusetts Commission on Clean Heat Final Report*. Retrieved from https://www.mass.gov/doc/massachusetts-commission-on-clean-heat-final-report-november-30-2022/download

Exec. Order No. 316 (2023). *Zero-Carbon Emission Space Heating and Cooling Systems and Office of Climate Action and the Green Economy.* Retrieved from https://nj.gov/infobank/eo/056murphy/pdf/EO-316.pdf

Exec. Order No. 317 (2023). *Plan for the Future of Natural Gas Utility in the State.* Retrieved from https://nj.gov/infobank/eo/056murphy/pdf/EO-317.pdf

Green & Healthy Homes Initiative. (2022). *New Jersey Whole House Pilot Design Project: Asset and Gap Analysis.* Retrieved from https://www.njcleanenergy.com/files/file/Library/6_17_22_GHH-NJ-Report-Final-revised.pdf

NESCAUM (2024). Nine States Pledge Joint Action to Accelerate Transition to Clean Buildings. Press Release. Retrieved from https://www.nescaum.org/documents/2.7.24-nescaum-mou-press-release.pdf

NJBPU. (n.d.). *Comfort Partners*. Retrieved from https://www.njcleanenergy.com/residential/programs/comfort-partners/comfort-partners

NJBPU. (2019). 2019 New Jersey *Energy Master Plan Pathway to 2050.*Retrieved from https://www.nj.gov/emp/docs/pdf/2020_NJBPU_EMP.pdf

NJBPU. (2022, September 7). *New Jersey Board of Public Utilities Approves State's Energy and Water Benchmarking Program for Large Commercial Buildings* [Press Release]. Retrieved from https://www.nj.gov/bpu/newsroom/2022/approved/20220907.html

NJBPU. (2023a). *Participation Guidelines: Higher Education Decarbonization Pilot Program.* Retrieved from https://www.njcleanenergy.com/files/file/LEUP/FY24/2023-11-01_Decarb%20Pilot%20Participation%20Guidelines%20FINAL.pdf

NJBPU. (2023b). *In the Matter of Advancing Geothermal Heating and Cooling Systems in New Jersey* [Docket No. QO23030158]. NJCEP (2024). *Commercial & Industrial Large Energy Users Program: Program Guide*. Retrieved from https://www.njcleanenergy.com/files/file/LEUP/FY24/FY24%20LEUP%20Program%20Guide(2).pdf

NJCEP (n.d.). *Find a Program: Multi-Family.* Retrieved from https://cepfindaprogram.com/transition.html?id=13

NJ Council on the Green Economy (2022). *Future of Green Jobs in New Jersey: 2022 One Year Plan.* Retrieved from https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap%20One%20Year%20Plan.pdf

Works Cited (continued)

NJDEP. (2020). *New Jersey's Global Warming Response Act 80x50 Report.* Retrieved from https://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdfhttps://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdf

N.J.S.A. § 52:27D-119. (2022). *Uniform Construction Code Act*. Retrieved from https://www.nj.gov/dca/divisions/codes/codreg/pdf_regs/52_27D_119.pdf

N.J.S.A. 5:23-3.16 (2022). *ASHRAE Standard 90.1-2019*. Retrieved from https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

N.J.S.A. 5:23-3.18 (2022*). International Energy Conservation Code (IECC)/2021*. Retrieved from https://codes.iccsafe.org/content/IECC2021P2

PNNL (n.d.). *Energy Savings Analysis 2024 Residential IECC Interim Progress Indicator.* Retrieved from https://www.iccsafe.org/wp-content/uploads/2024-IECC-Interim-Residential-Progress-Indicator-to-ICC.pdf

P.L. 2018 c. 17. (2018). *Clean Energy Act*. Retrieved from https://www.njleg.gov/bill-search/2018/A3723

P.L. 2021 c. 200. (2021). *School and Small Business Energy Efficiency Stimulus Program Fund.* Retrieved from https://pub.njleg.state.nj.us/Bills/2020/PL21/200_.PDF

P.L. 2021 c. 201. (2021). *Garden State Commercial Property Assessed Clean Energy Program*. Retrieved from https://pub.njleg.state.nj.us/Bills/2020/AL21/201_.PDF

P.L. 2021 c. 278. (2021). *Low Carbon Concrete Law.* Retrieved from https://pub.njleg.gov/bills/2020/PL21/278_.HTM

P.L. 2021 c. 290. (2021). *Solar Warehouse Law.* Retrieved from https://pub.njleg.gov/bills/2020/PL21/290_.HTM

P.L. 2021 c. 464. (2022). *Appliance Standards Law.* Retrieved from https://pub.njleg.state.nj.us/Bills/2020/PL21/464_.PDF

Regulatory Assistance Project (n.d.). *A Clean Heat Standard for Maryland.* Retrieved from https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/MWG/Clean%20Heat%20Standard%20overview%20for%20Maryland_RAP.pdf

SB21-264 (2021). *Adopt Programs to Reduce Greenhouse Gas Emissions by Utilities Act*. Retrieved from https://leg.colorado.gov/sites/default/files/documents/2021A/bills/sl/2021a_sl_328.pdf

Schwarz, M., Nakhle, C., & Knoeri, C. (2020). *Innovative designs of building energy codes for building decarbonization and their implementation challenges*. Journal of Cleaner Production, 248. Retrieved from https://doi.org/10.1016/j.jclepro.2019.119260

USCA. (2023, September 21). *U.S. Climate Alliance Announces New Commitments to Decarbonize Buildings Across America, Quadruple Heat Pump Installations by 2030* [Press Release]. Retrieved from https://usclimatealliance.org/press-releases/decarbonizing-americas-buildings-sep-2023/

Works Cited (continued)

US Census Bureau. (2021). Estimates of the total residential population and resident population age 18 years and older for the United States, regions, States, district of Columbia, and Puerto Rico: July 1, 2021. Accessed January 29, 2024. Retrieved from https://www2.census.gov/programs-surveys/popest/tables/2020-2021/state/detail/SCPRC-EST2021-18+POP.xlsx

USDOE (n.d.). *Decarbonizing the U.S. Economy by 2050: A National Blueprint for the Buildings Sector.* Retrieved from https://www.energy.gov/eere/decarbonizing-us-economy-2050-national-blueprint-buildings-sector

USEIA. (2023a). *2020 Residential Energy Consumption Survey*. Retrieved from https://www.eia.gov/consumption/residential/index.php

USEIA. (2023b). *2018 Commercial Buildings Energy Consumption Survey.* Retrieved from https://www.eia.gov/consumption/commercial/data/2018/

USEPA. (2018-2022). *Energy Star Unit Shipment and Market Penetration Report.* Retrieved from https://www.energystar.gov/partner_resources/products_partner_resources/brand_owner_resources/unit_shipment_data/archives

Vermont Public Utility Commission (2024). *Clean Heat Standard.* Accessed February 5, 2024, from https://puc.vermont.gov/clean-heat-standard

ELECTRIC GENERATION

Overview

Decarbonizing New Jersey's electric generation sector is vital to maximizing emission reductions in other sectors. A clean grid can supply carbon free energy for electrifying both the transportation and building sectors. Currently, electric power generated in the State comes primarily from natural gas (48% in 2021) and nuclear power (46%), while renewables contribute 8% and other sources such as solid waste incineration, fuel oil and, until recently, coal provide 3% (Figure 3.3.1).

With respect to greenhouse gas emissions, in 2021 the sector contributed 19.1 million metric tons of carbon dioxide equivalent (MMT CO_2e) (GWP_{100}) or 20% of net statewide emissions. New Jersey's greenhouse gas inventory accounts for emissions associated with in-state generation, in-state resource recovery facilities and imported electricity, which contributed 71%, 4% and 25% to the sector total, respectively (Figure 3.3.2).[1] In-state emissions for the sector in 2021 were largely associated with natural gas electric generation units (EGUs), which accounted for 84% of the sector total, with the remainder roughly split between coal (which has since retired) and solid waste incineration. The greatest contributors were the 93 EGUs of 25 megawatts (MW) capacity or more, which operated at 33 facilities across the State (in 2021). These facilities are subject to New Jersey's CO_2 Budget Trading Rule (N.J.A.C. 7:27C). NJDEP maintains a dashboard showing the emissions and generation data from these facilities.[2] Additionally, New Jersey relies on electricity imports from out-of-state, which typically have a higher emissions profile than electric generators located within New Jersey.

19.1 MMT CO_2e	20%	0.0 MMT CO_2e
2021 Emissions	**of Total State Emissions**	**2050 Reduction Goal**

[1] New Jersey participates in the PJM Interconnection LLC Regional Transmission Organization that operates the wholesale power markets and controls the transmission of electricity across much of thirteen States and the District of Columbia. At any given moment, New Jersey may be a net exporter or net importer of electricity across these transmission systems.

[2] This dashboard displays locational information for each power plant electric generating unit (EGU) subject to the Regional Greenhouse Gas Initiative, as well as historic annual emissions and operational information.

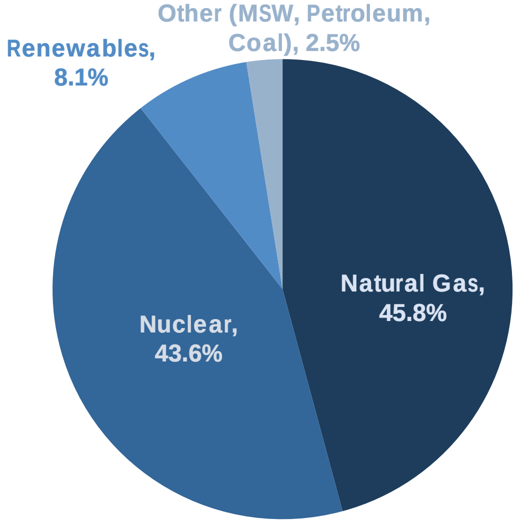


Figure 3.3.1. *Sources of in-state electricity generated in 2021 (Percent).*

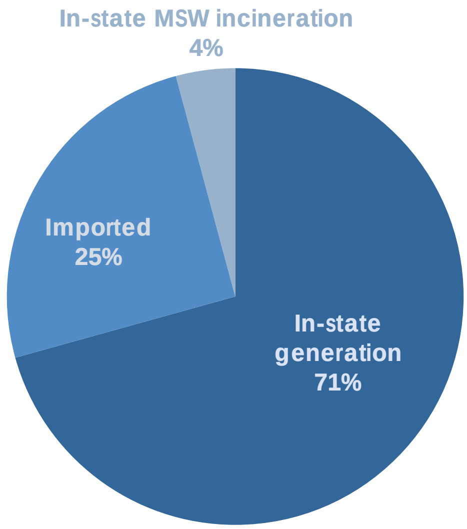


Figure 3.3.2. *2021 NJ Greenhouse Gas Emissions from Electric Generation (Percent of 19.1 MMT CO_2e).*

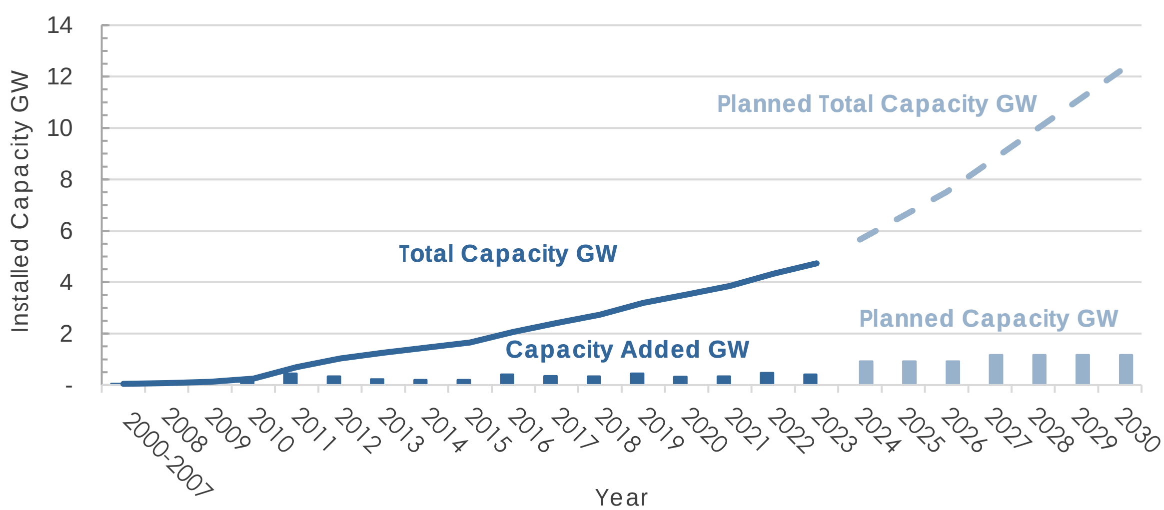
Achieving the State's ambitious greenhouse gas reduction goals rests upon its ability to build a vast infrastructure capable of generating, transmitting and storing increasing amounts of renewable energy. As modeled by the 2019 Energy Master Plan (2019 EMP) and 2020 Global Warming Response Act 80x50 Report (2020 GWRA 80x50 Report), by 2030, the State will need to increase in-state solar resources to 12.2 gigawatts (GW) of installed capacity, and 2.5 GW of installed energy storage while maintaining its existing nuclear energy production (NJDEP, 2020). Further by 2040, Governor Murphy has committed to constructing 11 GW of offshore wind. Looking further into the future, electric demand will more than double in the state by 2050, underlining the urgency to build in-state renewables and expand transmission capacity to bring renewable energy to the State from elsewhere on the PJM grid and beyond.

Progress to Date

New Jersey has made steady progress in decarbonizing its electricity supply, having reduced CO_2e emissions by nearly 40% since 2006. This reduction is largely related to phasing out coal generation in the State, which ceased entirely in 2022, and cutting reliance on out-of-state generation by almost 60%. Building upon these efforts, in 2020 New Jersey officially rejoined the Regional Greenhouse Gas Initiative (RGGI). RGGI is a regional market-based cap and investment program among the States of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Pennsylvania, and Vermont, to cap and reduce CO_2 emissions from the power sector. RGGI sets emission caps on fossil fuel power plants that generate CO_2 emissions at or above a 25 MW capacity. Through the State's participation in the RGGI cap and trade program, it is applying a regional emissions reduction of 30% from 2020 to 2030.

Simultaneous to driving down emissions from fossil fuel facilities, the State is working to increase its portfolio of in-state renewable generation. As of December 31, 2023, the State had over 4.7 GW of solar capacity from more than 192,000 installations; 40% of this capacity was added in the past five years (NJBPU, 2023) (Figure 3.3.3). This growth in solar is expected to continue. In July 2021, Governor Murphy signed the Solar Act of 2021 (P.L. 2021, c. 169) into law, providing incentives for the development of at least 3.75 GW of new solar by 2026. Two incentive structures were created: an Administratively Determined Incentive (ADI) for net metered facilities with capacity of 5 MW or less, and community solar facilities; and a Competitive Solicitation Incentive (CSI) for grid supply solar facilities and net metered facilities over 5 MW. While the ADI program accounts for 417 MW of capacity, to date, NJBPU has not awarded any projects via the CSI program. New Jersey also recently passed a Remote Net Metering law (P.L. 2023, c.190) which allows for solar to be hosted off-site on private land and allows for additional solar to be built for a given project based on the total demand of users instead of average demand.

Figure 3.3.3. Total Installed and Planned Solar PV Capacity in New Jersey (NJBPU, 2023)



Offshore wind also plays a key role in New Jersey's clean energy transition. Governor Murphy, via Executive Order (EO) 307 (2022), established a target for 11,000 MW of offshore wind by 2040. Currently, five wind projects have been awarded by the New Jersey Board of Public Utilities (NJBPU or the Board). Three of these, totaling 5,252 MW, are in active development. This goal is further supported via progress on the New Jersey Wind Port (NJWP). The NJWP is located in Lower Alloways Creek, Salem County on Artificial Island in the Delaware Bay and is a critical component for the construction of offshore wind on the coast.

Beyond ensuring the build out of clean energy resources in-state, Governor Phil Murphy signed E.O. 315 on February 1, 2023 calling for 100% clean electricity sold in New Jersey by 2035, via the creation of clean energy market mechanism paired with a clean energy standard (Exec. Order No. 315, 2023). The State also has approximately 0.5 GW of energy storage resources (NJBPU, 2022b) with goals to increase storage capacity in the future.

Community Driven Solutions

Public stakeholders provided comments through the online comment form, during the public webinars, and in-person at the Newark community listening session with environmental justice stakeholders. In the electric generation sector, stakeholders voiced a concern that the energy transition has the potential to leave stranded assets (e.g., natural gas) that may become more costly for low- and moderate-income households. Stakeholders also emphasized that capital costs, and planning and project development costs for renewables, energy storage, and energy efficiency are challenging when potential project developers do not understand the holistic value proposition and full lifecycle costs and returns. They suggest New Jersey should offer favorable financing (e.g., low interest loans or loan guarantees) to ease costs for higher risk, capital intensive projects. Further, several stakeholders emphasized the need for holistic decarbonization planning and implementation through cross-sector pilot projects (e.g., ecovillages).

> *"More community solar is needed, versus company-driven solar."*
>
> ***– comment heard at EJ Community Dialogue for CPRG in Newark***

Priority Measures

07 *Achieve 12.2 GW of Solar In-state by 2030*

Rapid development of in-state solar resources is critical to achieving New Jersey's clean energy transition. Recognizing this, the 2019 EMP and 2020 GWRA 80x50 Report set a goal of realizing 12.2 GW of in-state solar by 2030. Implementation of this measure will result in a cumulative total reduction of 15.2 MMT CO_2e by 2030, and 107.3 MMT CO_2e by 2050 (Table 3.3.1). Achieving this goal requires the expansion of existing incentive programs to encourage wider deployment of solar. Further, homeowners, businesses, and institutions need to evaluate their ability to host solar projects and swiftly move forward with implementation.

Table 3.3.1. *Priority Measure 7 Greenhouse Gas Reduction Estimates*

	Near Term by 2030	***Long Term by 2050***
	Cumulative Reduction	**Cumulative Reduction**
Estimated GHG reductions (MMT CO_2e, GWP_{100})	15.2	107.3

Implement Competitive Solar Incentive, Administratively Determined Incentive and Dual Use Solar Programs

The NJBPU is committed to continuing its work to grow the solar industry in New Jersey through its slate of solar incentives. Between now and 2030, NJBPU will offer funding via its existing solar programs and explore federal funding opportunities to grow these programs:

- The Administratively Determined Incentive (ADI) Program provides administratively set incentives for net metered residential projects, net metered non-residential projects, and community solar projects of 5 MW (dc) or less.
- The Competitive Solar Incentive (CSI) Program provides competitively set incentives for grid supply projects and net metered non-residential projects greater than 5 MW (dc). A new project solicitation is set to close on February 29, 2024.
- In 2024, the NJBPU expects to launch a Dual-Use Solar Energy Pilot Program (pursuant to P.L. 2021, c. 170) which will focus on the development of dual-use solar projects on productive farmland (also known as "agrivoltaics").

Expand the Community Solar Energy Program

Expansion of New Jersey's community solar program is a key tenet for ensuring a just and equitable clean energy transition. The Community Solar Energy Program (a subset of New Jersey's ADI program), allows those who rent, lack control of their roof, live in a multi-family building, do not have property suitable for solar, or cannot afford the cost of a solar installation to benefit from the cost savings and clean energy associated with solar power. New Jersey's Community Solar Energy Pilot Program was launched on February 19, 2019, pursuant to the Clean Energy Act (P.L.2018, c.17.) and was converted to a permanent program as of August 16, 2023. As of November 30, 2023, 101 community solar projects with 137 MW capacity have come online, serving more than 16,000 subscribers (NJBPU, 2023). Since the interest in community solar is outpacing the current program, the NJBPU applied to the federal Solar For All grant program, proposing to use $250M in funds to serve 36,000 low-income and disadvantaged community households and finance the deployment of 285 MW of solar. If awarded, NJBPU can award more solar projects, enable community solar in areas with weak electrical grids, extend solar access to multifamily affordable housing, create pathways to residential solar ownership for low-income and disadvantaged community households, and develop the solar workforce with assistance from the Department of Labor.

Site solar infrastructure at State and local government facilities

Siting solar photovoltaics (PV) on government owned buildings will reduce energy bills and emissions. When combined with storage, it will ensure government offices and services are available during emergencies. Collectively, "public" parcels[3] account for more than 3.6 million acres of land in the State (NJDEP, 2024). While the majority of this is characterized as forests and other natural lands that the State sets out to preserve and protect, there are still nearly 100,000 acres of rooftops and other impervious surfaces that could be suitable for siting solar PV in an environmentally responsible manner (NJDEP, 2024). State and local governments should work towards offsetting 100% of their electricity usage with solar systems.

Work is ongoing to enable more State agencies and local governments to install solar on their facilities. For State agencies, New Jersey's Department of the Treasury developed a standardized power purchase agreement (PPA) to streamline the bidding process. New Jersey's Department of Transportation is currently using the PPA to purchase a solar installation for its headquarters building, the first PPA executed under these new rules (NJDPMC, 2023).

State and local entities can also benefit from the NJ Clean Energy Program's Energy Savings Improvements Program, which is a form of energy performance contracting that allows government entities to make energy-related improvements to their facilities using the value of energy savings that result from the improvements.

The Alliance for Competitive Energy Services (ACES) is another program which can enable the procurement of additional solar power for New Jersey school districts. ACES procures electricity and natural gas at discounted prices for New Jersey schools, while the ACESplus program uses expert consulting support to implement advanced clean energy projects for districts (ACES, 2024)

Release revised Solar Siting Analysis

It is critical that future solar projects are properly sited to ensure the protection of open space, natural lands, and the critical habitats and ecosystems that can be found throughout the Garden State. NJDEP will release an update to its 2017 Solar Siting Analysis (NJDEP, 2017) that will incorporate additional environmental data, providing a more robust and refined indicator of the Department's solar siting preference. The guidance will seek to foster solar PV development in an environmentally responsible manner.

[3] Public parcels include the MOD-IV property classification codes of 15A, which includes Public Schools, Colleges and Universities, and 15C which includes other Federal, State, and Municipally owned/operated lands (NJDEP, 2024).

Table 3.3.2. *Priority Measure 7 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Implement Competitive Solar Incentive, Administratively Determined Incentive, and Dual Use Solar Programs	ADI potential rule updates – 2024 CSI second solicitation and award – 2024 Dual use rule proposal, adoption, & award – 2024	NJBPU
Expand the Community Solar Energy Program	Registration of 500 MW – 2024 Registration of 250 MW – 2025 Rule Adoption – 2024	NJBPU
Site solar infrastructure at State and local government facilities	2024 – Ongoing	NJDEP, NJTreasury, Local Governments
Release revised Solar Siting Analysis	2024	NJDEP

Table 3.3.3. *Priority Measure 7 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey will continue to support solar deployment through the societal benefit charge (SBC) per the Clean Energy Act and Solar Act of 2021.

Implementation of the Competitive Solar Incentive, Administratively Determined Incentive, and Dual Use Solar Programs are primarily funded through SREC-II mechanisms, with some funding coming from the SBC. As noted above, the NJBPU has also submitted a $250M application for the federal Solar for All grant program, to expand the Community Solar Program.

Funding Gaps and Opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts quicker and on a wider scale, achieving deeper decarbonization. Existing federal funding opportunities that could be leveraged include:

- Energy Efficiency and Conservation Block Grant
- Solar for All

New Jersey will continue to pursue federal funding opportunities as they become available to build upon these efforts.

Geographic Scope

Statewide

Authority to Implement

NJBPU has existing authority to implement the solar incentive programs described in this measure pursuant to the Electric Discount and Energy Competition Act, N.J.S.A. 48:3-49, et seq, and additional legislative provisions pertaining to solar, including N.J.S.A. 48:3-114 through -120, and P.L. 2021,c. 170.

The NJTreasury, along with its client agencies, have existing authority to implement site solar infrastructure at State-owned facilities pursuant to N.J.S.A. 52:18A-3, which provides central procurement authority for client agencies, as well as the responsibility for the operation and maintenance for many State-owned facilities throughout the State. Likewise, local authorities that own and operate infrastructure have the existing authority to undertake solar projects described in this measure.

The NJDEP is authorized to conduct statewide programs of education pursuant to N.J.S.A. 13:1D-9.

Metrics for Tracking Progress
MW of solar installed statewide, percent of solar by customer type (school, municipal, etc.)

08 *Facilitate the integration of clean distributed energy resources into the grid*

New Jersey's four electric distribution companies (electric utilities or EDCs) are not currently able to "host" the projected increase in distributed energy resources (DER) envisioned in the State's greenhouse gas reduction plans. Thus, transitioning the electric grid is as integral to decarbonizing the electric sector as batteries are to an electric vehicle. Consequently, nearly all projected emissions reductions from this sector hinge on timely transition and modernization of the State's grid. Emissions were not calculated for this measure directly; rather this measure enables emission reductions from other measures.

Improve hosting capacity of New Jersey electric distribution system through grid modernization efforts

New Jersey's clean energy future can only be realized through the improvement of the hosting capacity of its distribution grid. The grid needs to be modernized to accommodate greater amounts of distributed energy resources (such as solar PV) while maintaining system operations. In 2022, the NJBPU issued a Grid Modernization Study (NJBPU, 2022a), which recommended nine actions. NJBPU has since initiated rulemaking for four of these and is launching a series of working groups to evolve and implement the five more complex recommendations, with initial focus on collaboratively defining the requirements for a proactive DER Integration Roadmap/Plan that the utilities will file against to drive better transparency on high priority segments for future grid modernization.

Support implementation of FERC 2222 to help support distributed energy resources

Aggregation is recognized as a mechanism to bring structure and compensation to the increasing amounts of interconnected DER that offer valuable grid services. As PJM is finalizing its tariff for these services, attention is turning to how the EDC will enable the coordinated operation of the aggregation by DER *Aggregators* (DERA) without impacting system reliability. A detailed survey is being distributed to the EDCs that will frame the subsequent stakeholder process and ultimately lead to formal filings by each utility on policies and tariffs that will define the rules for configuration and operation of these Federal Energy Regulatory Commission (FERC) 2222 compliant aggregations.

Support development of 2.0 GW of energy storage by 2030 through the creation of an Energy Storage Incentive Program

New Jersey has a statutory mandate to achieve 2.0 GW of installed energy storage by 2030. The NJBPU is developing a New Jersey Energy Storage Incentive Program (NJ SIP), which is designed to achieve that goal. The NJBPU issued a straw proposal on September 29, 2022 (Docket No. QO22080540) describing the initial conceptual design for the NJ SIP and solicited comments.

The NJBPU analyzed the comments and issued a follow-on Request for Information (RFI) in August 2023. The NJBPU, with the assistance of a consultant, is preparing a revised NJ SIP, for which the NJBPU will seek public comments during the second quarter of 2024 and expects to place the program into operation during the second half of 2024.

Pilot grid supportive technologies such as Vehicle-to-Everything "V2X" and microgrid systems

Energy storage exists in an increasing number of areas but up to now has seldom been available to provide grid services. This is changing quickly. New Jersey has identified Vehicle-to-Everything "V2X" capabilities and microgrids as important elements of a modern grid. Elements of V2X include: Vehicle-to-Building (V2B), Vehicle-to-Grid (V2G) or Vehicle-to-Storage (V2S) which allows an electric vehicle to send power using a bidirectional (two-way) charger controlled via a remote management system. V2S coupled with microgrids or nanogrids can provide resilient power during times of emergency and alleviate peak load, avoiding peak energy costs and reducing CO_2 emissions. State and local entities should seek to pilot grid supportive technologies, to ensure resilient power during times of emergency. However, full scale adoption of these technologies will require the development of connection standards, which will allow these formerly isolated bodies of storage to benefit the grid and benefit from the grid.

In tandem, NJBPU has joined a U.S. Department of Energy led cohort through a "V2X Collaboration MOU" (USDOE, 2022) as approved by the Board, which will provide access to leading technical and business expertise all aligned toward standardizing and commercializing this latent capability.

Microgrids (a cluster of critical facilities and DERs that can connect and disconnect from the EDC grid) also support decarbonization efforts by virtue of their locally generated clean power. Presently, the NJBPU is supporting microgrids via a Town Center Distributed Energy Resources Incentive Program. Seven projects within the program are undergoing engineering design.

Implement storage component of Competitive Solar Incentive program

Adding energy storage to solar installations offers several benefits including energy shifting, increased local consumption, increased grid independence, peak shaving, demand charge reduction, and if done properly, environmental benefits due to reduced greenhouse gas emissions. NJBPU is supporting the buildout of energy storage in conjunction with large grid supply solar projects. NJBPU has proposed to award 160 megawatt-hour of storage combined with 40 MW grid supply as part of its CSI program (NJBPU, 2022b).

Support Resilient Local Governments

Energy resilience is essential for local governments which provide critical services during times of emergency. Local governments have a responsibility to ensure the well-being of the communities they serve. A major part of that responsibility is ensuring energy resilience in the face of grid disruptions. The deployment of renewable energy and storage systems for local government buildings also has the potential to reduce energy costs. Financial incentives for solar and storage can complement the newly available "direct pay" option where local governments receive up to 30% tax credits for such projects. A third-party administrator, or New Jersey's existing Community Energy Plan Implementation Program could disburse funding.

Table 3.3.4. *Priority Measure 8 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Improve the hosting capacity of the New Jersey electric distribution system through grid modernization efforts	2024 – Ongoing	NJBPU
Support implementation of FERC 2222 to help support distributed energy resources	Survey and public engagement – 2024 – Ongoing	NJBPU
Support development of 2 GW of energy storage by 2030 through the implementation of the Energy Storage Incentive Program	Launch the NJSIP Program – second half 2024	NJBPU
Pilot grid supportive technologies such as vehicle-to everything and microgrids	Pilot Technologies – 2024 – Ongoing USDOE "V2X Collaboration MOU" pending Board approval – 2024	NJBPU, State Agencies, Local Governments
Implement storage component of Competitive Solar Incentive program	Pending CSI awards	NJBPU
Support Resilient Local Governments	Apply for federal funding 2024. Implement 2025-2026	NJBPU, NJDEP, Local Governments

Table 3.3.5. Priority Measure 8 Implementation Approach

Plan to Leverage Funds
Secured Funding
New Jersey will continue to support the integration of clean distributed energy resources into the grid through its existing societal benefit charge (SBC), ratepayer recovery, business model adjustments, regional grid partnerships, $12 million from the Department of Energy Grid Resilience State and Tribal Formula Grant Program (40101d), and State budget allocations to cover the wide range of enabling actions for this measure.
Funding Gaps and Opportunities
All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts quicker and on a wider scale, achieving deeper decarbonization. Existing funding opportunities that could be leveraged include: • Energy Efficiency and Conservation Block • Solar for All • USDOE Grid Innovation Program • CPRG implementation grant funding • USDOE Lab Technical Assistance services Local governments can leverage complementary funding available through elective pay (direct pay) of certain clean energy tax credits (§45Y, §48E). New Jersey will continue to pursue federal funding opportunities as they become available to build upon these efforts.
Geographic Scope
Statewide
Authority to Implement
As set forth in Docket No. QO21010085 NJBPU has the existing authority to move forward with the various grid modernization efforts described in this measure. NJBPU has existing authority under the Clean Energy Act of 2018, (P.L. 2018, c.17) to offer an energy storage incentive program, and has approval via Docket No. QO22080540. NJTreasury, along with its client agencies, have existing authority to implement the pilot projects at State-owned facilities with state-owned fleets pursuant to N.J.S.A. 52:18A-3, which provides central procurement authority for client agencies, as well as the responsibility for the operation and maintenance for many State-owned facilities throughout the State. Likewise, local authorities that own and operate fleets and infrastructure have the existing authority to undertake the pilot projects described in this measure. NJBPU has received board approval to join the USDOE-sponsored "V2X" community-of-interest collaboration and will need to develop connection standards for larger scale work.
Metrics for Tracking Progress
The capacity of energy storage systems participating in NJBPU's program will be tracked relative to the 2.0 GW by 2030 goal.

09 Support Development of 11.0 GW of Offshore Wind by 2040

Over the last decade, New Jersey's renewable energy approach has been defined through its strong and increasing commitment to offshore wind power. While the timeline has shifted due to the cancellation of Ocean Wind I and II in 2023 by Orsted, New Jersey still intends to target 11.0 GW by 2040. On January 24, 2024, the Board awarded 2,400 MW of capacity to Leading Light Wind and 1,342 MW to Attentive Energy Two. These projects provide cornerstone economic benefits that promise to build upon New Jersey's standing as an offshore wind supply chain. Both projects have committed to supporting the establishment of a tower manufacturer at the New Jersey Wind Port in addition to sourcing monopiles from, and investing in, the expansion of the EEW monopile facility at the Port of Paulsboro. Together, the projects are estimated to create more than 27,000 direct, indirect, and induced full-time equivalent job years.

The State's comprehensive approach to offshore wind development aims to secure the best overall value for ratepayers while protecting the environment and commercial and recreational fishing interests. In addition to creating economic benefits and jobs, the awarded projects have also committed to provide $60 million of support for environmental and fisheries research, monitoring, and conservation efforts (NJBPU, 2024a).

Table 3.3.6. *Priority Measure 9 Greenhouse Gas Reduction Estimates*[4]

	Near Term by 2030	Long Term by 2050
	Cumulative Reduction	Cumulative Reduction
Estimated GHG reductions (MMT CO_2e, GWP_{100})	6.4	276.6

Launch and award New Jersey's fourth offshore wind solicitation

NJBPU is accelerating the launch and award of a fourth solicitation for 1,200 – 4,000 MW of capacity, which is expected to be issued in early 2024 with awards in early 2025 (NJBPU, 2022c). This solicitation shows the State's commitment to achieving a 100% clean energy economy by 2035.

Develop and implement State Agreement Approach 2.0 for the goal of 11 GW of wind energy by 2040

To meet New Jersey's commitment to offshore wind, a network capable of carrying that electricity will need to be built. In addition to vendor specific network build-outs, NJBPU is asking PJM, the regional grid operator of which New Jersey is a member, to "…examine whether an integrated array of open-access transmission facilities, both onshore and potentially offshore, can achieve New Jersey's expanded offshore wind goals in an economical and timely manner. This evaluation is conducted as part of PJM's Regional Transmission Expansion Planning process, and the results will be shared with the NJBPU for a final decision to determine which, if any, additional projects they may wish to pursue." (PJM, 2023)

That process, known as the State Agreement Approach, or SAA, was incorporated into the PJM Operating Agreement in 2013, with the implementation of the Federal Energy Regulatory Commission's Order (FERC) 1000. With that order, FERC required regional grid operators to 'provide for the consideration of transmission needs driven by public policy requirements in the regional transmission planning processes" (PJM, 2023). New Jersey and PJM had previously used the SAA to support New Jersey's 11.0 GW offshore wind goal. On February 2, 2023, PJM filed the SAA 2.0 Study Agreement with the FERC (NJBPU, 2024b).

Support construction of the New Jersey wind port

Ports are central to offshore wind development, as they play a critical role in supporting infrastructure supply chains, staging of equipment, and operations and maintenance. New Jersey has moved swiftly in developing its wind port, which

[4] Emissions estimates assume 1,510 MW of capacity online in 2028, with subsequent expansions in 2031 through 2035 for a total capacity of 7,500 MW. These emissions estimates do not consider the further expansions that are anticipated by the State.

is the nation's first purpose-built offshore wind marshaling port,[5] promising to position New Jersey as a hub for the U.S. offshore wind industry. The New Jersey Wind Port, located on the eastern shore of the Delaware River in Salem County, will serve offshore wind projects in New Jersey and up and down the U.S. East Coast (Figure 3.3.4).

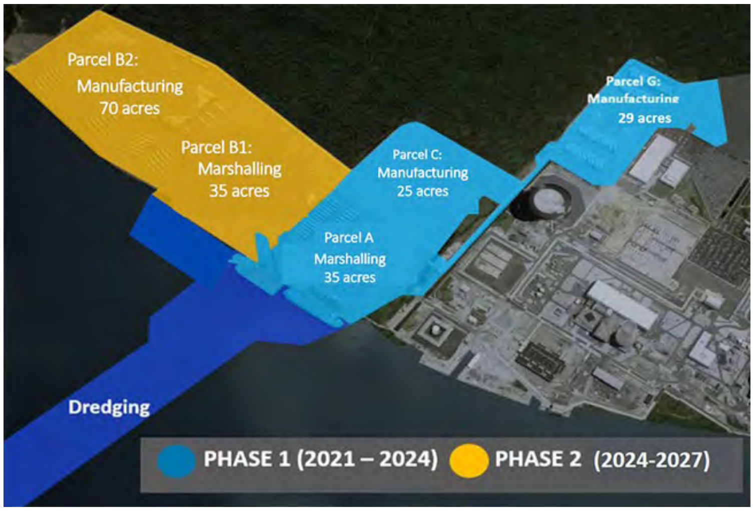


Figure 3.3.4. *New Jersey Wind Port Site Map*

New Jersey's wind port is moving forward via a two-phase approach. Phase one includes the construction of the 30-acre marshalling port which is expected to be complete in early 2024. Phase two is anticipated to come online in 2026 and will include 35 acres of additional marshalling space, enabling two projects to marshal concurrently. This phase will also bring 60-70 acres of additional manufacturing space online.

Table 3.3.7. *Priority Measure 9 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Launch and award New Jersey's fourth offshore wind solicitation	2024 – Launch 2025 – Award	NJBPU
Develop and implement State Agreement Approach 2.0 for the goal of 11 GW of wind energy by 2040	2024 – 2025	NJBPU
Support construction of the New Jersey wind port	Phase 1: Early 2024 Phase 2: 2026-2030 – Ongoing	NJEDA

Table 3.3.8. *Priority Measure 9 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey will continue to support the development of offshore wind through the societal benefit charge (SBC) and state budget allocations. New Jersey's Legislature authorized the NJBPU to offer an offshore wind renewable energy certificate (OREC) program to incentivize the build out of offshore wind in the State. The EDCs in the State will make monthly payments to eligible offshore wind projects based on generation. The Legislature also dedicated State funds towards the construction of the New Jersey wind port.

All of these enabling actions are considered partially funded and would benefit from additional funding.

Funding Gaps and Opportunities

[5] A marshaling port, also called a staging port, is a large water access site for storing, assembling, loading onto ships and launching wind turbine components before they are installed at their working location in the water. Marshalling port locations are preferably located close to their final installation locations and free of vertical restrictions.

More funds would allow New Jersey to expand and implement all enabling actions on a wider scale, achieving deeper decarbonization. The State will seek to leverage federal funding including:

- Investment Tax Credit (ITC) and Production Tax Credit (PTC)
- Advanced Manufacturing Production Tax Credit

Additional provisions related to leasing and transmission planning subsidies may also be available to projects. New Jersey will continue to pursue federal funding opportunities as they become available to build upon these efforts.

Geographic Scope

Statewide

Authority to Implement

New Jersey's Offshore Wind Development Act (P.L.2010, c.17) provides authority to NJBPU to establish an offshore wind renewable energy certificate (OREC), which will enable it to implement the solicitation and agreement approach described in this measure. NJBPU developed rules (N.J.A.C. 14:8-6.6 and 6.7) overseeing the OREC program.

The New Jersey Economic Development Authority (NJEDA) was formed by the Legislature, in part, to decrease unemployment in New Jersey by promoting manufacturing, industrial, and commercial jobs, as well as to undertake construction projects that would facilitate same. N.J.S.A. 34:1B-2. To accomplish these goals in the context of promoting New Jersey commerce and employment in the offshore wind industry through the construction of the New Jersey Wind Port, NJEDA has the authority to acquire property through purchase, lease, or otherwise necessary (N.J.S.A. 34:1B-5(c)); enter into construction contracts for capital projects (N.J.S.A. 34:1B-5(e)); and lease its assets or property to interested parties (N.J.S.A. 34:1B-5(g)).

Metrics for Tracking Progress

The capacity (MW) of offshore wind awarded, relative to our procurement goals, and generated (annually), as monitored via ORECs, will be tracked.

Works Cited

ACES. (2024). The Alliance for Competitive Energy Services (ACES) /ACESplus - New Jersey School Boards Association. Retrieved from https://www.njsba.org/services/aces/

Exec. Order No. 307. (2022). Retrieved from https://nj.gov/infobank/eo/056murphy/pdf/EO-307.pdf

Exec. Order No. 315. (2022). Retrieved from https://www.nj.gov/infobank/eo/056murphy/pdf/EO-315.pdf

NJBPU. (2022a). Grid Modernization Study. Retrieved from https://www.nj.gov/bpu/pdf/publicnotice/DRAFT%20Grid%20Modernization%20Report%206-20-22.pdf

NJBPU. (2022b). New Jersey Energy Storage Incentive Program Proposal. Retrieved from https://nj.gov/bpu/pdf/publicnotice/Notice_StakeholderMeetings_NewJerseyEnergyStorageProgram.pdf

NJBPU. (2022c). New Jersey's Offshore Wind Program. Retrieved from https://njoffshorewind.com/

NJBPU. (2023). Solar Activity Reports. Retrieved from https://www.njcleanenergy.com/renewable-energy/project-activity-reports/project-activity-reports

NJBPU. (2024a). NJBPU Approves Over 3,700 MW of Offshore Wind Capacity in Combined Award. Retrieved from https://www.nj.gov/bpu/newsroom/2023/approved/20240124.html

NJBPU. (2024b). New Jersey Board of Public Utilities Pursues Second State Agreement Approach. Retrieved from https://www.nj.gov/bpu/newsroom/2024/approved/20240205.html

NJDEP. (2017). Solar Siting Analysis Update. Retrieved from https://www.nj.gov/dep/aqes/SSAFINAL.pdf

NJDEP. (2020). *New Jersey's Global Warming Response Act 80x50 Report.* Retrieved from https://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdfhttps://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdf

NJDEP. (2024). Internal analysis conducted by the Bureau of Climate Change and Clean Energy.

NJDPMC. (2023). Solar PPA. *New Jersey Division of Property Management and Construction*. Retrieved from https://www.nj.gov/treasury/dpmc/project_solarpower_advertisements.shtml

PJM. (2023). PJM, New Jersey Reach Next Milestone in Pursuit of State's Offshore Wind Goals. Retrieved from https://insidelines.pjm.com/pjm-new-jersey-reach-next-milestone-in-pursuit-of-states-offshore-wind-goals/

P.L. 2018, c.17. New Jersey Clean Energy Act. Retrieved from https://www.njleg.gov/bill-search/2018/A3723

P.L. 2021, c. 169 Solar Act of 2021. Retrieved from https://www.njleg.gov/bill-search/2020/A4554

P.L. 2021, c. 170 Dual-Use Solar Energy Act. Retrieved from https://www.njleg.gov/bill-search/2020/A5434

P.L. 2023, c.190. New Jersey Net Metering Law. Retrieved from https://www.njleg.state.nj.us/bill-search/2022/S2848

Works Cited (continued)

Rutgers, The State University of New Jersey. (2019). New Jersey Energy Storage Analysis (ESA) Final Report. Retrieved from https://www.nj.gov/bpu/bpu/pdf/commercial/New%20Jersey%20ESA%20Final%20Report%2005-23-2019.pdf

USDOE. (2022). Department of Energy Announces First of Its Kind Collaboration to Accelerate "Vehicle-to-Everything" Technologies. Retrieved from https://www.energy.gov/technologytransitions/articles/department-energy-announces-first-its-kind-collaboration-accelerate

FOOD WASTE

Overview

The food we grow, eat and discard creates greenhouse gases that contribute to climate change. Emissions are produced at every stage of our food system however, methane emissions associated with food waste in landfills are particularly problematical, as methane is more than 28 times as potent as carbon dioxide in trapping heat in the atmosphere (IPCC, 2013; USEPA, 2023a; USEPA, 2023b). Food waste is the single most common material sent to landfills (NJDEP, 2022; NJDEP SAB, 2023; USEPA, 2023a; USEPA, 2023b). New Jersey's municipal solid waste stream contains about 17-22% of material characterized as food waste, while its commercial waste stream contains 13.6-25.7% (NJDEP SAB 2023, Rutgers EcoComplex 2022). Overall, landfilling generates 6.6 million metric tons of carbon dioxide equivalent (MMT CO_2e) or about 6.7% of New Jersey's net greenhouse gas emissions (GWP_{100}). In 2021, out-of-state disposal accounted for 56% of landfill emissions, in-state municipal solid waste landfills 38%, and industrial landfills 6% (Figure 3.4.1). Methane emissions from organic matter are the largest portion of waste emissions in New Jersey.

New Jersey's 80x50 goal is to reduce emissions from the waste sector by 15% to 4.9 MMT CO_2e by 2050 (GWP_{100}) (NJDEP, 2020). Pathways for reducing emissions in this sector include preventing and reducing food waste, source separation of waste materials, and use of organic matter as a feedstock for renewable biogas production. The New Jersey Department of Environmental Protection (NJDEP or Department) estimates that on average, New Jerseyans generate about 325 pounds of food waste per person per year, or almost one pound per day (NJDEP, 2023). Halving the amount of food waste landfilled by New Jersey requires concerted action along all stages of the food system, from producers to retailers and consumers.

6.6 MMT CO_2e
2021 Combined Emissions

6.7%
of Total State Emissions

$\leq$4.9 MMT CO_2e
2050 Reduction Goal

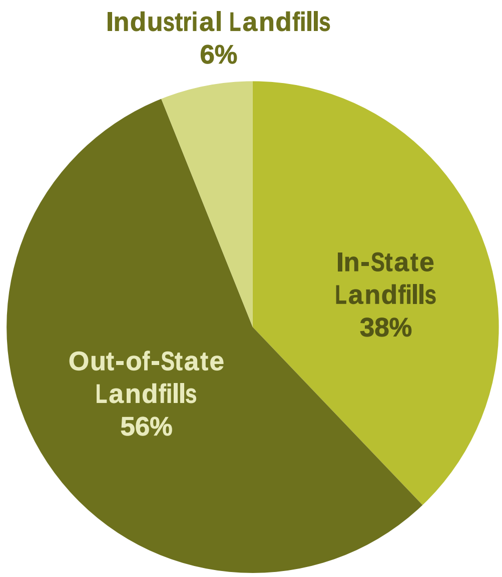


Figure 3.4.1: *2021 NJ Greenhouse Gas Emissions from Landfilled Solid Waste (Percent of 6.6 MMT CO_2e)*

Progress to Date

Taking actions to prevent food from being wasted in the first place is the most preferred pathway for reducing and diverting wasted food from landfills (USEPA, 2023a; USEPA, 2023b) (Figure 3.4.2). New Jersey has a long history of taking steps to address food-related waste issues. In 1982 New Jersey enacted the "Food Bank Good Samaritan Act" (N.J.S.A. 24:4A-1 to 24:4A-5) which provides protection to people donating excess food to food banks in good faith. Since then, New Jersey has continued to take steps to address food waste within the State. On July 21st, 2017, the Food Waste Reduction Act (2017, P.L. 2017, c.136) was signed into law and established a goal of halving the amount of food waste generated by 2030 (with 2017 as the base line). This law also required NJDEP to develop a Food Waste Reduction Plan (NJDEP, 2023). The Food Waste Reduction Plan was published in October 2023, and recommends that the State reinstate the Advisory Council on Solid Waste Management to take up the issue of food waste.

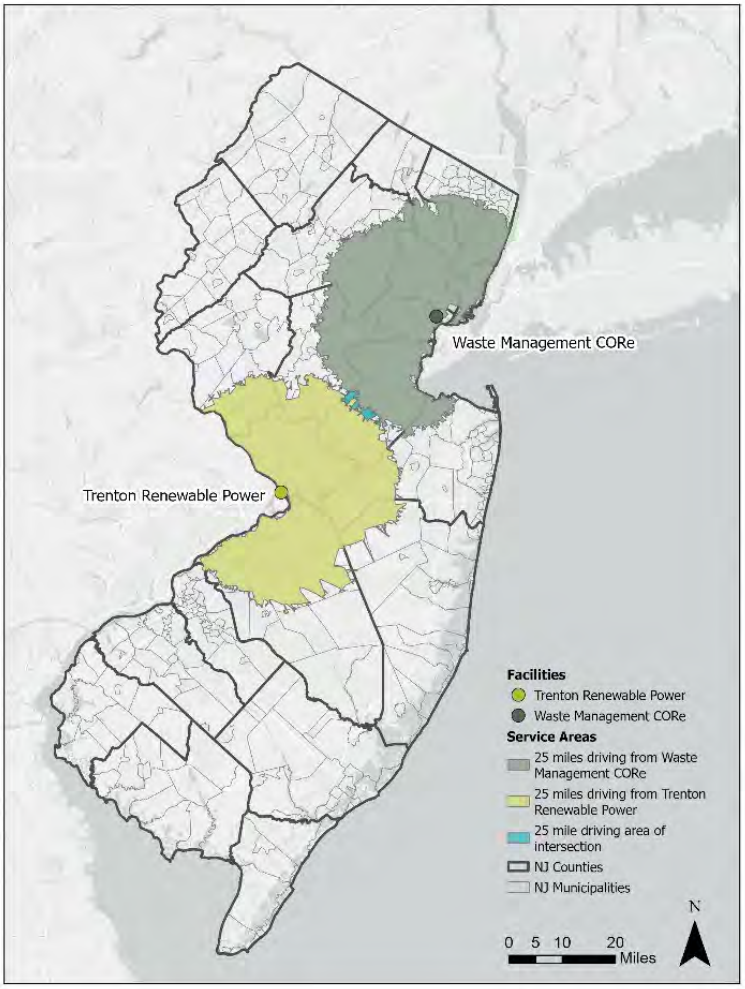
Figure 3.4.2. *USEPA's Wasted Food Scale*

In 2020, New Jersey passed the Food Waste Recycling and Food Waste-to-Energy Production Law (P.L. 2020 c.24). This law requires large food waste generators (those generating a projected average of 52 tons or more of food waste each year) to source separate and recycle food waste if they are located within 25 road miles of an authorized food waste recycling facility. There are currently only two authorized food waste recycling facilities in the State (Figure 3.4.3). Efforts are underway to map large food waste generators so that new food waste recycling facilities can be sited closer to food waste generators that are not currently within the 25 road miles of the two operating recycling facilities.

The NJDEP developed a food waste toolkit for residents to help reduce food waste at home, work, and schools. The Department also partnered with organizations to help educate the public about food waste issues. Through the Solid Waste Recycling Enhancement Act (REA) Higher Education Research Grant Program, NJDEP has funded a range of food waste reduction projects:

- Six food waste recycling programs at institutions of higher education, including Princeton's S.C.R.A.P. lab, Rutgers University, Raritan Valley Community College, Bergen Community College, Kean University, and NJ Institute of Technology.
- The College of New Jersey's "Sustainable and Scalable Food Waste Solutions for Schools" research on best practices and development of new and upgraded Sustainable Jersey for Schools food waste actions.
- Rutgers' "New Jersey Leaves No Bite Behind" environmental education program in for food waste education in elementary schools.
- Stockton University's "New Jersey Food Asset Inventory and Mapping Project" to create an interactive food asset map with improved estimates of excess food availability. Stockton anticipates this will be completed in summer of 2024, at which point NJDEP will take ownership of the mapping tool and provide regular updates.

Figure 3.4.3. *Map of New Jersey's waste recycling facilities*



Food waste is also the hearing topic for the 2024 NJ Clean Air Council meeting which will be held on Tuesday, April 16, 2024. Members of the public can submit detailed written comments and register for the meeting here. Additionally, the Department continues to investigate pathways for reducing food waste and emissions from wasted food through processes like composting and anaerobic digestion.

Community Driven Solutions

On November 9th, 2023, NJDEP held a stakeholder meeting in collaboration with Rutgers University focused on reducing greenhouse gas emissions from food and organic waste. Comments received during the stakeholder meeting and through NJDEP's online comment form identified five priorities within the sector: developing a statewide education/awareness campaign; establishing community-scale compost systems; including surplus meal recovery in food recovery and distribution programs; clarifying and revising permitting requirements for composting; and creating better guidelines for farms to manage food waste composting efficiently.

> *"Anecdotally, we have found that even the most climate change knowledgeable folks are unaware of the impact that food waste has on the production of methane gas, and therefore climate change. To the [sic] end, we believe the first priority in limiting food waste is a state-wide awareness campaign. There is a lot to do in helping people understand the problem before we can point them to long-term solutions."*
>
> ***- NJ Resident***
>
> *"This rule change [regarding the requirement for enclosures at food waste composting facilities], along with the rapid implementation of a tiered permitting structure, will unlock the two key barriers to the development of composting infrastructure in our state."*
>
> ***- NJ Resident***

Stakeholders report that the current regulatory system is a tremendous barrier that will continue to hinder statewide efforts to recover food waste and to manage it in ways that are sustainable and result in measurable reductions of emissions. Stakeholders indicate that the current regulatory system does not incorporate any incentives for sustainable organic waste management practices, including small-scale composting and food waste recycling, such as reduced permit application fees and less onerous permit application requirements. The State should work towards developing a tiered regulatory system that favors sustainable organic waste management, food waste recycling and composting; a differential fee structure that requires minimal or no permit fees for small scale composting applicants; and a reform of the permit structure for research, development and demonstration projects to promote sustainable organic waste management project innovation. Stakeholders pointed to chronic lack of access to refrigerated trucks to facilitate collection and recovery of food waste by food recovery organizations, and an education gap around the connection between food waste and climate change and the associated benefits of food recovery and composting.

Additionally, stakeholders in the EJ Community Dialogue emphasized the need for food recovery and distribution efforts and pointed to the economic, community and food security value of local community gardens that can be leaders in composting and which were tremendously affected by the COVID-19 pandemic.

Priority Measure

10 Achieve a 50% reduction in food waste by 2030

New Jersey's commitment to reducing food waste can have a substantial impact on this sector's greenhouse gas emissions. Specifically, swift action to halve food waste by 2030 (or approximately 742,038 tons) will achieve cumulative reductions of up to 2.1 MMT CO_2e by 2030 and up to 16.0 MMT CO_2e by 2050. To initiate this rapid abatement NJDEP has identified 13 critical enabling actions, ranging from updating waste regulations to raising public awareness through educational efforts. This goal has been codified into law in the form of the Food Waste Reduction Act (P.L. 2017 Chapter 136).

Table 3.4.1.: *Priority Measure 10 Greenhouse Gas Reduction Estimates*

	Near Term by 2030	Long Term by 2050
	Cumulative Reduction	Cumulative Reduction
Estimated GHG reductions (MMT CO_2e, GWP_{100})	2.1	16.0

Develop regulations to implement Food Waste Recycling and Food Waste-to-Energy Law

New Jersey passed the Food Waste Recycling and Food Waste-to Energy Production Law in 2020. As of October 14, 2021, large food waste generators located within 25 road miles of an authorized food waste recycling facility are required to source separate and recycle their food waste. However, other provisions, such as reporting requirements, will be implemented in the near term. Of the estimated 2,500 establishments that may be required to comply with source separation and recycling requirements, only 82 have reached out to NJDEP since the onset of the law in October 2021, and only 23 were subject to the requirements. NJDEP's implementing rules, which will include reporting requirements, are expected to be promulgated in 2025. This law is a big step in diverting food waste from landfills and incinerators, and thus lowering New Jersey's methane emissions. Full implementation will enable NJDEP and partners in the New Jersey Department of Agriculture (NJDA), as well as food pantries, to connect sources of food waste with potential recipients and lead to further reductions in the amount of food wasted.

Develop guidance and toolkit to encourage local governments to implement food waste management programs

Decisions made at every stage of the food supply chain by farmers, commercial retailers, institutions, nonprofits, and consumers contribute to food waste. Widespread outreach, education and behavioral interventions are necessary to achieve and maintain the State's goal of decreasing food waste 50% by 2030 (NJDEP, 2023). Further, the State's Food Waste Reduction Plan identifies the pivotal role that local governments and institutions play in encouraging these behavior changes.

NJDEP has begun to develop a series of guidance materials and tools to help local governments implement food waste management programs. The Food Waste Reduction Toolkit helps individuals, governments, schools, and institutions reduce their food waste (NJDEP, 2024). NJDEP has prioritized REA grant funding to support research and pilot projects related to food waste reduction. The NJDEP also secured $491,314 in Solid Waste Infrastructure for Recycling (SWIFR) funds to build upon this work and encourage local government to establish food waste management programs. However, these projects are merely scratching the surface and ongoing, dedicated resources are necessary, especially for engaging local governments in this work.

Develop tools to connect food waste generators with potential recipients to support food recovery

NJDEP will continue to seek out ways to connect food waste generators with potential recipients to support food rescue and recovery. This is the practice of salvaging or collecting edible food that would otherwise go to waste and distributing it to emergency food programs. The U.S. Environmental Protection Agency (USEPA) has identified food rescue and recovery as a preferred way of reducing food waste (USEPA, 2023a; USEPA, 2023b). A web application or “app” that could connect donors and recipient organizations has been repeatedly identified by stakeholders as priority. New Jersey’s 1982 “Food Bank Good Samaritan Act” would help to facilitate these efforts, and food pantries and other partners have already expressed a need and willingness to help in this effort. REA grant funding has been awarded to Stockton University to develop a map of potential sources and recipients of food materials, the results of which will inform efforts to build out food waste reduction programs in the State.

Raise awareness about food waste reduction

Raising awareness is a critical first step in piquing public interest in the issue of food waste reduction. NJDEP has already taken steps to raise awareness about food waste and will continue to work with partner organizations, such as the New Jersey Office of the Food Security Advocate, local governments, and other agencies, to expand the reach of shared messaging as it relates to food waste prevention. Additional funding would help to support public outreach and educational campaigns, a more robust web presence, social media campaigns, and conferences with partners including local government, other State agencies, food pantries, and other nongovernmental organizations.

Encourage counties to update district solid waste management plans to include food waste reduction

The Solid Waste Management Act (N.J.S.A.13:1E-1et seq.) gave statutory authority and regulatory responsibility to New Jersey’s counties for planning the handling of all types of solid waste. Counties develop district solid waste management plans, which serve as a blueprint for how each county implements waste reduction, recycling, and disposal. Currently the district plans do not include or prioritize food waste reduction so via this action, NJDEP would encourage the counties to update district plans and develop solutions for the reduction and sustainable management of food waste.

Implement statewide waste composition audits

NJDEP plans to implement statewide recurring waste audits in order to track the amount of food waste in the municipal solid waste stream. Rutgers University was awarded REA grant funding to perform waste audits of three counties in 2021 to determine municipal solid waste composition. REA funds can be dedicated for future waste audits as soon as summer of 2025 to carry out more audits. Data from these audits can be used to track the cumulative progress of the enabling actions.

Implement a community-scale reusable food-ware system pilot

Since plastics are made primarily of petrochemicals, they represent a significant source of global warming emissions. In 2020, New Jersey passed legislation to decrease the use of single-use plastic bags, straws, and polystyrene foam products (P.L. 2020, c.117). Due to the overlap between single-use plastics and the food waste sector, targeting reuse programs at restaurants and other food-service settings is expected to reduce waste. Reusable food-ware pilot programs for restaurants and other food-service settings would target specific communities, and provide opportunities for residents, consumers, and businesses to collaborate on lowering the amount of single-use food-ware. For example, restaurants within a community would provide reusable containers and utensils that could be returned and washed at any participating business, cleaned, and kept in use within the community. Pilot programs would offer incentives such as discounts to consumers and assistance for businesses to purchase reusable food-ware. Building an ecosystem of reusable food-ware within a community (or across several municipalities) would quickly result in increased circularity within the local economy and decreased emissions from single-use plastic products and waste. This would also provide opportunities to tie into local and regional scale composting programs as outlined below.

Support food waste recovery systems such as anaerobic digesters and co-digestion of food waste at wastewater treatment facilities

While measures like source reduction and upcycling have been identified as preferred ways of reducing food waste by USEPA, anaerobic digestion is preferable to landfilling (USEPA, 2023a; USEPA, 2023b). At least 37 New Jersey wastewater facilities have anaerobic digesters, and 11 of these have energy recovery systems for generating heat or electricity (NJDEP SAB, 2023). Adding food waste products to wastewater facilities should increase biogas generation which can in turn conceivably reduce the amount of natural gas used as well as theoretically reduce truck traffic and associated emissions if biogas is used for operations like sludge de-watering. The State can support the construction of these systems through the State Revolving Fund but additional funds would expand opportunities to implement these projects. In most cases, feasibility studies need to be funded to be able to take advantage of the State Revolving Fund.

Encourage wastewater treatment facilities to reduce landfilling of residuals

Residuals are the organic residues removed from wastewater during the treatment process. Many wastewater treatment facilities dispose of residuals in landfills, ultimately contributing to methane emissions. Wastewater treatment plants can utilize recovered heat from wastewater to stabilize and dewater residuals. By reducing the moisture content of the residuals, less material needs to be landfilled and has the added benefit of lowering associated transportation emissions.

Implement local and regional composting programs

As the Recycling Rules and district solid waste management plans are revised, NJDEP will seek to support local governments in implementing local and regional composting programs. By seeking funding for composting, local governments can help keep food waste out of landfills. As stated above, revisions to the relevant laws and policies will allow for and encourage small-scale composting, thus turning organic material into a valuable product to create soil amendments, and to decrease landfill methane emissions. NJDEP, as part of funding provided by USEPA's SWIFR grants, will also develop guidance and a toolkit to help local governments identify available infrastructure, navigate applicable regulations, and encourage them to establish local food waste management programs.

Encourage schools to adopt the New Jersey School Food Waste Guidelines and institute a food waste reduction curriculum in K-12 schools

In 2019, New Jersey developed a set of food waste guidelines for schools (both K-12 and higher education), in conjunction with the Rutger Cooperative Extension, and with the input of a range of organizations within the education and food sectors. Leveraging this report and providing guidance and incentives for schools to follow this toolkit can help to reduce the amount of food that ends up in landfills, decreasing emissions. Sustainable Jersey has piloted portions of this toolkit with REA funds. A law (P.L. 2023, c.193) was recently signed authorizing schools to receive certain food waste from other schools, and exempting those schools from certain NJDEP permits, under certain conditions. If implemented with the small-scale composting revisions action above, this action would allow schools with educational community gardens that produce edible foods to accept food waste and utilize compost from other schools, increasing healthy food for students, educating students about food waste recycling, and supporting environmental justice efforts. New Jersey is also the first State in the nation to require climate change education in schools (NJDOE, 2020). Sustainable Jersey for Schools completed a Food Waste Reduction toolkit for schools, published in December 2023 and funded in part by NJDEP REA grant. Since publication, Sustainable Jersey has hosted events to raise awareness and answer questions about the toolkit. NJDEP has also collaborated with the Department of Education to produce school food waste guidelines that will be made publicly available in Spring 2024. Schools can report on their use of various measures within the toolkit and how much food they rescued or recycled as a result.

Address opportunities for food waste reduction at state-owned buildings

State government operations in New Jersey contribute to greenhouse gas emissions primarily through vehicle, building, and resource use activities. Following a 2023 Administrative Order (AO 2023-13), NJDEP has been pioneering a "Lead By Example" initiative in order to quantify, and ultimately lower, emissions from NJDEP's activities. Conducting waste audits are necessary steps to quantify and reduce emissions associated with food waste from State buildings. Data from follow up audits can inform waste reduction measures which could then be used as a template for public, private, and non-profit buildings.

Continue to pursue revisions to the Recycling Rules (N.J.A.C. 7:26A)

In conjunction with updates to other sections the Recycling Rules and implementation of the Food Waste Recycling and Food Waste-to-Energy Production Law (P.L. 2020 c.24), NJDEP is currently evaluating revisions to the exemption provisions to encourage additional types of small-scale food waste recycling activities without the requirement to obtain a recycling General Approval. These provisions address exempting small scale in-vessel, outdoor and indoor food waste composting and small-scale anaerobic digestion, food waste transfer activities, and feeding wasted food to feedstock.

NJDEP is also evaluating adjustments to the regulatory requirements and fee structure associated with full scale food waste recycling facilities to further promote the development of New Jersey's food waste recycling infrastructure. The existing regulations include both a requirement that most food waste recycling occur in a fully enclosed structure (indoors) and only one set of fees – an initial fee of $11,582, and two annual fees of $7,928 for registration and $9,130 for compliance and monitoring. Due to costs associated with the permitting fees and regulatory requirements, stakeholders have commented that a tiered fee system and strict adherence to Best Management Practices or Quality Control Plans would help to enable the development of more food waste recycling systems. Reducing fees and regulatory requirements may be especially beneficial for local, small-scale operations. For example, small operations up to a certain size that require less monitoring might be able to pay a lower fee, especially if all material is used on-site. California and Idaho both have tiered permitting systems. Additionally, several states, including California, Massachusetts, and Maryland allow for food waste composting to occur outdoors with no requirement for an enclosed system.

If additional facilities accepted food waste, truck traffic for transporting waste would be reduced. Potential amendments to the existing regulations for food waste recycling facilities may expand opportunities for food waste recycling, thus lowering landfill methane emissions from food waste.

Table 3.4.2. *Priority Measure 10 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Develop regulations to implement Food Waste Recycling and Food Waste-to-Energy Law	Ongoing until 2025	NJDEP
Develop guidance and toolkit to encourage local governments to implement food waste management programs	2025-Ongoing	NJDEP
Develop tools to connect food waste generators with potential recipients to support food recovery	2025-Ongoing	NJDEP, REA Recipients
Raise awareness about food waste reduction.	2024-Ongoing	NJDEP, NJ Food Security Advocate, NJDA
Encourage Counties to update district solid waste management plans to include food waste reduction	2025	NJDEP, Local Governments
Implement statewide waste composition audits	Annual Ongoing	NJDEP
Implement a community-scale reusable food-ware system pilot	2025-2030	Local Governments
Support food waste recovery systems such as anaerobic digesters and co-digestion of food waste at wastewater treatment facilities	2026-2030	NJDEP, Local Governments, Sewerage Authorities
Encourage wastewater treatment facilities to reduce landfilling of residuals	2024-Ongoing	NJDEP, Sewerage Authorities
Implement local and regional composting programs	Ongoing	Local Governments
Encourage schools to adopt the New Jersey School Food Waste Guidelines and institute a food waste reduction curriculum in K-12 schools	2024-Ongoing	NJDEP, Local Governments, School Boards
Address opportunities for food waste reduction at state-owned buildings	Ongoing	NJDEP
Continue to pursue revisions to the Recycling Rules (N.J.A.C. 7:26A)	2025	NJDEP

Table 3.4.3. Priority Measure 10 Implementation Approach

Plan to Leverage Funds

Secured Funding

The State has secured $491,314 in SWIFR funds to support food waste reduction toolkits and guidance for local governments. NJDEP will continue to dedicate REA funds for a range of food waste projects including recycling programs, best practices development, environmental education campaigns for schools, food asset mapping, and higher education cooperative extension projects.

The State Revolving Fund can be used for infrastructure improvement at wastewater treatment facilities, related to anerobic digestion.

Funding gaps + opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts more quickly and on a wider scale, achieving deeper decarbonization. Funding is also needed to sustain educational efforts, develop impactful interventions and to embed work in local governments and regional organizations.

Existing funding opportunities that could be leveraged to expand and continue these programs include:

- Local Foods, Local Places
- Solid Waste Infrastructure for Recycling (SWIFR) Grants
- USEPA Recycling, Education and Outreach Grant
- USDA Composting and Food Waste Reduction for local governments
- USDA Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Guaranteed Loans & Grants

New Jersey will continue to monitor federal funding opportunities to support all these efforts.

Geographic Scope

Statewide

Authority to Implement

NJDEP has existing authority to support policy and programming and take actions to encourage and support programs and projects for sustainable food waste management, including food waste reduction and recovery and composting, as well as for wastewater treatment facilities. NJDEP also has authority to promulgate rules pertaining to food waste and recycling. See, e.g., N.J.S.A. 13:1E-1 et seq., 13:1E-99.11 et seq., 13:1E-99.122 et seq., and 58:10A-1 et seq. NJDA and local governments similarly have authority to implement supporting and educational projects. County governments have existing authority to update district solid waste management plans, and local governments have planning authority to implement supporting projects.

Metrics for Tracking Progress

Food waste audits of New Jerey's waste stream will allow for the quantification of food-waste reductions, gauge the effectiveness of particular programs, and make adjustments as necessary.

Progress of rule revisions.

The number of food waste recycling facilities and their throughput of food waste will be a useful metric. This can include food waste utilized in anaerobic digestion, as well as the resulting reduction in natural gas use when substituted by biogas. Likewise, tracking the number of new composting sites and their composting generation will also provide useful metrics. Acceptance of food waste at wastewater treatment facilities will also be tracked.

If an application or other platform is created or adopted, this will allow for the tracking of food waste donors and recipients, and the amount of food diverted. It may also support the tracking of toolkit measures in use by towns and schools. Towns interested in reusable food-waste programs have proposed quantification schemes for tracking participation by the food services industry.

Works Cited

AO 2023-13. (2023). *Lead by Example Administrative Order*. New Jersey Department of Environmental Protection. Retrieved from https://dep.nj.gov/wp-content/uploads/dep-ao-2023-13-climate-mitigation-lead-by-example-initiative.pdf

International Panel on Climate Change, (IPCC) (2013) (AR5), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment report of the Intergovernmental Panel on Climate Change.* https://www.ipcc.ch/report/ar5/wg1/

NJDEP. (2020). *New Jersey's Global Warming Response Act 80x50 Report*. New Jersey Department of Environmental Protection. Retrieved from https://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdf

NJDEP. (2023). *Food Waste Reduction Plan*. New Jersey Department of Environmental Protection. Retrieved from https://www.nj.gov/dep/dshw/food-waste/food_waste_reduction_plan.pdf

NJDEP. (2024). *Food Waste Toolkit*. New Jersey Department of Environmental Protection. Retrieved from https://dep.nj.gov/sustainability/outreach-and-education/food-waste-toolkit/

NJDEP SAB. (2023). *Biofuels*. Ad Hoc Biofuels Work Group. Trenton, NJ. 55 pp. New Jersey Department of Environmental Protection Science Advisory Board. Retrieved from https://dep.nj.gov/wp-content/uploads/sab/sab-biofuels-final.pdf

NJDOE. (2020). *Climate Change Standards by Grade Band*. New Jersey Department of Education. Retrieved from https://www.nj.gov/education/climate/learning/gradeband/

P.L. 2017, c.316. (2017). *New Jersey Food Waste Reduction Act.* Retrieved from https://pub.njleg.gov/Bills/2016/AL17/136_.HTM

P.L. 2020 c.24. (2020). *Food Waste Recycling and Food Waste-to-Energy Production Law.* State of New Jersey. Retrieved from https://pub.njleg.gov/bills/2020/PL20/24_.HTM

P.L 2020 c.117. (2020). *New Jersey Single Use Plastics Act*. State of New Jersey. Retrieved from https://dep.nj.gov/wp-content/uploads/plastic-ban-law/docs/plastic-bag-law-c117.pdf

P.L. 2023 c.193. (2023). *New Jersey Schools Food Waste Act.* State of New Jersey. Retrieved fromhttps://pub.njleg.state.nj.us/Bills/2022/AL23/193_.PDF https://pub.njleg.state.nj.us/Bills/2022/AL23/193_.PDF

Rutgers EcoComplex. (2022). *Municipal Solid Waste Quantification and Characterization of Burlington, Mercer, & Passaic Counties*. August, 2022. New Jersey Department of Environmental Protection Retrieved from https://www.nj.gov/dep/dshw/recycling/WasteCharacteriazation.pdf

USEPA. (2023a). *Food Waste Management: Quantifying Methane Emissions from Landfill Food Waste*. United States Environmental Protection Agency. Retrieved from https://www.epa.gov/system/files/documents/2023-10/food-waste-landfill-methane-10-8-23-final_508-compliant.pdf

USEPA. (2023b). *Part 2: From Field to Bin: The Environmental Impacts of U.S. Food Waste Management Pathways*. United States Environmental Protection Agency. Retrieved from https://www.epa.gov/system/files/documents/2023-10/part2_wf-pathways_report_formatted_no-appendices_508-compliant.pdf

HALOGENATED GASES

Overview

High-Global Warming Potential (GWP)[1] hydrofluorocarbons (HFCs) and other halogenated gases used in refrigeration and chillers pose a disproportionate impact to climate change. Halogenated gases are considered a climate "super pollutant" because these greenhouse gases have hundreds to thousands of times the heat trapping power of carbon dioxide (CO_2). For example, R-404A, the most prevalent refrigerant in use in large refrigeration systems in New Jersey, has 3,920 times the GWP of CO_2 (USEPA, 2023). In 2021, high-GWP HFCs and other halogenated gases accounted for 5.2 million metric tons of carbon dioxide equivalent (MMT CO_2e) (GWP_{100}), or 5.3% of total net statewide emissions.

Halogenated gases are used in air conditioning, heat pumps, refrigeration, fire suppressants and blowing agents. Emissions may occur from leaks of the gases during the installation, servicing, and disposal of the equipment containing them. As of October 2023, under the New Jersey Department of Environmental Protection's (NJDEP or Department) Greenhouse Gas Monitoring and Reporting Rule (N.J.A.C. 7:27E), New Jersey had nearly 900 registered facilities with large refrigeration systems[2] using high-GWP refrigerants. The sum of the full charge amounts of just the top five most popular high-GWP refrigerants used by these facilities (for the first reporting period) equaled 3.9 MMT CO_2e.

Refrigeration system leaks comprised up to 37% of the State's estimated halogenated gas emissions in 2021, while leaks from stationary air conditioning, including heat pumps, comprised up to 36% (Figure 3.5.1). To achieve the State's ambitious greenhouse reduction goals, HFCs will have to be phased out of equipment across the State. However, equipment generally has a lifetime of 10 – 20 years, and costs pose a significant barrier to facilities' ability to upgrade to low-GWP refrigerants. Financial incentives can help facilities, particularly those in low-income and disadvantaged communities, to transition to low-and ultra-low GWP refrigerants on an expedited schedule. Furthermore, better handling, management and leak detection for existing systems can reduce emissions.

[1] Global Warming Potential is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given time relative to the emissions of 1 ton of CO_2. The larger the GWP, the more that a given greenhouse gas warms the Earth comparted to CO_2. The GWP referenced on this page is based on a 100-year scale (GWP100), https://dep.nj.gov/ghg/about/.

[2] Large facilities are defined as those that "use 50 pounds or more of high global warming potential (GWP) refrigerants in refrigeration systems," (N.J.A.C. 7:27E).

5.2 MMT CO_2e

2021 Emissions

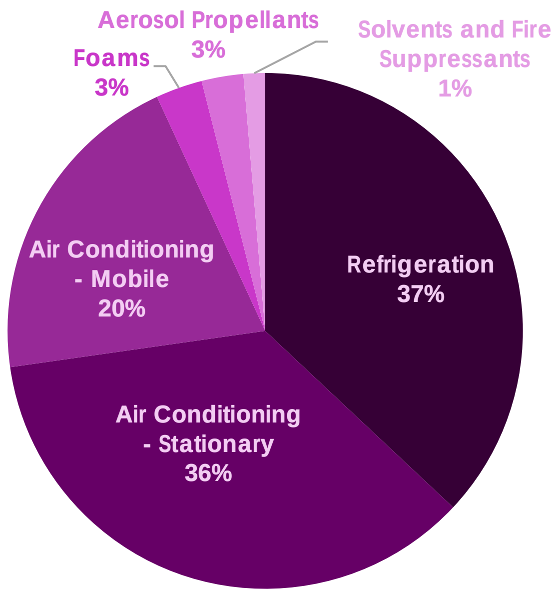
5.3%

of Total State Emissions

≤ 3.4 MMT CO_2e

2050 Emissions Goal [3]

Figure 3.5.1. *2021 NJ Greenhouse Gas Emissions from HFCs (Percent of 5.2 MMT CO_2e)*



Progress to Date

New Jersey is actively working towards tracking and reducing emissions from HFCs. In 2019, New Jersey passed an HFC law (P.L. 2019, c.507), which authorizes the Department to adopt rules and regulations to further regulate HFC use in the State and establishes a timeline to phase out the sale, lease, renting and installation of certain new equipment or products containing HFCs by 2024. In June of 2022, the NJDEP adopted a Greenhouse Gas Monitoring and Reporting Rule (N.J.A.C. 7:27E), which requires facilities with large refrigeration systems or chillers, using 50 lbs or more of a high-GWP refrigerant or blend, to register and report usage to the NJDEP annually. This data will be utilized to inform the State's GHG inventory and to assist in prioritizing systems for replacement.

In 2023, the New Jersey legislature also updated requirements for the State's building code (P.L. 2023, c.178) to allow for the use of ultra-low refrigerants, such as A2L refrigerants,[4] in building appliances and equipment in new and existing buildings. The introduction of A2L refrigerants will increase the ultra-low refrigerant options available for replacement and

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[3] In the 2020 GWRA 80x50 Report, the HFC 80x50 goal was assumed to be 5.1 MMT CO_2e, reflecting New Jersey's adoption of a refrigerant management program and SNAP regulations in 2030, with emissions being held constant until 2050. This goal has now been updated to reflect the United States' ratification of the Kigali Amendment to the Montreal Protocol (which phases down the production and consumption of HFCs by more than 80 percent by 2050) with emissions still being held constant from 2030 to 2050. See modelling on page 129 of the 2020 GWRA 80x50 report and UNEP, 2016.

[4] A2L refrigerants are a class of refrigerants with mild flammability and low toxicity. "A" refers to lower toxicity, while "2" refers to flammable/low burning (ASHRAE, 2022).

system retrofits across New Jersey. Once the New Jersey Department of Community Affairs adopts these building code amendments into the State Uniform Construction Code (N.J.A.C. 5:23), by December 31, 2026, according to P.L. 2023, c.178, then they would begin to enforce the new regulations.

In tandem to these regulatory efforts, in 2023, the New Jersey Economic Development Authority (NJEDA) committed $15 million in RGGI auction proceeds toward a program that replaces highly warming refrigerants during commercial building retrofits in order to reduce greenhouse gas emissions, improve indoor and outdoor air quality, and reduce energy costs. The NJ Cool Program will provide grants of $50,000 to $1 million to upgrade building heating and cooling systems to less polluting alternatives, as well as implement other energy efficiency measures or install on-site renewables in Newark, Edison, and Atlantic City (NJEDA, 2023). Approved on November 16, 2023, the pilot grant program is expected to start accepting applications in 2024. This is New Jersey’s first incentive program encouraging the adoption of low-GWP refrigerants.

Community Driven Solutions

This measure has been identified as a priority measure by both public stakeholders and New Jersey State agencies. The Department collected stakeholder feedback during development of its Greenhouse Gas Monitoring and Reporting Rule, and this feedback supports the need for incentives. This was further confirmed by a follow-up survey of two regulated companies with large refrigeration systems. Both companies supported monetary incentives for retrofits and replacements of refrigeration equipment and cited the need to train workers for safe disposal and recycling of refrigerant equipment.

“If the Department’s rules do not require advanced leak detection technology, the Department should include incentives for facilities that use advanced leak detection systems.”

– Industry Stakeholder

“In addition to the current rulemaking, the State should address current barriers to companies wanting to transition from hydrofluorocarbons (HFCs) to anhydrous ammonia,” [which is an ultra-low GWP refrigerant].

– Environmental Stakeholder

Priority Measure

11 Reduce halogenated gas emissions from refrigeration equipment

New Jersey has identified two key enabling actions that are vital to reducing halogenated gas emissions from large refrigeration systems and air-conditioning/cooling systems such as heat pumps. These include piloting a low-GWP incentive program for refrigeration systems and developing programs for private businesses, institutions, and local governments to switch their existing high-GWP refrigerant systems to low-GWP refrigerants. Specifically, phasing out high-GWP refrigerant systems could lead to a cumulative reduction of 0.7 MMT CO_2e by 2030, and 8.8 MMT CO2e by 2050.

Table 3.5.1: *Priority Measure 11 Greenhouse Gas Reduction Estimates*[5]

	Near Term by 2030	Long Term by 2050
	Cumulative Reduction	Cumulative Reduction
Estimated GHG reductions (MMT CO_2e, GWP_{100})	0.7	8.8

Pilot a low-GWP incentive program for refrigeration systems

Recognizing that cost and lack of familiarity with low-GWP refrigerants pose a challenge to their adoption, NJDEP proposes to seek funding to implement a low-GWP incentive program for refrigeration systems which may also reduce energy use since new refrigeration and chiller systems that use low-or ultra-low refrigerants can be more energy efficient than existing systems (CARB, 2017).

The new program could be structured similarly to the programs of states such as California, Delaware, Massachusetts, and New York (CARB, n.d., DNREC, n.d., MassDEP, 2024, and NYDEC, n.d.). New Jersey's program could include the following features:

- Provide funding to incentivize retrofits and replacement of high-GWP refrigerants with low-GWP refrigerants in commercial refrigeration and chiller equipment across the State, particularly in overburdened communities.
- Offset the costs related to the installation of new low- and ultra-low GWP systems.
- Offset the costs of purchasing and installing leak detection equipment and making repairs to existing systems.

Replace high-GWP refrigerant equipment

NJDEP will work to phase out high-GWP refrigerants at state and local facilities and promote similar voluntary actions across refrigerant equipment statewide. The Department will focus on encouraging business owners, local governments, and institutions to begin the work of phasing out these polluting synthetic gases starting with cataloging their equipment and moving toward actively planning and funding the replacement of high-GWP refrigerants and/or equipment with low-GWP refrigerants and/or equipment.

[5] This GHG reduction estimate includes benefits from only the first of the two enabling actions, "Pilot a low-GWP incentive program for refrigeration systems." As a result, the total benefits are likely to be higher than shown here.

Table 3.5.2. *Priority Measure 11 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Pilot a low-GWP incentive program for refrigeration systems	2026	NJDEP
Replace high-GWP refrigerant equipment	Ongoing	NJDEP, Local Governments

Table 3.5.3. *Priority Measure 11 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey, via NJEDA's NJCOOL program has committed $15 million in Regional Greenhouse Gas Initiative proceeds towards the decarbonization of commercial buildings. This funding will also cover the cost of replacing high GWP equipment.

Funding gaps + opportunities

All enabling actions described in this measure would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts quicker and on a wider scale, achieving deeper decarbonization. Existing funding opportunities that could be leveraged include:

- Environmental and Climate Justice Community Change Grant
- Energy Efficiency and Conservation Block Grant
- Green and Resilient Retrofit Program

New Jersey will continue to pursue federal funding opportunities as they become available to build upon these efforts.

Geographic Scope

Statewide

Authority to Implement

NJDEP has policy and planning authority to implement these voluntary incentive programs. Local governments also have authority to implement supporting projects.

Metrics for Tracking Progress

New Jersey will continue to track the largest users of refrigerants via its Greenhouse Gas Monitoring and Reporting Rule. Any incentive program the State offers will require reporting for 3 years following installation of new equipment.

Works Cited

ASHRAE and UNEP. (2022, November). *Fact Sheet: Update on New Refrigerants Designations and Safety Classifications.* American Society of Heating, Refrigerating and Air-Conditioning Engineers and the United Nations Environment Programme. Retrieved from https://www.ashrae.org/file%20library/technical%20resources/bookstore/factsheet_ashrae_english_november2022.pdf

CARB. (n.d.). *F-gas Reduction Incentive Program*. California Air Resource Board. Retrieved from https://ww2.arb.ca.gov/our-work/programs/FRIP

CARB. (2017). *Short-Lived Climate Pollutant Reduction Strategy*. California Air Resource Board. Retrieved from https://ww2.arb.ca.gov/sites/default/files/2020-07/final_SLCP_strategy.pdf

DNREC. (n.d.). *Cool Switch Low Impact Refrigerant Program.* Delaware Department of Natural Resources and Environmental Control. Retrieved from https://dnrec.delaware.gov/climate-coastal-energy/efficiency/cool-switch/

MassDEP. (2024). *Apply for a MassDEP Commercial Refrigeration Grant*. Massachusetts Department of Environmental Protection. Retrieved from https://www.mass.gov/how-to/apply-for-a-massdep-commercial-refrigeration-grant

N.J.A.C. 7:27E. Greenhouse Gas Monitoring and Reporting Rule. Retrieved from https://dep.nj.gov/wp-content/uploads/ghg/njac7-27e.pdf

NJEDA. (2023). *NJ Cool Program*. New Jersey Economic Development Authority. Retrieved from https://www.njeda.gov/njcool/

NYDEC. (n.d.). Climate Smart Communities Grants: Refrigerant Management at the Community Level. New York State Department of Environmental Conservation. Retrieved from https://extapps.dec.ny.gov/docs/administration_pdf/refrigfs.pdf

P.L. 2019, c.507. (2019). *An Act concerning the reduction of greenhouse gas emissions from hydrofluorocarbons and supplementing Title 26 and Title 52 of the Revised Statutes*. State of New Jersey. Retrieved from https://pub.njleg.gov/bills/2018/PL19/507_.HTM

P.L. 2023, c.178 (2023). *An Act concerning the use of certain refrigerants and amending P.L.2019, c.507.* State of New Jersey. Retrieved from https://pub.njleg.state.nj.us/Bills/2022/AL23/178_.PDF

UNEP. (2016). *The Kigali Amendment: The amendment to the Montreal Protocol agreed by the Twenty-Eighth Meeting of the Parties (Kigali, 10-15 October 2016).* United Nations Environment Programme, Ozone Secretariat. Retrieved from https://ozone.unep.org/treaties/montreal-protocol/amendments/kigali-amendment-2016-amendment-montreal-protocol-agreed

USEPA (2023, September 8). *Substitutes in Refrigerated Food Processing and Dispensing Equipment*. United States Environmental Protection Agency. Retrieved from https://www.epa.gov/snap/substitutes-refrigerated-food-processing-and-dispensing-equipment

NATURAL AND WORKING LANDS

Overview

New Jersey's natural and working lands are vital in helping the State achieve its greenhouse gas reduction goals. The term natural and working lands encompasses the State's forested lands, urban and community trees, wetlands, and agricultural lands. "Blue carbon" sinks such as salt marshes, tidal wetlands, seagrass beds, as well as "green carbon" sinks such as forested lands, play a critical role in the carbon cycle. These natural spaces serve as a stock of sequestered carbon and continually remove and store additional carbon from the atmosphere. Urban and community forests can also contribute to demand side energy reductions by providing shade and reducing the need for air conditioning, thus avoiding emissions (Nowak et al., 2017). While agricultural lands are often sources of atmospheric carbon, implementing management practices that improve soil health have the potential to convert them to carbon sinks.

Collectively, in 2021, the State's natural resources sequestered the equivalent of 8.1 million metric tons CO_2e (MMT CO_2e). This estimate is based on the quantity of carbon stored in both biomass and soil for forests, grasslands, agricultural lands, and wetlands. Sequestration of atmospheric carbon offset approximately 8% of the State's total gross greenhouse gas emissions. While terrestrial carbon sequestration regularly occurs in nature, there are human actions that can enhance or impede the carbon sequestration capacity of land and its ability to mitigate the effects of climate change. For example, changes in land use can contribute to changes in carbon storage, causing the release of greenhouse gases. To meet the State's 2050 greenhouse gas reduction goals, New Jersey needs to maintain, and if possible, increase, the amount of carbon sequestered in its natural sinks (NJDEP, 2020).

8.1 MMT CO_2e	8%	$\geq$ 8.1 MMT CO_2e
2021 Emissions Sequestered	**of Total State Emissions**	**2050 Sequestration Goal**

Progress to Date

Since the 2020 release of the Global Warming Response Act 80x50 recommendations report (2020 GWRA 80x50 Report), the New Jersey Department of Environmental Protection (NJDEP or Department) has further refined its strategic vision through three key planning documents:

- **State Forest Action Plan** (December 2020)
  Ten-year strategic plan focused on the State's forests more broadly, providing a holistic look at what is needed to protect and enhance its forest resources.

- **NJ Wetland Program Plan** (December 2022)
  Five-year strategic plan focused on the State's wetlands more broadly, providing a holistic look at what is needed to protect and enhance its wetland resources.

- **NJ Natural and Working Lands Strategy** (*Forthcoming* – 2024)
  Plan focused on carbon sequestration explicitly, establishing key targets by land type, and setting near and long-term goals.

The NJDEP has also continued to support local stewardship and effective management of trees, forest ecosystems and open space in urban communities through the Urban and Community Forestry Program which disburses grants for conducting tree inventories, developing community forest management plans, implementing priority tree maintenance, removing hazardous trees, hiring professional foresters, and planting street and shade trees. The Green Acres Program also invests in protecting open spaces, public parks, and outdoor recreational spaces. The Department launched the Natural Climate Solutions (NCS) Grant Program in May of 2022. This program funds on the ground implementation of 'shovel-ready' project types which include living shorelines, tidal wetland restoration, tidal flow reconnection, submerged aquatic vegetation restoration, urban forest canopy enhancement, and reforestation and afforestation projects (NJDEP, 2022). In April of 2023, the NJDEP in partnership with Sustainable Jersey launched its Trees for Schools grant program which funds the planting of trees on the campuses of New Jersey public schools, county colleges, and state colleges and universities. New Jersey will continue to implement programs and policies that maintain, protect, and enhance its natural carbon sinks as part of this PCAP.

NJDEP has also dedicated CPRG planning grant funding to develop a New Jersey specific methodology for estimating land-based sources and sinks of greenhouse gases. The new methodology and tools could apply land use and land cover data, Forest Inventory and Analysis data, cutting edge models (such as COMET Planner) and field study data to refine state-specific soil and biomass estimates. Tools developed could also explore scaling down the data to assist in project prioritization. The Department anticipates beginning this work later in 2024.

Community Driven Solutions

During the stakeholder engagement process, the NJDEP heard support from a broad array of stakeholders for urban forestry programs and other programs that fund planting trees, green streetscapes, shade trees, deer fencing installation and project design. Stakeholders also stated that preventing development of natural, undeveloped land or inactive farmland to preserve existing carbon sinks and prevent further greenhouse gas emissions should be a priority. While there was less emphasis on coastal and aquatic strategies, stakeholders did express the need to address transgression opportunities in tidal wetlands. NJDEP also heard from agricultural advocates that the Natural Resources Conservation Service Environmental Quality Incentives Program (EQIP) funding is inadequate to address the real costs of doing business in the State and more funding is needed to support carbon sequestering agroforestry practices to make them affordable for farmers to implement. Stakeholders mentioned the need to think holistically across sectors and couple carbon sequestration strategies with strategies that address emissions reductions from energy generation and buildings. Another major theme was the need to reduce barriers to accessing funding. Stakeholders stressed the need for grant program applications to be simplified so that more entities can access funding and implement projects.

"There will be a significant need for carbon sequestration through the next decades through the end of the 21st century if the globe is to stay within the 2-degree rise in global temperature [...] Given the need for carbon sequestration, the CPRG funds should be used to fund significant urban reforestation and plant trees in disadvantage communities and to fund urban forestry plans."

- NJ Resident

"We agree that planting trees in degraded forests or other open areas is positive, but it will not increase carbon storage significantly in the short run [...] We can't plant our way out of the climate crisis. The truth is that we need continuing help from our existing mature trees [...] We need them for the carbon they are presently sequestering and for the amount they can continue [sequestering] if we keep them healthy. To be sure planting is important, but keeping large trees standing and healthy takes on extra importance during this climate crisis."

- Coalition of NJ environmental advocacy groups

Priority Measure

12 Maintain, protect, and enhance New Jersey's natural carbon sinks

In order to reach the State's goal of reducing statewide greenhouse gas emissions 80% by 2050, it must maintain, and if possible increase, its natural carbon sinks. However, attaining sizable carbon sequestration benefits from newly planted younger trees, re-established and protected vegetation in salt marshes, restored flows in tidal wetlands, or improved agricultural practices requires immediate action. Carbon accrues on longer timescales in these systems and will take years to be realized. The NJDEP has identified six actions that will enable the State to achieve this priority measure.

Table 3.6.1. *Priority Measure 12 Greenhouse Gas Sequestration Estimates*

	Near Term by 2030	Long Term by 2050
	Cumulative Sequestration	Cumulative Sequestration
Estimated GHG sequestration ($MMT\ CO_2e$, GWP_{100})[1]	0.01	0.2

Plant 250,000 street trees/shade trees by 2030

Local governments, public entities and private landowners should plant a total of 250,000 street trees and shade trees by 2030. This action will be supported through the ongoing work of established programs like the Urban and Community Forestry (UCF) Program, the Natural Climate Solutions Grant Program, and the Trees for Schools Program. NJDEP has already committed funding for the planting of at least 7,274 street and shade trees for the primary purpose of sequestering carbon and has planted additional trees through other DEP programs like UCF and the Green Acres program. To be on track to achieve the 250,000 goal, the State and local partners will need to plant approximately 42,000 street and shade trees per year starting in 2024. NJDEP estimates that achieving this enabling action could help sequester an additional 5,194 metric tons of CO_2e by 2030 and a total of 70,860 metric tons of CO_2e by 2050. Beyond providing carbon benefits, these trees will act as nature's air conditioners, delivering a cooling effect through shade, reducing heat island effect in urban areas and lowering energy bills.

Identify and restore 800 degraded acres of forested lands by 2030

A total of 800 acres of degraded forest across the State should be restored by 2030 by continuing and expanding established programs like the Natural Climate Solutions Grant Program, which has already committed funding towards reforesting 45 acres, and the Forest Stewardship Program. To meet the goal of restoring 800 degraded acres, local governments, public entities, and private landowners will need to restore an average of about 126 acres of degraded forested lands by year over the next six years. NJDEP estimates that achieving this enabling action could result in sequestering approximately 60,198 additional metric tons of CO_2e by 2050.

Develop a native supply and production initiative

NJDA will create a nursery supply and production initiative under the existing Jersey Native Plants program. This initiative will ensure the availability of native plants by incentivizing plant nurseries in the State to start or expand the growing of native plants, label their native plants, and to establish native plant seed orchards. Ensuring a dependable and available

[1] Near term sequestration estimate only includes carbon that will be sequestered from street/shade tree planting actions due to data limitations.

supply of native plants and seeds within New Jersey reduces the emissions associated with shipping plants from out of State nurseries and provides the plants best suited to New Jersey's ecosystem. The Jersey Native Plants program is also seeking funding to develop a "Where to buy" website for homeowners and municipalities to locate local sellers and provide education on utilizing native plants in their home or municipality. By using more native plants to replace and reduce turf grass there will be a reduction in greenhouse gas emissions from gasoline powered lawn and garden equipment (GLGE) used to maintain turf grass. GLGE is a significant source of toxic exhaust and particulate matter (Banks, 2015). This action will enable the many ambitious restoration projects in the natural and working lands sector that will require a large number of native plants over the next thirty years. In order to implement the projects and reach the 80x50 goal, the supply of plants must be readily available and dependable.

Complete 1 tidal reconnection project per year (total of 6) by 2030

Removing tidal restrictions to reestablish saltwater flow into a tidal wetland provides greenhouse gas reduction benefits by decreasing the release of methane into the atmosphere (through increasing the salinity of the water) while creating additional marsh habitat that naturally sequesters carbon. Public and private land managers should work towards completing six projects restoring tidal flow to wetlands by 2030. In many cases, due to avoided methane emissions from impounded salt marsh, restoring tidal connections in salt marshes is expected to be dramatically more effective at cooling the climate per unit area than other wetland-based climate change interventions (Kroeger et al., 2017).

Install 7,800 linear feet of living shoreline per year by 2030

Living shorelines address the loss of vegetated shorelines, beaches, and habitat in the littoral zone by protecting, restoring, or enhancing these habitats. Living shoreline projects focus on protecting against the erosion of carbon rich soils in tidal wetlands and often add vegetation which sequesters more carbon. NJDEP's NCS program has already awarded funding to five projects that will install a total of 32,318 ft of living shorelines in New Jersey's coastal wetlands in the next 5 years. As a result, about 14,482 additional ft of living shorelines is needed before 2030, averaging about 2,414 linear feet each year. NJDEP estimates that achieving this enabling action could help sequester about 34,500 additional metric tons of CO_2e by 2050.

Relaunch conservation cost share program

Conservation Cost Share Program (CCSP) is an established, but unfunded program within the Department of Agriculture. Funding for on-farm conservation practices is in high demand and federal funding availability provides the opportunity to reinvigorate this existing program which has been defunct due to lack of funding since the early 2000s. When funded, the CCSP has offered conservation cost share grants that provide technical, educational, and financial assistance for eligible agricultural producers on unpreserved farms to develop best management practices for erosion and sediment control, animal waste management, and other resource concerns. Many of these management practices mitigate and sequester carbon. NJDA will seek funding to relaunch and expand the CCSP to provide supplemental funds to match federal NRCS-EQIP incentives. Under an EQIP contract, USDA pays up to 75% of the projected costs associated with planning, design, materials, equipment, installation, labor, management, maintenance, or training. Initial payments are made in the year in which the contract is signed, but most payments are made after the practices are completed. Unfortunately, with rising costs and set federal rates, for New Jersey producers these payments from EQIP alone fall very short. Funds from a CCSP will be able to be combined with NRCS EQIP rates to help make conservation practices affordable. The USDA's CarbOn Management & Emissions Planner Tool (COMET-Planner) provides estimates for the associated GHGs sequestered per acre per year for various agriculture management practices (USDA, 2024).

Table 3.6.2. *Priority Measure 12 Implementation Schedule*

Enabling Actions	Timeline	Implementing Agencies
Plant 250,000 street/shade trees by 2030	2024 - 2030	NJDEP, NJDA, Local Governments
Identify and restore 800 degraded acres of forested lands by 2030	2024 - 2030	NJDEP, Local Governments
Develop a nursery supply and production initiative	2025	NJDA
Complete 1 tidal reconnection project per year (total of 6) by 2030	2024 - 2030	NJDEP, Local Governments
Install 7,800 linear feet of living shoreline per year by 2030	2024 - 2030	NJDEP, Local Governments
Relaunch conservation cost share program	2025 - 2030	NJDA

Table 3.6.3. *Priority Measure 12 Implementation Approach*

Plan to Leverage Funds

Secured Funding

New Jersey will continue to support carbon sequestration efforts through its existing funding sources such as, regional greenhouse gas initiative proceeds, and via targeting federal grants. New Jersey has secured the following funds towards implementation of this measure and its enabling actions:

- NJDEP and several municipalities were awarded a USDA (IRA) - Urban and Community Forestry Grant to support urban tree planting projects.
- RGGI Proceeds offer grants to NJ local governments, school districts and other entities through the NCS and Trees for Schools programs.
- NJUCF Stewardship Grant
- Blue Acres program
- Section 319h grants

Funding Gaps and Opportunities

All enabling actions described in this chapter would benefit from additional funds. More funds would allow New Jersey to expand and implement these efforts on a wider scale, achieving deeper decarbonization. The State has applied to or intends on applying to several federal grants to support its ongoing carbon sequestration efforts under this measure, including, but not limited to the:

- USDA (IRA) Forest Service Urban and Community Forestry 2024 Cost Share Grant
- NRCS- Conservation Stewardship Program (CSP)
- NRCS- Environmental Quality Incentive Program (EQIP)
- USFW National Coastal Wetland Conservation Grants
- Federal NOAA grants

New Jersey will continue to pursue federal funding opportunities as they become available to build upon these efforts.

Geographic Scope

Statewide

Authority to Implement

NJDEP and NJDA have the authority to support policy and programming and take actions to maintain and increase natural carbon sinks in the State. See, e.g., N.J.S.A. 4:1C-11, 4:10-25.10, 13:1D-9, 13:1L-4. Local governments also have authority to implement supporting projects.

Metrics for Tracking Progress

Refinement of the State's natural and working land inventory that will occur with CPRG planning grant funds will inform the long-term tracking of actions implemented under this measure. In addition, NJDEP will continue tracking:

- the number of trees planted from each of its various grant programs that fund street and shade tree planting
- the number of acres of forest that projects plan to restore
- the grant project types awarded in the NCS program
- the number of feet of living shorelines the projects propose to install
- the number of vegetated salt marsh added

NCS Projects are required to submit adaptive monitoring data and as-built construction reports as part of the final report after the project is completed. NJDEP will use this data to track progress towards this measure's 2030 goals. The Department may also attempt to track the number of shade street and shade trees that local governments plant over this period by surveying municipalities, particularly communities that have a local tree advocacy or advisory group.

After the launch of the nursery supply and production initiative, the NJDA will seek to evaluate changes in the number of native tree species for sale at NJ nurseries. NJDA will track enrollment in CCSP and contracting with EQIP. NJDA will collect location, acres of implementation for each agriculture best management practice, soil tests, and run the COMET model.

Works Cited

Banks, J. L., & McConnell, R. (2015, April 16). *National emissions from lawn and garden equipment.* International Emissions Inventory Conference, San Diego, CA, United States. Retrieved from https://www3.epa.gov/ttn/chief/conference/ei21/session10/banks_pres.pdf

Kroeger, K. D., Crooks, S., Moseman-Valtierra, S., & Tang, J. (2017). *Restoring tides to reduce methane emissions in impounded wetlands: A new and potent Blue Carbon Climate Change Intervention*. Scientific Reports, 7(1). Retrieved from https://doi.org/10.1038/s41598-017-12138-4

NJDEP. (2020). *New Jersey's Global Warming Response Act 80x50 Report.* Retrieved from https://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdf

NJDEP. (2022). *Natural Climate Solutions Grant Program Request for Proposals*. Retrieved from https://dep.nj.gov/wp-content/uploads/climatechange/ncs-rfp.pdf.

Nowak, D. J., Appleton, N., Ellis, A., Greenfield, E. (2017). *Residential building energy conservation and avoided power plant emissions by urban and community trees in the United States*. Retrieved from https://doi.org/10.1016/j.ufug.2016.12.004. Date accessed January 2024.

USDA. (2024). COMET-Planner. U.S. Department of Agriculture's Natural Resources Conservation Service and Colorado State University. http://comet-planner.com/

LOW-INCOME AND DISADVANTAGED COMMUNITY (LIDAC) BENEFIT ANALYSIS

Environmental Justice in New Jersey

Environmental Justice (EJ) is central to the work of the New Jersey Department of Environmental Protection (NJDEP or Department). The Department defines environmental justice as the right of all residents of the State of New Jersey to live, work, learn, and recreate in a clean and healthy environment regardless of income, race, ethnicity, color, or national origin (NJDEP, 2023a). New Jersey recognizes this to mean the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, in the development, implementation, and enforcement of environmental laws, rules, and policies (NJDEP, 2023a). In September 2020, New Jersey's Environmental Justice Law, N.J.S.A. 13:1D-157, et seq., was approved.

Developing the LIDAC Analysis

The Department considered the federal Climate and Economic Justice Screening Tool (CEJST) and New Jersey's Environmental Justice Mapping, Assessment and Protection Tool (EJMAP) parameters and definitions to determine the scope of the Low Income and Disadvantaged Community (LIDAC) analysis.

New Jersey's Adversely Impacted Overburdened Communities

New Jersey's Environmental Justice Law (N.J.S.A. 13:1D-157) defines overburdened communities (OBCs) as census block groups (a subdivision of census tracts)[1] that meet the following criteria:

- At least 35 percent low-income households; or
- At least 40 percent of the residents identify as minority or as members of a State recognized tribal community; or
- At least 40 percent of the households have limited English proficiency.

Also, block groups with zero population and adjacent to an OBC are identified as adjacent block groups (ABGs). As defined in New Jersey's Environmental Justice Rules (N.J.A.C. 7:1C., 2023), a regulated "facility" seeking new permits or permit renewals in OBCs or ABGs must analyze their existing and potential contributions to environmental and public health stressors. "Environmental or public health stressors" may result from sources of environmental pollution. The rule lists 26 stressors categorized in eight separate groups (six of which come directly from the EJ law): (1) concentrated areas of air pollution; (2) mobile sources of air pollution; (3) contaminated sites; (4) transfer stations or other solid waste facilities, recycling facilities, scrap metal facilities; (5) point sources of water pollution; (6) stressors that may cause potential public health impacts (e.g., drinking water, potential lead exposure, and lack of tree canopy); (7) proximity stressors; and (8) social determinants of health (NJDEP, 2023b).

If a stressor value is already higher in the OBC than in that OBC's geographic point of comparison (GPC) or would be higher than the GPC due to the facility's contribution, then the stressor is considered an "adverse environmental and public health stressor."[2] If the sum of the adverse stressors, or the "combined stressor total" (CST), in the OBC is greater than the value of the GPC, then the OBC is referred to as an Adversely Impacted OBC (AIOBC).

The White House's CEJST Disadvantaged Communities

The White House's CEJST identifies a disadvantaged community (DAC) as one that meets one of 3 conditions: (1) it is located in a census tract that is at or above the 90th percentile for an environmental, climate, or other burden *and* it is above the 65th percentile for low income; (2) it includes federally recognized tribal land; or (3) it is located in a census tract that is surrounded by disadvantaged communities and itself is at or above the 50th percentile for low income (The White House, 2022). CEJST considers 8 categories of burdens (and 30 subcategories, not shown here): climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development (The White House, 2022).

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[1] For further information on how the U.S. Census Bureau defines census tracts, block groups and other geographic entities, please see [here.]

[2] The geographic point of comparison, GPC, is the lower of the 50th percentile of the State or relevant County non-OBC census block groups. Relevant ABGs are included in the GPC for an OBC. For further information, see NJDEP, 2023b.

Figure 4.1.1. Comparison of New Jersey AIOBCs and the White House DACs

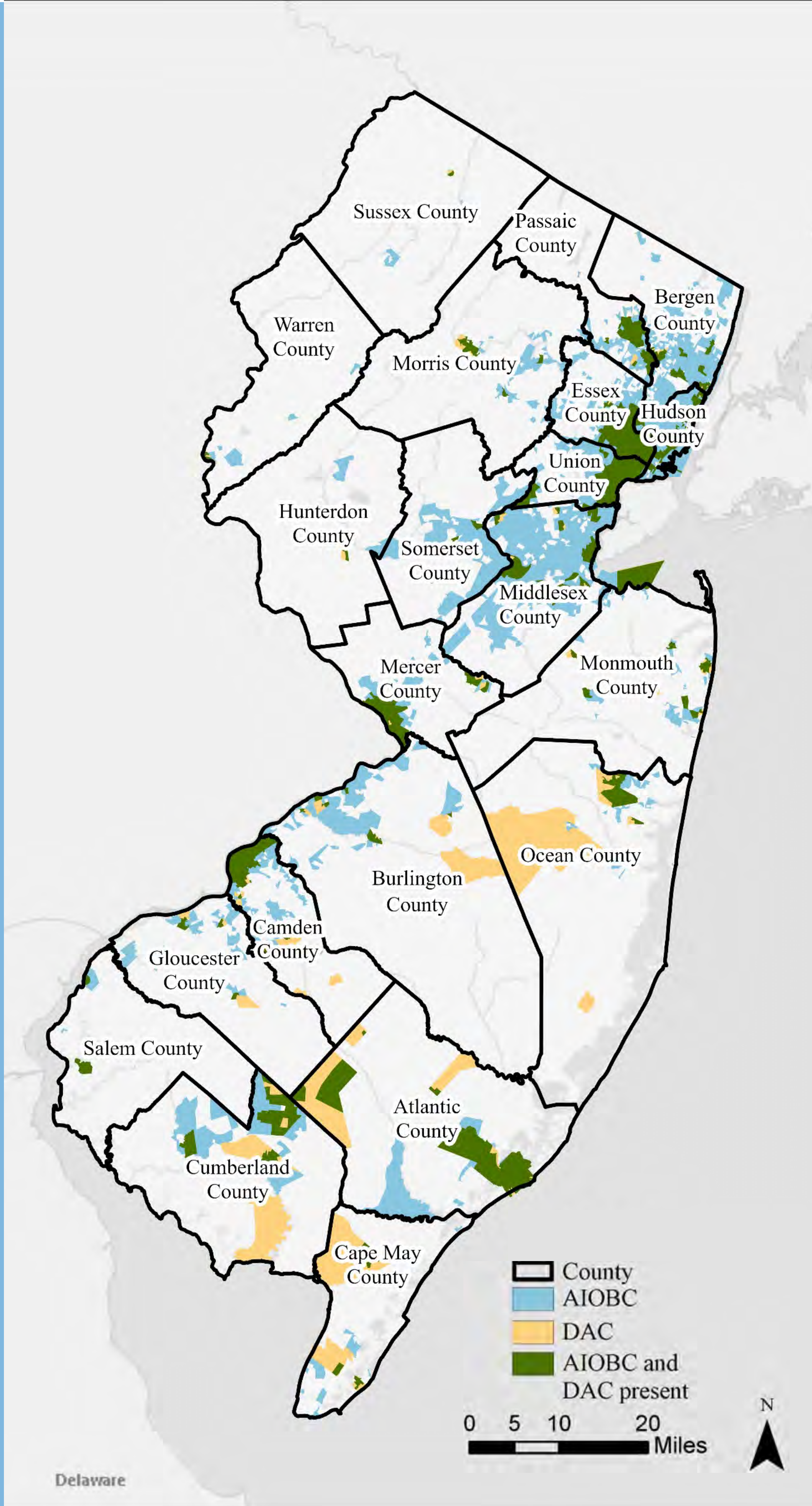
As described above, New Jersey's AIOBCs and the White House DACs have distinct definitions but areas of overlap:

- Both include thresholds for low income, tribal land within their jurisdiction (state vs. federal), adjacent communities, and environmental and health stressors (NJ) or burdens (The White House, 2022).
- New Jersey includes a threshold for the percentage of minority residents, includes air pollution stressors such as ground-level ozone, and is based on census block groups.
- The White House includes climate change burdens such as expected building loss rate, includes workforce development burdens such as linguistic isolation and education of less than a high school diploma, and is based on census tracts.

Figure 4.1.1 is a map showing a comparison of the AIOBCs (light blue shading), the DACs (orange shading), and areas of overlap between the two (dark green shading). The full LIDAC analysis, including a table of all the counties and municipalities and whether they contain AIOBCs and/or DACs, can be found in Appendix 7.4.

Overall, NJDEP has found the following:

- DACs and AIOBCs overlap, but AIOBCs cover a greater population and area than DACs
- Overall, AIOBCs capture most of the population that DACs capture
- AIOBCs and DACs have 14 similar stressors/criteria



Low Income and Disadvantaged Community (LIDAC) Benefits Analysis

The Department had Rutgers, the State University of New Jersey's Bloustein School of Planning and Public Policy conduct a LIDAC Benefits Analysis. This included identifying possible benefits, disbenefits, and considerations to avoid disbenefits to LIDACs, when implementing the PCAP. LIDACs, for the purposes of this analysis, are comparable to the White House's CEJST DACs. USEPA guidance indicated that LIDACs could be identified using the White House's CEJST on its own or in combination with USEPA's Environmental Justice Screening and Mapping Tool (EJScreen) (USEPA, 2023). New Jersey chose to use CEJST alone and then to compare those findings to New Jersey's AIOBCs.

Given the similarity in populations that are identified as LIDACs and AIOBCs, as described in the previous section, and the general nature of the priority measures (*i.e.,* none have site-specific plans at this time), the LIDAC Benefits Analysis focused on CEJST DACs. As a result, New Jersey AIOBCs that do not overlap with CEJST DACs were not directly included in this LIDAC analysis. They will, however, be included in NJDEP's prioritization of work to reduce greenhouse gas emissions, sequester greenhouse gases, and improve the health, quality of life, and economic well-being of communities, particularly those hardest impacted by climate change.

Applying these parameters concerning CEJST alone, 540 census tracts in New Jersey were found to be LIDACs. These LIDACs cover 399,596.7 acres of land (*i.e.,* 8.5% of all state land) with a population of 2,218,361 (24.0% of the state population). A total of 256 New Jersey municipalities contained census tracts classified as LIDACs. While 111 of the 256 municipalities with LIDACs are in urbanized areas (NJDEP, 2023b), by population, 87.9% of individuals living in LIDACs are in urban areas. Other LIDACs are located in the State's rural southwest, the Pinelands (a 1.1-million-acre area of central/southern New Jersey under special conservation regulations), and other scattered non-urban locations.

The search to identify benefits, disbenefits, and considerations to avoid disbenefits when implementing priority measures focused on the impact the PCAP priority measures would likely have on public health (including physical and mental health), access to smart transportation alternatives, housing quality, access to greenspaces, energy costs, workforce development opportunities, and the overall resilience of LIDACs to climate change. LIDACs are often disproportionately impacted by environmental stressors (*e.g.,* flood events, temperature extremes, pollution) because they are in areas that are more vulnerable to environmental stressors and have been subject to historic inequities that hinder their ability to adapt to these stressors.

The LIDAC analysis consisted of three primary tasks:

- GIS Analysis: CEJST and ArcGIS were used to identify LIDAC census groups and municipalities.
- Literature Review: The purpose was to identify likely outcomes and impacts of the priority measures to LIDACs, including both primary impacts and coincidental/indirect impacts. The literature review yielded 538 possible sources which were narrowed down to 129 based on a review of the abstracts of each resource for relevance.
- Stakeholder Engagement: Stakeholder feedback on the priority measures was collected in fall 2023 and has been integrated into this analysis. Stakeholders provided input through comments submitted online to the NJDEP CPRG website and in direct emails, five virtual CPRG Topical Stakeholder Sessions, two virtual stakeholder engagement sessions, one in-person stakeholder engagement session with residents and advocacy groups in a municipality with LIDACs (*i.e.,* Newark, New Jersey), and one-on-one survey phone calls with two industrial facilities.

The LIDAC analysis identifies three cross-cutting insights that are relevant to any of the PCAP priority measures and that may enhance the positive impact the enabling actions will have on LIDACs:

- Siting more energy-saving and pollution-reducing infrastructure in or near LIDAC communities would help to mitigate the disproportionate impacts to (and vulnerabilities of) these populations to greenhouse gas pollution and co-pollutants.
- Long-term planning will be essential to avoiding unintended disbenefits from implementing priority measures. Enabling actions may offer short-term benefits to LIDACs (*e.g.,* community beautification, energy savings, increased resilience) but renters/homeowners in LIDACs may be at risk of future displacement due to the increase in value of their home (green gentrification).

- Sustained funding, proactive outreach to communities, and proactive technical assistance are important for ensuring LIDACs know what CPRG programs they have access to and the benefits of engaging in the enabling actions.

Below is a summary of the priority measures' impact on LIDACs (Table 4.1.1). The table assigns each priority measure with a low, medium, and high ranking, corresponding to 1, 2, or 3 dots, respectively where "high" (3 dots) indicates a measure with a high positive impact on LIDACs. As mentioned above, if an emphasis was put on the siting of energy-saving and pollution reducing infrastructure in or near LIDAC communities, then that would increase the positive impact of those measures on LIDACs. Then, the impact ranking for each measure would be expected to become higher if the measure was implemented with this emphasis. Specifically, all "mediums" would become "highs," and one of the two "lows," the food system priority measure, would become "medium". For the full analysis, please refer to Appendix 7.4.

Table 4.1.1. *Priority Measure Impacts on LIDACs*

Rankings indicate the level of positive impact a priority measure may have on LIDACs. Each priority measure below is dependent on the implementation of enabling actions to achieve the measure.

LEGEND: ●●● High ●● Medium ● Low

	PRIORITY MEASURE	IMPACT RANK	IMPLICATIONS FOR LIDACS
	TRANSPORTATION		
01	Achieve 30% zero-emission medium- and heavy-duty vehicle sales by 2030 and 100% by 2050	●●●	Reducing the number of diesel-powered MHDV improves local air quality and provides many physical and mental health benefits in nearby areas. Maximize benefits by removing some diesel-powered trucks and buses from the road, rather than simply adding electric vehicles to existing diesel fleets.
02	Achieve light duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c. 362)	●●	Multi-unit dwellings (MUD) are common in LIDACs, and access to charging may be the most important infrastructure to convince consumers to purchase electric vehicles (EVs). This measure makes progress on the hurdles to LIDAC individuals owning EVs and promotes green transportation for individuals not owning EVs, but more can be focused on LIDACs.
03	Reduce emissions in and around ports	●●●	New Jersey ports are in and around LIDAC areas that are disproportionately exposed to emissions. Cleaner ports would cause human health and socioeconomic benefits.
04	Reduce vehicle miles travelled	●●	Enabling actions are an important precursor to green transportation for individuals but are not solely focused on LIDACs. Moreover, some enabling actions, e.g., expanding work from home programs, raise equity concerns due to a dearth of LIDAC individuals with jobs that could be performed from home.
	BUILDINGS		
05	Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties	●●	Enabling actions under this priority measure will provide physical and mental health benefits to LIDACs if enabling actions are completed in LIDAC households or municipal buildings that individuals from LIDACs utilize. Enabling actions, though, must be implemented safely to avoid disbenefits mentioned below.

06	Make at least 10% of all low-to-moderate income properties electrification-ready by the year 2030	Electrifying LIDAC homes could have a significant positive effect on the physical health and energy security of LIDAC if funding is focused on LIDAC homes and disbenefits are avoided. Potential disbenefits include "green gentrification" and putting renters/homeowners at risk of displacement due to the increase in value of their home. Additionally, if homes are sealed for efficiency purposes, it could reduce ventilation and increase indoor pollutants causing health problems for families.

ELECTRIC GENERATION

07	Achieve 12.2 GW of solar in-state by 2030	This is an important action for a green grid (which other priority measures rely on). Moreover, solar arrays could be implemented at the local LIDAC level.
08	Facilitate the integration of clean distributed energy resources into the grid	This is an important precursor to ensuring a green and resilient grid. For LIDACs, this priority measure ensures LIDACs could use solar arrays and adopt other energy efficiency measures to augment their energy supply costs.
09	Support development of 11.0 GW offshore wind by 2040	This is an important precursor action for other benefits to be realized but is not directed to LIDACs specifically.

FOOD WASTE

10	Achieve a 50% reduction in food waste by 2030	Enabling actions do not target LIDAC communities, but they could have an indirect benefit on LIDACs; for example, if food was diverted to food pantries via enhanced waste and composting programs.

HALOGENATED GASES

11	Reduce halogenated gas emissions from refrigeration equipment	The impacts to LIDACs are low: energy savings from switching from high-GWP to low-GWP refrigerants would benefit the owners of industrial facilities, not LIDACs, and there would be a risk of exposing refrigerant workers (while low in numbers) to toxic chemicals during the transition process.

NATURAL AND WORKING LANDS

12	Maintain, protect and enhance New Jersey's natural carbon sinks	Planting trees and restoring natural landscapes can provide physical and mental health benefits and foster resilience of LIDACs to flood events. Still, these efforts may trigger property value increases that could escalate residential displacement of lower-income residents.

Works Cited

N.J.A.C. 7:1C. (2023). *Environmental Justice Rules*. New Jersey Department of Environmental Protection. Retrieved from https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_1c.pdf

NJDEP. (2023a). *Environmental Justice Rules: Frequently Asked Questions, N.J.A.C. 7:1C.* New Jersey Department of Environmental Protection. Retrieved from https://dep.nj.gov/wp-content/uploads/ej/docs/ej-rule-frequently-asked-questions.pdf

NJDEP. (2023b). *Guidance Document for Environmental Justice: New Rule N.J.A.C. 7:1C and Online Mapping Tool; Environmental Justice Mapping, Assessment, and Protection (EJMAP): Technical Guidance.* New Jersey Department of Environmental Protection. Retrieved from https://dep.nj.gov/wp-content/uploads/ej/docs/njdep-ej-technical-guide.pdf

NJDEP. (2024). *What are Overburdened Communities (OBC)?* New Jersey Department of Environmental Protection. Retrieved from https://dep.nj.gov/ej/communities/

N.J.S.A. 13:1D-157. (2020). *An Act concerning the disproportionate environmental and public health impacts of pollution on overburdened communities, and supplementing Title 13 of the Revised Statutes*. State of New Jersey. Retrieved from https://dep.nj.gov/wp-content/uploads/ej/docs/ej-law.pdf

USEPA. (2023). *Climate Pollution Reduction Grants Program: Technical Reference Document for States, Municipalities and Air Pollution Control Agencies Benefits Analyses: Low-Income and Disadvantaged Communities.* United States Environmental Protection Agency. Retrieved from https://www.epa.gov/system/files/documents/2023-05/LIDAC%20Technical%20Guidance%20-%20Final_2.pdf

The White House. (2022). *Climate and Economic Justice Screening Tool*: *Methodology.* White House Council on Environmental Quality. Retrieved from https://screeningtool.geoplatform.gov/en/methodology#3/33.47/-97.5

WORKFORCE PLANNING ANALYSIS

Overview

NJDEP employed Rutgers, the State University of New Jersey, via their John J. Heldrich Center for Workforce Development, to assist with preparing this optional workforce planning analysis. New Jersey decided to carry out this optional analysis because having a strong workforce is essential to implementing the priority measures in this PCAP and to New Jersey's overall greenhouse gas reduction goals (80x50 and 50x30)[1]. A workforce that is insufficiently trained in the specialized areas of the sector-specific priority measures, too small in numbers to accomplish the work, unaware or unable to access the relevant training and education, or in other ways not connected to the new and growing occupational fields will prevent the priority measures from being fully implemented.

Four different analyses were performed to understand the workforce and labor market implications of New Jersey's PCAP:

1. Modeled anticipated labor changes;
2. Mapped out the State's strengths, weaknesses, and opportunities;
3. Analyzed barriers that underserved communities face in accessing related job opportunities and suggested strategies to overcoming those barriers; and
4. Identified opportunities for sector-specific workforce strategies.

For the full workforce planning analysis report, please see Appendix 7.5.

Analysis 1: Modeling Anticipated Labor Changes

The analysis modeled the estimated workforce impacts as job-years per $1 million of spending on each priority measure. This enables refinement of the magnitudes of workforce impacts once project expenditure amounts are solidified. A job-year is equivalent to one job lasting one year. It expresses the employment impacts of investments (i.e., one-time project expenditures). As a result, job-year is distinct from a permanent job that is supported by recurring operating expenditures. For each priority measure, the report includes the calculated estimated number of direct, indirect, and induced job-years likely to be supported by the initial expenditures. The analysis includes a breakdown of the supported job-years by industry and occupation. Priority measure types with the same distribution of expenditures across industries are grouped together in the analysis.

The report finds greater job-years impacts in sectors such as Natural and Working Lands, and Electric Generation, based on the fact that these are generally labor-intensive service sectors rather than capital-intensive sectors. The Natural and Working Lands findings include jobs and services such as landscaping; greenhouse, nursery, and floriculture production; and the production, acquisition, and planting of trees in urban, natural, and agricultural environments. Electric Generation includes jobs in the architectural, engineering, and related services sector.

This workforce planning analysis found that $1 million of spending on a New Jersey PCAP priority measure resulted in 11.1 to 19.6 job-years in employment impacts, or 11.1 to 19.6 jobs lasting one year.

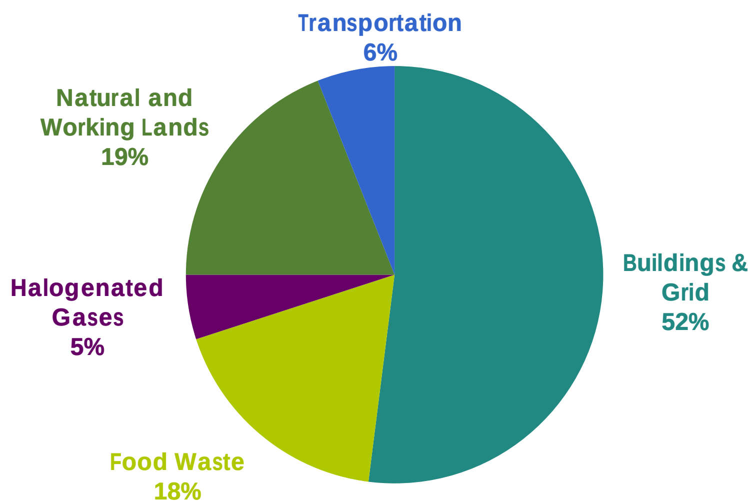
Analysis 2: Examination of the State's Workforce Capacity in PCAP Sectors

The Workforce Planning Analysis report includes an inventory of education and training programs to assess the state's workforce capacity for each priority sector identified in New Jersey's PCAP. The inventory provides information on career cluster, occupation, program name, program type, award level, and county for every education and training program by priority area. Education and training providers included in the inventory are universities/colleges, community colleges, vocational-technical schools, high schools, employers, associations, nonprofits, community-based organizations (CBOs), townships, and unions.

[1] 80x50 refers to a legislative mandate to reduce statewide greenhouse gas emissions 80% below 2006 levels by the year 2050; 50x30 refers to an executive order, by the Governor, to reduce greenhouse gas emissions 50% below 2006 levels by 2030. For further information, please see https://dep.nj.gov/ghg/ghg-emissions-goals/.

The report identifies approximately 6,217 education and training programs in New Jersey for occupations associated with the PCAP's 6 priority sectors. This includes programs that offer apprenticeship, certificate, degree, grant, internship, training, and/or youth opportunities in New Jersey. As shown in Figure 5.1.1, most education and training programs are concentrated in Buildings and Electric Generation (52%), Natural and Working Lands (19%), and Food Waste (18%). Likewise, the report identifies more occupations for Buildings and Electric Generation, particularly because of the extent of industries involved, as compared to the other priority sectors.

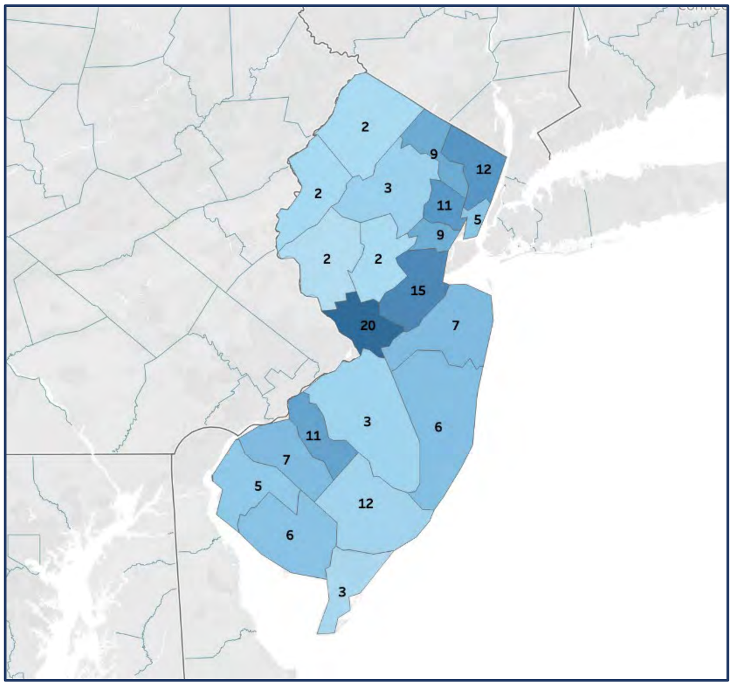
Figure 5.1.1: *Percentage of NJ Education & Training Programs by PCAP Sector*



Mapping of education and training providers pertaining to the 6 priority sectors as a whole, shows that most are concentrated in Mercer County (20), Middlesex County (15), Bergen County (12), and Essex County (11) counties. The report notes, though, that this may not include all providers in New Jersey due to filtering and region-based unions.

Counties with more education and training providers have more education and training programs related to the 6 priority areas, except in Hudson County. Essex County has 888 education and training programs. Hudson County has 672 education and training programs, followed by Mercer County (633) and Middlesex County (617). As there are often fewer providers in rural areas, the report finds that Hunterdon County, Cape May County, and Salem County have the fewest education and training programs (Figure 5.1.2).

Figure 5.1.2. *Map of Number of Education and Training Providers Related to Priority Areas in New Jersey*



Note: This figure may not reflect *all* education and training providers related to the six priority areas due to filtering (e.g., county, career cluster, and program name). Unions are excluded from this data visualization because local chapters tend to operate out of multiple counties and/or regions.

The report uses Overburdened Community (OBC) data from NJDEP to assess the number of education and training programs in counties with higher frequencies of limited English proficiency, low income, and/or minority populations. Counties with higher frequencies of OBC populations are Middlesex, Union, Essex, Hudson, and Bergen. These counties tend to have more education and training providers and, therefore, programs and these are the most densely populated counties. Rural counties with high limited English, low income, and/or minority populations, have fewer opportunities through existing education and training providers. These communities need targeted workforce development to ensure equitable access to education and training programs for priority sectors.

The report also examines New Jersey's workforce strengths, weaknesses, and opportunities as they relate to the priority measures for the PCAP by analyzing the current education and training scope in the State. Areas of strength and areas for improvement are highlighted, ensuring that gaps in the education and training infrastructure can proactively be addressed to maximize success of the priority measures outlined in the PCAP.

1. **Strengths**
   a) Substantial buy-in exists for workforce development infrastructure related to Buildings, Electric Generation and Transportation at the state and local level.
   b) Workforce development infrastructure appears to be stronger for Buildings and Electric Generation than other priority areas.

2. **Weaknesses**
   a) Workforce development infrastructure appears to be less developed for Food Waste, Halogenated Gases, and Natural and Working Lands.

3. **Opportunities**
   a) Create and/or expand incentive programs for technologies that reduce GHG emissions (e.g., heat pumps, leakage reduction technology, food waste recycling, etc.) to drive demand for workers and education and training programs that provide them with the skills and necessary licenses and/or credentials.
   b) Generate greater awareness about job opportunities within Buildings and Electric Generation, Food Waste, Halogenated Gases, Natural and Working Lands, and Transportation.
   c) Support and expand targeted investment in rural areas with greater limited English, low income, or minority populations.

Analysis 3: Barrier Identification

The report identifies five barriers for OBCs in accessing job opportunities. This is not an exhaustive list; these as the most critical barriers from a workforce development lens. Below are a series of strategies that New Jersey state and local agencies can deploy to address the identified barriers.

Table 5.1.1. *Barriers to Accessing Job Opportunities*

Barrier	Strategies
1. A lack of job quality and diversity standards	Embed job quality and diversity standards in procurement processes at the State and local level
2. A lack of an adequate public transit system to get to better quality, healthier jobs	Conduct a needs assessment focused on transportation in OBCs.
3. A lack of community input and prioritization of community needs	Work with community and faith-based organizations to conduct community round-table awareness sessions on clean energy and opportunities that may be present and/or forthcoming for these populations.
4. Barriers to education and employment, specifically, job availability and pay; qualifications, education, and training; transportation; childcare and family issues; crime and substance abuse; housing instability; disabilities and mental and physical health; and public assistance programs	Provide dedicated funding for supportive services to reduce the barriers experienced by historically underserved populations in OBCs.
5. OBCs tend to have poorer education systems, lower career awareness about jobs and job training, and inadequate investment in high quality career and vocational-technical education	Make a significant investment of funds to address the employment barriers that are a result of a historic lack of investment in workforce development infrastructure in OBCs.

Analysis 4: Workforce Strategies

The report identifies eight cross-cutting sector workforce strategies that could be deployed for any of the priority measures to bring greater awareness to sector employment and stronger alignment with the workforce, employers, and sector investments. Moreover, the report offers supportive evidence and/or examples of each sector strategy to demonstrate the feasibility and impacts of each potential sector strategy. The report includes an evaluation of the following workforce strategies taking into account the needs of OBCs.

1. **Develop the Talent Pipeline** via secondary and postsecondary institutions and vocational training opportunities
2. **Upskill the Existing Workforce** via cross-training, customizing training priorities by sector, and connecting with existing training programs and wraparound services
3. **Conduct Career Awareness Campaigns** expanding STEM-related curricula, secondary and post-secondary career exploration, public schools, apprenticeships, and career mapping
4. **Offer Employer Engagement** via sector panels with employers and professional associations, greater union engagement and labor agreements, and related grants
5. **Connect Employers to Education** via creating specialized industry partnerships at the state level, encouraging employer-driven curriculums, connecting industry to secondary schools, etc.
6. **Foster Locally Driven Career Awareness and Engagement Strategies** via local and regional hiring initiatives, developing sector-specific workforce development, highlighting local resources, establishing One-Stop Career Center connection sites, and implementing school staff development
7. **Encourage Engagement with State and Local Workforce Development Systems** via developing on-the-job training opportunities and apprenticeships, incentivizing training/outreach in OBCs, etc.
8. **Offer High Touch & Wraparound Services** via engaging with Community Based Organization as trusted entities within OBCs, and conducting a community barriers analysis re: childcare, drug rehabilitation, transportation, etc.

Examples of sector-specific workforce strategies

1. **Transportation:** Create and/or expand specialized workforce training programs for electric vehicles.
2. **Buildings:** Support and strengthen workforce development infrastructure for electrifying residential and commercial buildings.
3. **Electric Generation:** Invest in the creation of solar design and installation training programs that provide a clear training-to-career pipeline in New Jersey.
4. **Food waste:** Develop an awareness and education campaign to highlight the development of food waste processing facilities, better food waste practices, and energy recovery efforts from wastewater treatment facilities.
5. **Halogenated gases:** Incentivize low-global warming potential (GWP) refrigerant products to drive demand and transition workforce training programs to support new technologies.
6. **Natural and Working Lands:** Develop a federally registered apprenticeship program.

NEXT STEPS

This Priority Climate Action Plan (PCAP) outlines many of the key actions that state and local government can take between now and 2030 to achieve the ambitious interim goal of halving statewide greenhouse gas emissions by 2030 with a particular focus on actions that can benefit the State's most vulnerable populations. The PCAP builds on the New Jersey 2020 Global Warming Response Act 80x50 report and the 2019 Energy Master Plan. A priority greenhouse gas emissions reduction measure's inclusion in this PCAP is a prerequisite for state agencies and local governments to compete for Climate Pollution Reduction Grant Program (CPRG) Phase 2 implementation grant funding. This plan is intended to act as a resource and guide for applicants seeking these implementation grants. Accordingly, the measures included in this PCAP are designed to be broad enough to support a variety of funding applications.

CPRG Phase 2: Implementation Grants

The second phase of the United States Environmental Protection Agency's (USEPA) CPRG makes $4.3 billion in competitive funding available to states, metropolitan statistical areas (MSAs) and municipalities nationwide to carry out the greenhouse gas reduction measures proposed in the PCAPs. Implementation grant "eligible entities" include New Jersey state agencies, municipalities, counties, and MSAs. They can apply for implementation funding directly to the USEPA to implement projects or programs that align with one or more of the priority measures included in this PCAP. NJDEP suggests citing in the implementation grant application the specific page(s) of this plan that contains the measure(s) with which the grant application proposal aligns. Applicants should follow the guidance set out by the USEPA in its CPRG: Implementation Grants General Competition Notice of Funding Opportunity (NOFO). The deadline to apply is April 1, 2024.

Comprehensive Climate Action Plan (CCAP)

The next CPRG deliverable that New Jersey will submit to USEPA is the Comprehensive Climate Action Plan (CCAP) in mid-2025. This plan will expand upon the PCAP, focusing on all sectors and significant sources and sinks of greenhouse gases in the State. NJDEP anticipates approaching the CCAP as an update of the 2020 GWRA 80x50 report.

Status Report

The last CPRG deliverable is a status update report, which is due to USEPA in 2027. In this report NJDEP will analyze and report on its progress implementing measures in the PCAP and CCAP, outline intended next steps, and document additional financial or staffing needs.

APPENDICES

APPENDIX 7.1

FULL LIST OF MEASURES AND ENABLING ACTIONS

Transportation

PRIORITY MEASURE 1: **Achieve 30% zero-emission medium- and heavy-duty vehicle sales by 2030 and 100% by 2050**		
	Enabling Actions	**Implementing Agency**
1	Implement the Advanced Clean Truck Rule	NJDEP
2.	Implement technical assistance program(s) to help fleet owners transition to electric vehicles and provide workforce training programs	NJDEP, NJEDA and Labor
3.	Purchase zero emission buses and modify and build depots in the NJ TRANSIT system to achieve Electric Vehicle Law goals	NJ TRANSIT
4.	Electrify NJ TRANSIT Access Link Paratransit, local service, and rail	NJ TRANSIT
5.	Incentivize replacement of diesel medium- and heavy-duty vehicles, including school buses, with battery electric vehicles or green hydrogen fuel cell electric vehicles	NJDEP, NJBPU, NJEDA, Local Governments
6.	Expand medium- and heavy-duty charging infrastructure	NJDEP, NJBPU

PRIORITY MEASURE 2: **Achieve light duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c. 362)**		
	Enabling Actions	**Implementing Agency**
1.	Implement Advanced Clean Cars II Rule	NJDEP
2.	Electrify State and local government fleets to achieve Electric Vehicle Law goals	All State Agencies
3.	Ensure low- and moderate-income residents have access to clean transportation by expanding eMobility programs that provide electric ride sharing, ride hailing and similar services	NJDEP, Local Governments
4.	Expand publicly available electric vehicle charging infrastructure with specific focus on charging for multi-unit dwellings	NJDEP, NJBPU, Local Governments

PRIORITY MEASURE 3: **Reduce emissions in and around ports**		
	Enabling Actions	**Implementing Agency**
1.	Electrify drayage trucks	NJDEP, Port authority/corporation
2.	Electrify cargo handling equipment	NJDEP, Port authority/corporation
3.	Electrify marine vessels and ferries	NJDEP, Port authority/corporation

PRIORITY MEASURE 4: Reduce vehicle miles travelled		
	Enabling Actions	**Implementing Agency**
1.	Expand active transportation infrastructure and complete streets	Metropolitan Planning Organizations, NJDOT, Local Governments
2.	Increase NJ Transit ridership and expand development of transit villages	NJ TRANSIT, NJDOT, Local Governments
3.	Expand work-from-home and ridesharing programs	NJDEP, Local Governments

Buildings

PRIORITY MEASURE 5: Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties		
	Enabling Actions	**Implementing Agency**
1.	Launch a digital "one stop shop" summarizing federal and state energy rebate funding	NJBPU
2.	Offer training grants for residential energy contractors	NJBPU
3.	Work with utilities to launch building decarbonization start-up programs	NJBPU, Energy Utilities
4.	Develop a renewable heating and cooling web calculator tool for New Jersey	NJBPU
5.	Develop a ground source heat pump siting tool for New Jersey Stakeholders	NJDEP, NJBPU
6.	Adopt the 2024 International Energy Conservation Code for residential buildings and ASHRAE 90.1-2022 for commercial buildings	NJDCA
7.	Explore the adoption of a stretch code to maximize energy efficiency in new construction	NJDCA, NJBPU, Local Governments
8.	Implement the appliance standards law and develop the appliance standards recommendations report	NJDEP
9.	Pilot community/campus/neighborhood scale district geothermal system decarbonization demonstration projects	NJBPU, NJDEP
10.	Explore the adoption of a clean heat standard	NJBPU
11.	Continue energy benchmarking efforts and explore building performance standards	NJBPU
12.	Develop building decarbonization resources for local government lead by example efforts	NJDEP
13.	Pilot building decarbonization efforts at State facilities and at local government facilities	NJBPU, Treasury, Local Governments

14.	Seek grants and funding to pilot beneficial reuse of wastewater for building electrification at wastewater treatment facilities	Local Governments, Sewerage Authorities
15.	Seek grants and funding to implement NJBPU's Higher Education Decarbonization Pilot Program	NJBPU, Local Governments

PRIORITY MEASURE 6: Make at least 10% of all low-to-moderate income properties electrification-ready by the year 2030		
	Enabling Actions	**Implementing Agency**
1.	Expand NJBPU's Whole House Pilot Program to enable energy efficiency for low- and moderate-income residential buildings	NJBPU
2.	Expand electrification and efficiency programs for low- and moderate-income residential buildings	NJBPU
3.	Expand NJBPU's multifamily pilot program which offers energy audits and installation of energy efficiency measures at multifamily properties	NJBPU

Electric Generation

PRIORITY MEASURE 7: Achieve 12.2 GW of solar in-state by 2030		
	Enabling Actions	**Implementing Agency**
1.	Implement Competitive Solar Incentive, Administratively Determined Incentive, and Dual Use Solar Programs	NJBPU
2.	Expand the Community Solar Energy Program	NJBPU
3.	Site solar infrastructure at State and local government facilities	Treasury, NJ TRANSIT, Local Governments
4.	Release revised Solar Siting Analysis	NJDEP

PRIORITY MEASURE 8: Facilitate the integration of clean distributed energy resources into the grid		
	Enabling Actions	**Implementing Agency**
1.	Improve the hosting capacity of the New Jersey electric distribution system through grid modernization efforts	NJBPU
2.	Support implementation of FERC 2222 to help support distributed energy resources	NJBPU
3.	Support development of 2.0 GW of energy storage by 2030 through the creation of an Energy Storage Incentive Program	NJBPU
4.	Pilot grid supportive technologies such as vehicle-to-everything "V2X" and microgrids systems	NJDEP, State Agencies, Local Governments

5.	Implement storage component of Competitive Solar Incentive program	NJBPU
6.	Support Resilient Local Governments	NJBPU, NJDEP, Local Governments

PRIORITY MEASURE 9: Support the development of 11.0 GW of offshore wind by 2040		
	Enabling Actions	**Implementing Agency**
1.	Launch and award New Jersey's fourth offshore wind solicitation	NJBPU
2.	Develop and implement State Agreement Approach 2.0 for the goal of 11 GW of wind energy by 2040	NJBPU
3	Support construction of the New Jersey wind port	NJEDA

Food Waste

PRIORITY MEASURE 10: Achieve a 50% reduction in food waste by 2030		
	Enabling Actions	**Implementing Agency**
1.	Develop regulations to implement Food Waste Recycling and Food Waste-to-Energy Law	NJDEP
2.	Develop guidance and toolkit to encourage local governments to implement food waste management programs	NJDEP
3.	Develop tools to connect food waste generators with potential recipients to support food recovery	NJDEP, REA Recipients
4.	Raise awareness about food waste reduction	NJDEP, NJ Food Security Advocate, NJDA
5.	Encourage Counties to update district solid waste management plans to include food waste reduction	NJDEP, Local Governments
6.	Implement statewide waste composition audits	NJDEP
7.	Implement a community-scale reusable food-ware system pilot	Local Governments
8.	Support food waste recovery systems such as anaerobic digesters and co-digestion of food waste at wastewater treatment facilities	NJDEP, Local Governments, Sewerage Authorities
9	Encourage wastewater treatment facilities to reduce landfilling of residuals	Local Governments, Sewerage Authorities
10.	Implement local and regional composting programs	Local Governments
11.	Encourage schools to adopt the New Jersey School Food Waste Guidelines and institute a food waste reduction curriculum in K-12 schools	NJDEP, Local Governments, School Boards

12.	Address opportunities for food waste reduction at state-owned buildings	NJDEP
13.	Continue to pursue revisions to the Recycling Rules (N.J.A.C. 7:26A)	NJDEP

Halogenated Gases

PRIORITY MEASURE 11: Reduce halogenated gas emissions from refrigeration equipment		
	Enabling Actions	**Implementing Agency**
1.	Pilot a low-GWP incentive program for refrigeration systems	NJDEP
2.	Replace high-GWP refrigerant equipment	NJDEP, Local Governments

Natural and Working Lands

PRIORITY MEASURE 12: Maintain, protect and enhance New Jersey's natural carbon sinks		
	Enabling Actions	**Implementing Agency**
1.	Plant 250,000 street trees/shade trees by 2030	NJDEP, NJDA, Local Governments
2.	Identify and restore 800 degraded acres of forested lands by 2030	NJDEP, Local Governments
3.	Develop a nursery supply and production initiative	NJDA
4.	Complete 1 tidal reconnection project per year (total of 6) by 2030	NJDEP, Local Governments
5.	Install 7,800 linear feet of living shoreline per year by 2030	NJDEP, Local Governments
6.	Relaunch conservation cost share program	NJDA

APPENDIX 7.2

GREENHOUSE GAS REDUCTION MEASURES QUANTIFICATION METHODOLOGY

Introduction

The quantification of greenhouse gas emissions found in this Priority Climate Action Plan (PCAP) uses data from federal government sources (e.g., USEPA, EIA, and the USDOE), state government sources (e.g., various NJDEP reports), and others. Often, these data were from the calendar year 2020 or 2021, although some were from even earlier years, nonetheless NJDEP sought to use the most recently available data that were consistent, reliable, and high quality. All estimates were calculated using Global Warming Potential 100 (GWP_{100}). Each measure quantified cumulative emissions reduced by 2030, and by 2050.

Readers are cautioned not to add the estimated reductions from each of these sectors and their measures to arrive at a total state-wide emissions reduction. The estimated reductions from the electric generation sector were calculated with the assumption that new renewables generation will displace electricity produced via natural gas combustion, and that there would be no overall increase in electricity production. However, it is expected that electrification of transportation and buildings will increase overall electricity demand. It is likely that a portion of this extra demand, at least in the short run, will be met by additional gas consumption, and this additional gas consumption will offset some of the emissions reductions achieved by electrification. To the degree that electricity production shifts to clean, renewable sources of power, this offsetting factor will diminish, and a greater portion of the estimated reductions will be realized.

3.1 Transportation Emissions Reduction Calculations

Priority Measures

1. Achieve 30% zero-emission medium- and heavy-duty vehicle sales by 2030 and 100% by 2050

2020 Multi-State Medium-and Heavy-Duty Zero-Emissions Vehicle Memorandum of Understanding:

Seventeen US states, the District of Columbia, and the Canadian province of Quebec signed a Memorandum of Understanding (MOU) to achieve electrified Medium and Heavy Duty (MHD) vehicle sales rates of 30% by 2030 and 100% by 2050 (NESCAUM, 2020). The emissions reductions benefits of successfully achieving the MOU's goals were assessed by International Council on Clean Transportation (ICCT) (2022) based on the District of Columbia and 14 states (Colorado, Connecticut, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington). California was excluded from the analysis because the California Air Resources Board had already completed a technical assessment of implementing policies related to the MOU objectives. Nevada, Virginia, and Quebec were also not included in the analysis because they signed the MOU more recently. .

The analysis applied data and output from the MOVES3 model to the ICCT Roadmap Emissions Model as described in ICCT (2022) to calculate e emissions benefits on a well-to-wheels basis. The reference scenario (Business as Usual) assumed no increase in zero-emission sales shares through 2050, no further improvements in new ICE vehicle energy efficiency after 2027, EIA reference grid carbon intensity, and no change to federal USEPA 2010 emissions standards or additional state low-NOx standards. The zero emission (ZEV) 2050 scenario assumed at least 30% zero-emission MHD sales in 2030 and 100% in 2050, no backsliding on ICE energy efficiency after 2027, and grid carbon intensity reflecting the EIA reference grid and a net zero carbon grid by 2050. The individual scenarios contained additional assumptions as described in ICCT (2022).

To estimate emissions benefits specific to New Jersey, totals for the study group were scaled using the proportion of MHD vehicles registered in New Jersey to the total registered in the study group. Registration data was taken from USDOT (2023). Estimated reductions reported at five-year intervals were interpolated to find emissions during intervening years, and then totaled to find cumulative emissions for the respective period. Cumulative avoided emissions from 2025 through 2030 were 1.2 MMT CO_2e and from 2025 through 2050, 53.4 MMT CO_2e.

2. Achieve light-duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c. 362.)

The Electric Vehicle Law (P.L. 2019, c. 362) establishes three goals for electric vehicle adoption:

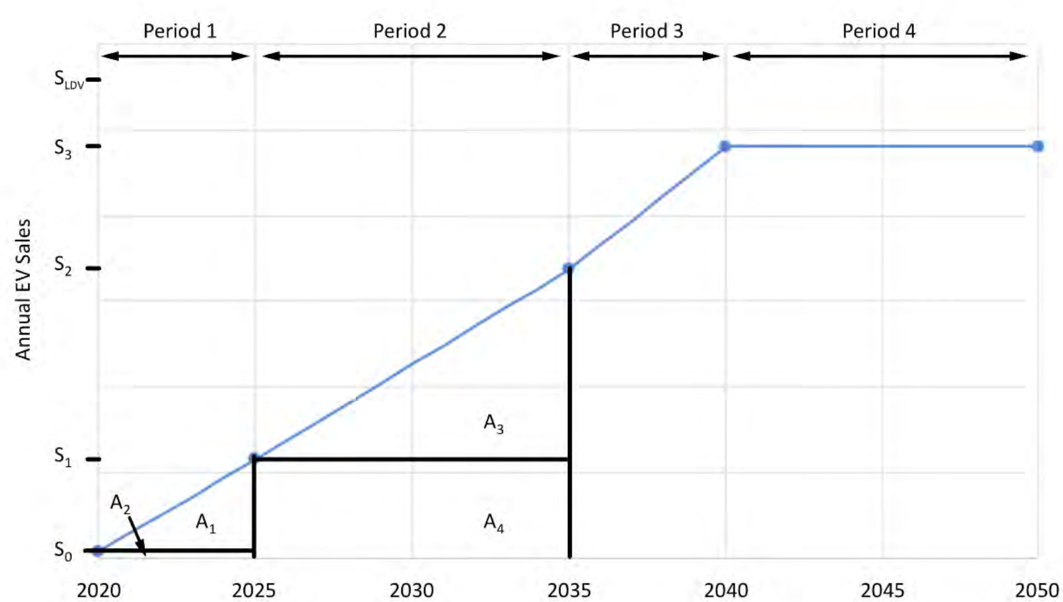
> Registrations of light-duty EVs (including plug-in hybrids) are to reach 330,000 units by December 31, 2025;
>
> Registrations of light-duty EVs are to reach 2 million by December 31, 2035; and
>
> At least 85% of all new light-duty vehicle sales are to be EVs by December 31, 2040.

Based on NJ motor vehicle registration history, the average length of a vehicle's registration in the State was as assumed to be 11 years.

Two of the three goals in P.L. 2019 c.362 are based on total registration numbers, and an analysis was performed to establish annual sales goals consistent with these targets. Calculations assumed that sales will increase linearly between years where specific goals have been set by statute.

Referring to Figure 1, a geometric solution was used to find annual EV sales under the law. The study period was divided into four periods: 2020 to 2025; 2026 to 2035, 2036 to 2040, and 2041 to 2050, based on the dates specified in the EV Law and the New Jersey Global Warming Response Act (P.L. 2007 c.112, as amended by P.L. 2019 c.197). Initial EV registrations in 2020 were taken from NJ vehicle registration data. The number of registered electric vehicles at the end of any given period is the sum of sales during each individual year during that period, plus any vehicles registered prior to the beginning of the period, minus those that have been replaced. The sales line shown in blue in the figure is the effective sales level, before considering replacements due to sale or loss. Final sales figures were found by adjusting for replacements, which do not increase the number of registered vehicles.

Figure 1, Analysis of EV sales under P.L. 2019 c. 362



The average emissions per fossil-powered Light Duty Vehicle (LDV) were estimated by dividing the total LDV emissions for the most recent year available (2021), based on NJDEP MOVES3 output, by the number of registered LDVs for the most recent year available (2023). The average emissions per fossil-powered LDV was estimated to be 3.9 MT CO_2e/vehicle-year. The use of emissions and registration data from different years is not thought to have introduced significant variability because the number of registered vehicles is unlikely to have changed substantially between the two years.

Emissions reductions were found by assuming total LDV fleet size remained constant (fossil plus EV). Emissions were then reduced in proportion to the number of EVs added to the fleet using the average emissions per fossil-powered LDV found above. Cumulative emissions were calculated by summing reductions from a reference year of 2024, that is, by adding emissions reductions occurring in 2025 and later. Potential emissions increases from fossil electricity generation were not included in these estimates, assuming the buildout of renewable energy sources occurs in tandem with the addition of new EVs such that the expansion of fossil electricity generation to serve the new load is avoided. Cumulative avoided emissions from 2025 through 2030 were 9.6 MMT CO_2e and from 2025 through 2050, 268.2 MMT CO_2e.

3. Reduce emissions in and around ports

Greenhouse gas emitting activities at facilities under the jurisdiction of the Port Authority of New York and New Jersey (PANYNJ) that were evaluated for potential emissions reductions included those from heavy-duty trucks, cargo handling equipment, ocean-going vessels, and harbor craft such as tugboats. Potential emissions reductions from rail freight were not considered and represent an additional opportunity. The assessment was limited to PANYNJ facilities located in New Jersey because these represent the largest portion of port-related emissions. Further emissions reductions are likely to occur at other port facilities as well. Activity data and 2022 estimated emissions at PANYNJ New Jersey facilities were taken from PANYNJ (2023a).

Medium- and heavy-duty vehicle activity at the port facilities is dominated by heavy-duty vehicles in weight classes 8a and 8b, typically tractor trailers exceeding 33,000 lbs GVWR (PANYNJ, 2023a).[1] Projected emissions reductions for tractor-trailers as percentages of 2020 baseline emissions under the Multi-State MHDV MOU (NESCAUM, 2020) were taken from Table A6 of ICCT (2022). 2022 emissions from PANYNJ (2023) were used as 2020 reference emissions to reduce pandemic-related influences.[2] Projected emissions reduction percentages at five-year intervals from ICCT (2022) were interpolated to find annual estimates, and future emissions found by multiplying these percentages by baseline emissions. Cumulative emissions benefits were found with respect to a 2024 reference, i.e. by summing benefits occurring in 2025 and subsequent years.

For cargo handling equipment and marine emissions, reduction goals from PANYNJ (2023b) were applied to 2022 emissions estimates taken from PANYNJ (2023a). Percentage reduction targets from PANYNJ (2023b) were adjusted for a 2022 baseline and interpolated to estimate annual reduction percentages. These in turn were applied to 2022 baseline emissions. Cumulative totals include reductions occurring in 2025 and later year. Some emissions reductions from ocean-going vessels may be outside the scope of PANYNJ (2023b), for example emissions at anchorage while waiting for access to port facilities, but these were considered reasonable to address given the long timeframe available for implementation. Cumulative avoided emissions from 2025 through 2030 were 0.4 MMT CO_2e and from 2025 through 2050, 8.2 MMT CO_2e.

Potential emissions increases from fossil electricity generation were not included in these estimates, assuming the buildout of renewable energy sources occurs in tandem with the addition of new EVs such that the expansion of fossil electricity generation to serve the new load is avoided.

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[1] Information on weight classifications can be found at USDOE (2012).

[2] Emissions reductions due to the 2020 MOU were projected to be very small in the years immediately following its adoption (on the order of 0.4% based on interpolation of five-year incremental projections), allowing use of 2022 emissions as baseline for 2020.

4. Reduce vehicle miles travelled

Emissions were estimated for increasing public transit ridership and increasing participation in work-from-home programs.

To estimate potential reductions in public transit ridership a scenario of doubling bus ridership by 2050 was chosen as a representative and achievable example. Bus ridership of 123,821,256 trips and total bus travel distance of 877,300,000 miles were taken from NJ Transit (2024) to find average bus travel distance per passenger of 7.09 miles per trip. Doubling ridership would result in 123,821,256 new passengers annually, and 877,300,000 additional passenger miles travelled. A mode shift factor of 0.508 from APTA (2018) was used to estimate vehicle miles travelled (VMT) avoided of 445,668,400 miles due to increased ridership. It was assumed that VMT avoided would be attributed to single-passenger LDVs with emissions as published by USEPA (2023a), specifically emitting 0.0088877 MT CO_2/gallon and having fuel efficiency of 22.2 mpg. At full implementation in 2050, the scenario would reduce unadjusted emissions by 178,408 MT CO_2/year before accounting for projected electrification of the light-duty vehicle fleet.

Estimated benefits from increased work-from-home participation were based on an analysis performed for NJDEP (2020) and considered a phased approach whereby participation ramped up between 2020 and 2035, and then maintained that rate through 2050. A pre-pandemic baseline of 5% was selected for 2020 based on US Census Bureau data (U.S. Census Bureau, 2019). More recent data for 2022 (U.S. Census Bureau, 2023) indicated a work-from-home rate of 15%, which is consistent with scenario development as described below. Average one-way travel time for New Jersey commuters was assumed to be 32.4 minutes based on recent estimates (U.S. Census Bureau 2019, U.S. Census Bureau 2023), and a typical travel speed of 30 mph was applied to estimate miles travelled. The estimated number of employed workers was 4.3 million, based on US Bureau of Labor Statistics for 2018 and 2019; data for 2023 indicates that the number of employed people is now approximately 4.8 million (11% increase) but estimates were not adjusted to consider this (USBLS 2024). Actual emissions reductions could therefore be greater than estimated. In the policy scenario, an initial work-from-home rate of 20% was assumed in 2020, ramping up to 40% in 2035, and remaining at 40% through 2050. Dingel and Nieman (2020) concluded that between 29% and 35% of jobs in New Jersey were suitable for full-time telework at that time, and it is reasonable to assume that some additional jobs can be made suitable for work-from-home given incentives to adapt. Setting a goal of 40% for 2035 was therefore considered reasonable. Under this scenario, work-from-home participation in 2025 would already have ramped up to approximately 27%, the effective starting point for cumulative emissions assessment here.

Initial Emissions benefits were based on displacement of fossil LDVs having the characteristics of typical passenger vehicles (USEPA 2023a), before accounting for vehicle electrification. Annual emissions reductions from increased public transit ridership and work-from-home participation were summed to find total unadjusted emissions benefits. Benefits were reduced in proportion to the anticipated expansion of electrified light-duty vehicles under the NJ EV Law, P.L. 2019 c. 362, as described above. Cumulative emissions were found by summing emissions benefits occurring in 2025 and later years. Cumulative avoided emissions from 2025 through 2030 were 4.2 MMT CO_2e and from 2025 through 2050, 25.9 MMT CO_2e.

3.2 Commercial and Residential Buildings Emissions Reduction Calculations

Priority Measures

5. Install zero-carbon emission space heating and cooling systems and water heating systems in 400,000 residential properties and 20,000 commercial properties.

For residential properties, building energy usage data for space heating, water heating and other applications was taken from the USEIA 2020 Residential Energy Consumption Survey (RECS) (USEIA 2023a) and total sector-wide energy consumption was taken from the USEIA State Energy Data System (USEIA, 2023b). Natural gas, distillate fuel oil, and propane consumed for space heating and water heating were multiplied by emissions factors from USEPA (2023b) to estimate 2020 emissions. It was then assumed that this emissions rate would remain applicable in 2024 given the relatively slow rate of growth in New Jersey housing stock and historical emissions patterns seen in the New Jersey Greenhouse Gas Inventory Report (NJDEP 2024). The total number of residences in USEIA (2023a) was 3.39 million, and it was assumed that this would remain constant. Baseline 2024 emissions were then adjusted to account for electrification of 400,000 homes, or 11.8% of residential stock, by 2030. Linear interpolation was used to estimate annual emissions reductions for 2026 through 2029. Cumulative emissions reductions were found by summing emissions for 2025 and later years. Emissions from electricity generation used to supply electrified heating equipment were not included in the calculations.

For commercial buildings, quantities of natural gas, fuel oil and total energy used for space heating, water heating, cooking and other applications in the Mid-Atlantic region were taken from the USEIA 2018 Commercial Building Energy Survey (CBECS) (USEIA 2023c). The percentages of total energy supplied by natural gas and fuel oil were then calculated based on this data. For propane, USEIA (2023c) did not publish energy data by application due to small sample size, so the fraction of propane used for space heating and water heating in the residential sector was used to disaggregate propane by application in the commercial sector. Total commercial-sector energy for 2020 from USEIA (2020b) was then allocated to individual end uses using the percentages found from CBECS data, and the emissions were then calculated using emissions factors from USEPA (2023b). It was further assumed that these baseline emissions continued to apply in 2024.

The total number of commercial buildings in the state was found by allocating total Mid-Atlantic commercial building stock from CBECS (USEIA 2023c) (518,000 buildings) to New Jersey based on Mid-Atlantic population proportions from the US Census (2021), yielding a total commercial building stock of 114,112 structures. Electrification of 20,000 buildings would therefore represent 17.5% of commercial building stock. At full implementation in 2030, space heating emissions would decrease by 1.12 MMT CO_2e and water heating by 0.09 MMT CO_2e, for a total of 1.22 MMT CO_2e. Reductions for years 2025 through 2029 were found by interpolation and emissions were assumed constant for 2030 through 2050. Cumulative emissions reductions summed the estimates for 2025 and later years. No adjustment was made for unheated buildings, but if an adjustment had been made, emissions benefits would have been slightly greater than calculated since a greater fraction of the remaining, heated buildings would have been electrified. Cumulative avoided emissions from 2025 through 2030 were 9.5 MMT CO_2e and from 2025 through 2050, 63.8 MMT CO_2e.

6. Make at least 10% of all low- and moderate income properties electrification-ready by 2030

The commitment to prepare homes for future electrification by 2030 implies an expectation that full electrification will be achieved in subsequent years. Based on the usable lifetimes of heating equipment and water heaters, a scenario was considered where full electrification of electrification-ready homes was completed by 2050. To estimate the number of affected households, the definition of low-income families was taken to be those with incomes between zero and 50% of the area median income (AMI), and moderate-income families were taken to be those with incomes between 50% and 80% of the AMI (USHUD, 2024). The AMI for New Jersey was found to be $117,988. (US Census Bureau, 2023, Table B19133), implying that low-income families have incomes up to $58,994, and moderate-income families have incomes between $58,994 and $94,390. From US Census Bureau (2023, Table S2503) it was determined that 1,716,531 occupied housing units in the state qualify as low- and moderate-income (LMI). Tabular data for those with incomes between $75,000 and $99,999 was interpolated to find the fraction that qualify as LMI in this category. However, the total number of families (of all incomes) in the US Census Bureau data was about 4% greater than the number of residences estimated in USEIA (2023a). Since USEIA (2023a) was used for other emissions reductions estimates, the number of LMI households was reduced to align with USEIA (2023a), yielding a total number of LMI residences of 1,654,557. Assuming that a negligible number of these homes have already been electrified or made electrification-ready, a total of 165,456 residences would need to be converted under the proposed measure. Conversion of electrification-ready residences to full electrification was assumed to begin in 2031 and reach completion in 2050, resulting in cumulative reductions through 2050 of 6.5 MMT CO_2e. No cumulative reductions were projected to occur by 2030 since the scenario assumes full electrification will begin in 2031, but residents could opt to complete the electrification process sooner.

3.3 Electric Generation Emissions Reduction Calculations

Priority Measures

7. Achieve 12.2 GW of solar in-state by 2030

Power output was calculated by multiplying rated capacity by a capacity factor (the fraction of rated output actually produced under normal operating conditions, or megawatts generated per megawatts rated at full capacity) and by the number of hours per year (8760).

Capacity factors vary based on the type of installation, due in part to the ability to optimize grid-based systems compared to rooftops, which may not be ideally situated. USDOE (2023) estimated that utility-scale solar PV installations have capacity factors of 24.5%, commercial resources 14.6%, and residential resources 14.5%. The regional grid operator PJM (2021) found utility scale installations had capacity factors of 25% and behind-the-meter installations (typical commercial and residential configurations) were 15%. For the sake of the present analysis, utility scale installations are assumed to have capacity factors of 25%, and behind-the-meter commercial and residential installations are assumed to have 15% capacity factors.

Annual amounts of solar capacity installed annually were assumed to be 950 MW during 2024 through 2027, and 1,225 MW during 2028 through 2030. Added to 4,738 MW of pre-existing capacity as of January 1, 2024, total projected capacity under this schedule will be 12,213 MW at the end of 2030. For the purposes of this analysis, no further expansion of solar PV was assumed.

Historically, solar PV installations in New Jersey have been mostly behind-the-meter, and as of January 2024 approximately 80% was behind-the-meter and 20% grid-based. However, grid-based resources are anticipated to expand rapidly under future conditions due to added incentives at the federal level and faster review by grid operator PJM. As a result, a mix of 50% behind-the-meter and 50% grid-based solar PV was assumed in the analysis. Accordingly, grid-based capacity and behind-the-meter capacity would each increase by 3,263 MW between 2024 and 2030. For BAU, we assumed new combined cycle natural gas resources would be needed to serve the newly electrified loads resulting from decarbonization of the transportation, residential and commercial sectors. Using an observed heat rate of 7,580 Btu input per kWh generated for combined cycle natural gas resources in 2022 (USEIA 2023d) and the natural gas emissions factors from USEPA (2023b), avoided annual emissions were calculated for years 2025 through 2050. The total cumulative emissions reduction benefit from 2025 to 2030 is 15.2 MMT CO_2e. By 2050, the cumulative benefit would be 107.3 MMT CO_2e. However, reductions in the state's total emissions will require sufficient low- or zero-carbon energy, either from in-state resources or imported from outside, to both offset increased loads from electrification and to replace existing fossil power supplies (NJBPU, 2019).

8. Facilitate the integration of clean distributed energy resources into the grid

Emissions were not calculated for this measure directly; rather this measure enables emission reductions from other measures.

9. Support Development of 11.0 GW of offshore wind by 2040

Power output from offshore wind is found by multiplying rated capacity by a capacity factor and the number of hours per year.

USDOE (2023) found that the median capacity factor for Class 3 resources such as those sited in New Jersey waters had a capacity factor of 0.395 (or 39.5%) in 2018, and that the factor would likely increase to 0.473 in 2024 and 0.500 in 2030. For the purposes of this analysis, a conservative estimate of 0.40 was chosen. This factor is also consistent with the 40% factor cited by PJM (2021).

The following hypothetical installation schedule was chosen based on existing agreements and anticipated future solicitations:

Date	Project Size MW	Total Online MW	Project
2025			
2026			
2027			
2028	1,510	1,510	Atlantic Shores, 1,510 MW
2029		1,510	
2030		1,510	
2031	2,542	4,052	Leading Light Wind, 1,200 MW; Attentive Energy Two, 1,342 MW
2032	1,200	5,252	Leading Light Wind, 1,200 MW
2033		5,252	
2034	1,300	6,552	Future Solicitation
2035	1,300	7,852	Future Solicitation
2036	1,300	9,152	Future Solicitation
2037	1,300	10,452	Future Solicitation
2038	548	11,000	Future Solicitation

Total MWh per year from the added resources were found as described above based on the 40% capacity factor and 8760 hours per year operation time.

For BAU, we assumed new combined cycle natural gas resources would be needed to serve the newly electrified loads resulting from decarbonization of the transportation, residential and commercial sectors. Using an observed heat rate of 7,580 Btu input per kWh generated for combined cycle natural gas resources in 2022 (USEIA 2023d) and the natural gas emissions factors from USEPA (2023b), avoided annual emissions were calculated for years 2025 through 2050, cumulative avoided emissions from 2025 through 2030 were 6.4 MMT CO_2e and from 2025 through 2050, 276.6 MMT CO_2e.

3.4 Food Waste Emissions Reduction Calculations

Priority Measure

10. Achieve a 50% reduction in food waste by 2030

Estimating GHG Emissions Per Ton of Food Waste:

A comprehensive report on methane emitted in landfills is USEPA (2023c). This report indicated that there are significant gaps in landfill gas collection systems, and that many systems fail to capture methane emissions generated in the early stages of decomposition – when methane production from food decomposition is at its highest. The findings of this report indicate that 1,000 tons of landfilled food waste will emit, on average, 34 metric tons of methane, which is equivalent to 952 metric tons CO_2e (USEPA 2023c, IPCC 2013). This would imply that 0.952 metric tons CO_2e are emitted for each short ton of food waste landfilled. We have used this figure as an estimate for how much methane is avoided for each ton of food waste kept out of a landfill. Therefore, since New Jersey's Food Waste Reduction Plan calls for reducing annual food waste being landfilled from 1.46 million short tons per year to 730,000 short tons per year, this would represent a reduction from 1.39 million metric tons CO_2e to 694,960 metric tons CO_2e. Therefore, the annual reduction would be approximately 695,000 metric tons CO_2e for each year once food waste being landfilled is halved. The CO_2e emissions resulting from food waste disposed of in New Jersey are assumed herein to be reduced starting from zero reduction in the current year to a total of 695,000 metric tons in 2030. Assuming a linear trend, the average yearly CO_2e reduction over the six-year period from 2024 to 2030 would be approximately 347,500 metric tons, for a cumulative reduction over the period of approximately 2,085,000 metric tons. From 2030 on, assuming the 50% reduction goal is achieved, a yearly reduction of 695,000 metric tons could be expected, which would translate to a cumulative reduction of 2,085,000 plus 20 x 695,000, or approximately 16.0 million metric tons.

It should be noted that, while overall yearly reductions of methane released from food waste decomposition can be estimated as described above, these emissions reductions will occur over a period of many years, because methane emissions from landfills typically follow an exponentially declining curve. Also, the report noted that conditions in landfills are different, and change over time, and as such, this figure is not perfect. However, it seems to be the most up to date estimate based on current data. Future efforts should be undertaken to better understand methane production from food waste in New Jersey's landfills. Further, since some of New Jersey's waste is deposited in out-of-state landfills, reductions in food waste generated in New Jersey will also lead to methane emissions reductions elsewhere. These reductions are not quantified in this analysis.

Cumulative avoided emissions from the measure by 2030 are estimated to be C2.1 MMT CO_2e and by 2050, 16.0 MMT CO_2e.

3.5 Halogenated Gases Emissions Reduction Calculations

Priority Measure

11. Reduce halogenated gas emissions from refrigeration equipment

The New Jersey GHG Monitoring and Reporting Rule (N.J.A.C. 7:27E) requires facilities with one or more commercial refrigeration systems or chillers with a full charge equal to 50 lbs of high-GWP refrigerant or combination of refrigerants (at least one of which is high-GWP) to report information on these systems and their charge capacities to the Department of Environmental Protection. For the purpose of the rule, a high GWP refrigerant is defined as one having GWP_{100} equal to or greater than 150.

For each reported installation, the CO_2e was found by multiplying by the refrigerant's GWP_{100}. Because many newer low-GWP refrigerant gases were not included in earlier releases of the IPCC assessment reports, and GWPs were reported for some gases in earlier editions but not in more recent releases, the most recent GWP value for each gas was taken from IPCC (2021), IPCC (2013) or IPCC (2007). Values for gases not listed in the IPCC reports were taken from WMO (2022). The climate impacts of CFCs and HCFCs were also taken into consideration, distinguishing this assessment from USEPA methodologies.

Overall, 4,439 installations had total refrigerant mass of 1,747,284 kg representing 4,620,931 MT CO_2e based on GWP_{100}. Based on GWP_{20}, they totaled 9,453,150 MT CO_2e. Dividing GWP_{100} total by mass total, the average GWP_{100} was 2,645 kg CO_2e/kg mass, and the average GWP_{20} was 5,410 kg CO_2e/kg mass. Reported refrigerants in use included a variety of HFCs, HCFCs and CFCs.

Equipment was assumed to have a 10-year life expectancy, consistent with assumptions made in USDOE rulemaking under 10 CFR 431 (88 FR 70196, 74 FR 1092-1142, 73 FR 50096). Total loss of refrigerant was assumed to occur at failure, such that 10% of total charge in use would escape annually.

To assess the benefits of phasing out high-GWP equipment, it was assumed that they would be replaced with new equipment having refrigerants with an average GWP of 150 (GWP_{100}). In the scenario considered, 90% of high GWP equipment would be replaced by the end of 2035, and the remaining 10% by the end of 2040. This timeline is consistent with a 10-to-15-year product lifetime. For a given year, the mass of high-GWP refrigerants in use was multiplied by the average GWP calculated above for the starting population to find the CO_2e of high GWPs remaining in use, and the mass of low-GWP refrigerant-in-use was multiplied by its corresponding GWP. Total CO_2e for the year was found by summing the CO_2e's for high- and low-GWP refrigerants. Annual leakage was taken as the sum divided by the average equipment lifetime of 10 years. This annual CO_2e release was compared to the CO_2e release rate prior to the phaseout program to find the annual reduction benefit. Cumulative emissions benefits were found by summing annual emissions reductions for 2025 and subsequent years. Using GWP_{100} values, cumulative reductions for 2025-2030 are 0.7 MMT CO_2e and cumulative reduction for 2025-2050 are 8.8 MMT CO_2e.

3.6 Natural and Working Lands Sequestration Calculations

Priority Measure

12. Maintain, protect, and enhance New Jersey's natural carbon sinks

An estimate of the greenhouse gas emissions sequestered from this measure were derived by summing the carbon sequestration estimates generated for each of the following enabling actions:

Plant 250,000 street trees/shade trees by 2030

Identify and restore 800 degraded acres of forested lands by 2030

Install 7,800 linear feet of living shoreline per year by 2030

The sum total of the estimates (described below) generated for these enabling actions for the priority measure equal

Plant 250,000 street trees/shade trees by 2030

The carbon sequestered from planting 250,000 street or shade trees by 2030 was estimated using i-Tree planting calculator tool developed by the USDA Forest Service and numerous cooperators (the Davey Tree Expert Company, The Arbor Day Foundation, Urban and Community Forestry Society, International Society of Arboriculture, Casey Trees, and SUNY College of Environmental Science and Forestry) (USDA Forest Service, 2024). Estimates were generated using the tool by inputting a group of 41,667 trees[3] using a project lifetime equal to the number of years until 2030 and 2050 for each year of the project. Lifetime inputs assumed that trees planted in 2024 would sequester carbon for 6 years and 26 years until 2030 and 2050 respectively, whereas trees planted in 2025 would sequester carbon for 5 years and 25 years respectively, and so on for a total of 12 different runs of the i-Tree planting calculator tool. All input assumptions were the same for all runs of the tool except for the lifetime years. Tree species input were standard for all runs of the i-tree planting calculator and assumed trees planted would be no more than 10% of the same species of tree and 30% of the species would be smaller street tree species (10'-12') while 70% larger species (12'-14'). The tree species used in the i-tree calculation were: 10% red maple, 10% American hornbeam, 10% common hackberry, 10% eastern red bud, 10% black gum, 10% Kentucky coffeetree, 10% black cherry, 10% northern red maple, 10% littleleaf linden, and 10% American sycamore. All trees were assumed to be planted with a diameter at breast height (DBH) of 2.5; be in excellent condition; be planted with 50% of trees in full exposure to sun and 50% of trees in partial exposure. Location inputs are required when using the i-Tree planting calculator tool. All calculations assumed trees were planted in Trenton, in Mercer County, NJ. All calculations assumed a 90% survival rate of trees by 2030 and 50% survival rate by 2050. This estimate is based on Hilbert et. al mortality rate data for urban tree plantings (2019), assuming an average of 2.45% mortality per year, which at 25 years approaches 50% (USFS, 2019). Sequestration estimates by 2030 and 2050 from each of the 6 years of planting trees by 2030 were then summed for a total estimate of 9,003 metric tons of CO_2 equivalent emissions sequestered by the enabling action by 2030 and 129,384 metric tons of CO_2 equivalent by 2050.

Identify and restore 800 degraded acres of forested lands by 2030

The carbon sequestered from restoring 800 degraded acres of forested lands used an approximate per acre rate of sequestration (75.25 MT CO_2e) which was multiplied by 800 (acres to be reforested by 2030). This totals to an estimate of 60,198 MT CO_2e that will be sequestered by 2050 from this enabling action. Projected carbon sequestration estimates used to arrive at the approximate per acre rate of sequestration used were derived from the calculations for individual forest restoration projects selected in the Department's Natural Climate Solutions grant program that used forest stand inventory data from the project partner and the U.S. Forest Service Forest Vegetation Simulator (FVS) to model three

[3] This value was rounded down to 41,666 trees for the last three planting years to equal a total of 250,000 trees.

scenarios a "no management" run, a "management" run specific to the proposed project, and a "forest carbon risk" run (USDA Forest Service, 2023). The FVS output carbon sequestration from the management scenario provides an estimate of the carbon sequestered per acre by 2050 in metric tons of CO_2 equivalent for the NCS project (NJDEP, 2023).

Install 7,800 linear feet of living shoreline per year by 2030

The carbon sequestered per foot of installed living shoreline was derived from existing calculations for the blue carbon sequestration from the New Jersey Department of Environmental Protection's Natural Climate Solutions (NCS) grant projects underway (NJDEP, 2023b). Benefits from living shoreline projects in the DEP's NCS program are calculated as (1) the prevention of the re-emission of stored soil carbon as CO_2 + (2) maintaining the carbon sequestration of the vegetated shoreline + (3) increased in carbon sequestration as a result of any increase in vegetated area. There is an assumed 5-year lag regarding (3) to account for vegetation establishment required prior to carbon sequestration.

(1) Protecting current levels of soil carbon: Acres of marsh loss per year is generated by taking the length of shoreline to be protected in feet multiplied by the rate of erosion (ft/yr) and dividing the value by 43,560 (number of square feet in an acre). This rate is then multiplied by 24 years (number of years to 2050 assuming the project is installed by 2026). The resulting value is then multiplied by 401 metric tons of CO_2 equivalent in the top meter of marsh soil per acre (Holmquist et al., 2018). This value is then multiplied by 0.25 which is the percent of eroded carbon emitted (Lovelock, 2017). The resulting value is the avoided loss of stored carbon (in CO_2e) over the lifetime of the project that installs living shoreline on existing marsh.

(2) Maintaining current carbon sequestration rates: Acres of loss per year is generated by taking the length of shoreline to be protected in feet multiplied by the rate of erosion (ft/yr) and dividing the value by 43,560 (number of square feet in an acre). This rate is then multiplied by 24 years (number of years to 2050 assuming the project is installed by 2026). The resulting value is then multiplied by a sequestration rate based on the salinity of the water. For salinities between 0-5PPT, a rate of 0 MT CO_2e/acre/year was used; for salinities between 5-17PPT, a rate of 1.26 MT CO_2e/acre/year was used; and for salinities greater than 18PPT, a rate of 2.52 MT CO_2e/acre/year was used (Settelmyer, 2018). These rates of sequestration are derived from sequestration rates reported in Settelmyer 2018 of 0.688 for >18PPT, 0.344 for 5-18PPT, and 0 for < 5PPT based on methane emissions in MT C /acre/year and multiplied by 3.67 to convert C to CO_2 equivalent (CO_2e). This resulting value is an estimate of the retained and protected sequestration (CO_2e) resulting from the installation of the living shoreline at the existing marsh.

(3) Increase in carbon sequestration in newly vegetated areas: Newly added acres of vegetated marsh behind the living shoreline are multiplied by 19 years (number of years to 2050 assuming the project is installed by 2026, and subtracting 5 years because it will take approximately that long to revegetate). The resulting value is then multiplied by a sequestration rate based on the salinity of the water (same sequestration rates as described above in (2)). The resulting value is an estimate of the increase in net sequestration (CO_2e) from installing living shoreline on existing marsh.

The resulting values from sections (1), (2), and (3) above are summed to get a total carbon sequestration benefit (CO_2e) by 2050 for the living shoreline project.

Following this methodology, the current DEP NCS program projects are estimated to sequester and retain 23,858.30 MT CO_2e by 2050 from the installation of 32,318 ft of living shoreline that is currently planned and funded with NJ's NCS grant funds. Dividing the carbon sequestered by the feet of shoreline installed provides an approximate rate of 0.738 MT CO_2e/ft/yr sequestration per foot of living shorelines by 2050. To reach the goal of 46,800 ft of living shorelines installed by 2030, 14,482 additional feet of living shoreline must still be planned, funded and installed. Multiplying this value by the rate of 0.738 MT CO_2e/ft/yr results in and additional 10,691.13 MT CO_2e sequestered by 2050. The sum of estimated sequestration from existing, funded living shorelines projects under the NCS program, (23,858.30 MT CO_2e) and the estimated sequestration from additional future living shorelines projects (10,691.13 MT CO_2e) to achieve this enabling action is 34,549.43 MT CO_2e by 2050.

Enabling actions that were not factored into this measure's GHG estimate

The other enabling actions in this priority measure, listed below, could provide some additional GHG sequestration benefits by 2030 and 2050, however the DEP does not have the data needed to generate reasonable estimates at this time:

- Develop a native supply and production initiative
- Complete 1 tidal reconnection project per year (total of 6) by 2030
- Relaunch conservation cost share program

Works Cited

American Public Transportation Association (APTA) (2018), *Quantifying Greenhouse Gas Emissions from Transit,* Revision 1. APTA SUDS CC-RP-001-09, https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-SUDS-CC-RP-001-09_Rev-1.pdf

An Act concerning food waste generated by school and supplementing Title 13 of the Revised Statutes, S3153 (2023). Retrieved 12 January 2024 from https://pub.njleg.state.nj.us/Bills/2022/S3500/3153_R3.PDF

Brand, C. et al., (2021) The climate change mitigation effects of daily active travel in cities," *Transportation Research Part D*, (93), 102764, https://doi.org/10.1016/j.trd.2021.102764

Dingel, J. L., and Neiman, B. (2020), *How Many Jobs Can be Done at Home?.* Becker Friedman Institute, University of Chicago Booth School of Business. https://bfi.uchicago.edu/wp-content/uploads/BFI_White-Paper_Dingel_Neiman_3.2020.pdf. Supporting data at https://github.com/jdingel/DingelNeiman-workathome

Hilbert, Deborah R.; Roman, Lara A.; Koeser, Andrew K.; Vogt, Jess; van Doorn, Natalie S. (2019). *Urban Tree Mortality: A Literature Review.* Arboriculture & Urban Forestry: 45(5): 167-200. https://doi.org/10.13140/RG.2.2.25953.15204

Holmquist, J.R., Windham-Myers, L., Bliss, N. et al. (2018). *Accuracy and Precision of Tidal Wetland Soil Carbon Mapping in the Conterminous United States*. Scientific Reports. 8(1). https://doi.org/10.1038/s41598-018-26948-7

International Council on Clean Transportation (ICCT) (2022), *Benefits of the 2020 Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding.* https://theicct.org/wp-content/uploads/2022/04/md-hd-mou-benefits-apr22.pdf.

International Council on Clean Transportation (ICCT). (2023), *Benefits of Adopting California's Advanced Clean Cars II (ACC II) Standards in New Jersey*, Retrieved from https://theicct.org/wp-content/uploads/2023/05/nj-acc-ii-benefits-fs-may23.pdf. Supporting files are available at: https://theicct.org/benefits-ca-advanced-clean-cars-ii-reg-data/

International Panel on Climate Change, (IPCC) (2007) (AR4), *Climate Change 2007 - The Physical Science Basis, contribution of Working Group I to the Fourth Assessment Report of the IPCC.* https://www.ipcc.ch/report/ar4/wg1/

International Panel on Climate Change, (IPCC) (2013) (AR5), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment report of the Intergovernmental Panel on Climate Change.* https://www.ipcc.ch/report/ar5/wg1/

International Panel on Climate Change (IPCC) (2021) (AR6), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* https://www.ipcc.ch/report/ar6/wg1/

Levis, J., and Barlaz, M.A. (2014). Landfill Gas Monte Carlo Model Documentation and Results. U.S. Environmental Protection Agency. Retrieved from https://www.epa.gov/sites/default/files/2016-03/documents/lanfl_gas_mont_carlo_modl.pdf

Lovelock, Catherine & Fourqurean, James & Morris, James. (2017). *Modeled CO2 Emissions from Coastal Wetland Transitions to Other Land Uses: Tidal Marshes, Mangrove Forests, and Seagrass Beds*. Frontiers in Marine Science. 4(1). https://doi.org/10.3389/fmars.2017.00143

New Jersey Board of Public Utilities (NJBPU) (2019), *2019 New Jersey Energy Master Plan, Pathway to 2050.* https://nj.gov/emp/docs/pdf/2020_NJBPU_EMP.pdf

New Jersey Department of Environmental Protection (NJDEP). (2020, October 15th). *New Jersey's Global Warming Response Act 80x50 Report*. New Jersey Department of Environmental Protection. https://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdf

New Jersey Department of Environmental Protection (NJDEP). (2023a). *Food Waste Reduction Plan*. New Jersey Department of Environmental Protection: Food Waste. https://www.nj.gov/dep/dshw/food-waste/food_waste_reduction_plan.pdf

New Jersey Department of Environmental Protection (NJDEP). (2023b). *RGGI Natural Climate Solutions Grants*. https://dep.nj.gov/climatechange/mitigation/ncs-grant/

New Jersey Transit (NJ TRANSIT) (2024). Facts at a Glance (July 1, 2022 through June 30, 2023). https://content.njtransit.com/sites/default/files/FY23%20FACTS%20AT%20A%20GLANCE.pdf. Accessed February 13, 2024.

Northeast States for Coordinated Air Use Management (NESCAUM) (2020), *Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding*, https://www.nescaum.org/documents/mhdv-zev-mou-20220329.pdf. Accessed February 2, 2024.

Port Authority of New York and New Jersey (PANYNJ) (2023a). 2022 Multi-Facility Emissions Inventory. Port Department. https://www.panynj.gov/content/dam/port/our-port/air-emissions-inventory-reports/PANYNJ-2022-Multi-Facility-EI-Report.pdf

Port Authority of New York and New Jersey (PANYNJ) (2023b). Net Zero Roadmap. https://www.panynj.gov/content/dam/port-authority/about/environmental-initiatives-/panynj-NetZeroRoadMap.pdf

PJM Interconnection, LLC., (PJM), (2021). "Offshore Wind Transmissions Study: Phase 1 Results," https://www.pjm.com/-/media/library/reports-notices/special-reports/2021/20211019-offshore-wind-transmission-study-phase-1-results.ashx

Settelmyer S. (2018). *Delaware Bay Blue Carbon Feasibility Study: Phase 2 Report*. Unpublished report by TerraCarbon for the Nature Conservancy.

U.S. Bureau of Labor Statistics (USBLS) (2024). Economy at a Glace, New Jersey; Occupational Employment and Wage Statistics. https://www.bls.gov/eag/eag.nj.htm

U.S. Census Bureau (2019), *2018 American Community Survey*,

Table S0801, Commuting Characteristics by Sex, New Jersey. https://data.census.gov/table/ACSST1Y2018.S0801?q=commuter%20miles&hidePreview=false

Table S0802, Means of Transportation to Work by Selected Characteristics, New Jersey https://data.census.gov/table/ACSST1Y2018.S0802?q=S0802&g=040XX00US34&moe=false&tid=ACSST1Y2022.S0802

U.S. Census Bureau (2021), Estimates of the Total Resident Population and Resident Population Age 18 Years and Older for the United States, Regions, States, District of Columbia, and Puerto Rico: July 1, 2021. https://www2.census.gov/programs-surveys/popest/tables/2020-2021/state/detail/SCPRC-EST2021-18+POP.xlsx

U.S. Census Bureau (2023), *2022 American Community Survey*

Table B19133, Median Family Income in the Past 12 Months (in 2022 Inflation-Adjusted Dollars). https://data.census.gov/table/ACSDT1Y2022.B19113?q=household%20income&g=040XX00US34

Table S0801, Commuting Characteristics by Sex, New Jersey. https://data.census.gov/table?q=commuting%20characteristics%20by%20sex&g=040XX00US34

Table S0802 Means of Transportation to Work by Selected Characteristics, New Jersey. https://data.census.gov/table/ACSST1Y2022.S0802?q=S0802&g=040XX00US34&moe=false

Table S2503, Financial Characteristics https://data.census.gov/table/ACSST1Y2022.S2503?q=household%20income&g=040XX00US34

U.S. Department of Agriculture Forest Service (USDA Forest Service). (2023). Forest Vegetation Simulator (FVS). https://www.fs.usda.gov/fvs/

U.S. Department of Agriculture Forest Service (USDA Forest Service). (2024). *i-Tree planting calculator.* The U.S. Forest Service, Davey Tree Expert Company, The Arbor Day Foundation, Urban and Community Forestry Society, International Society of Arboriculture, and Casey Trees. https://planting.itreetools.org/

U.S. Department of Energy (USDOE). (2012). *Vehicle Weight Classes & Categories*. Alternative Fuels Data Center. https://afdc.energy.gov/data/10380

U.S. Department of Energy (USDOE) (2023), "2023 Annual Technology Baseline". National Renewable Energy Laboratory (NREL) https://atb.nrel.gov.

U.S. Department of Housing and Urban Development (USHUD), (2024), ACS 5-Year 2011-2015 Low and Moderate Income Summary FAQs, Hud Exchange. https://www.hudexchange.info/programs/acs-low-mod-summary-data/acs-low-mod-summary-data-faqs-2011-2015/

U.S. Department of Transportation (USDOT). (2023). *Highway Statistics 2022*. Table MV-1. Federal Highway Administration. Retrieved from https://www.fhwa.dot.gov/policyinformation/statistics/2022/.

U.S. Energy Information Agency (USEIA). (2023a). *2020 Residential Energy Consumption Survey*. https://www.eia.gov/consumption/residential/data/2020/index.php?view=state

U.S. Energy Information Agency (USEIA). (2023b) *State Energy Data System.* https://www.eia.gov/state/seds/seds-data-complete.php

U.S. Energy Information Agency (USEIA). (2023c). *2018 Commercial Building Energy Survey*. https://www.eia.gov/consumption/commercial/data/2018/

U.S. Energy Information Agency (USEIA) (2023d). Electric Power Annual with Data for 2022. Table 8.2, Average tested heat rates by prime mover and energy source, 2012-2022. https://www.eia.gov/electricity/annual/html/epa_08_02.html

U.S. Environmental Protection Agency (USEPA). (2023a) *Tailpipe Greenhouse Gas Emissions from a Typical Passenger Vehicle*, EPA-420-F-23-014. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1017FP5.pdf. Accessed January 29, 2024.

U.S. Environmental Protection Agency (USEPA). (2023b). *GHG Emissions Factors Hub.* https://www.epa.gov/climateleadership/ghg-emission-factors-hub

U.S. Environmental Protection Agency (USEPA) (2023c), Office of Research and Development. *Food Waste Management: Quantifying Methane Emissions from Landfilled Food Waste*. EPA-600-R-23-064, https://www.epa.gov/system/files/documents/2023-10/food-waste-landfill-methane-10-8-23-final_508-compliant.pdf

World Health Organization (WHO) (2022), Scientific Assessment of Ozone Depletion 2022. GWW Report 278. Annex, Summary of Abundances, Lifetimes, ODPs, REs, GWPs and GWPs.

APPENDIX 7.3

STAKEHOLDER ENGAGEMENT REPORT

RUTGERS
New Jersey Climate Change
Resource Center

Stakeholder Engagement Informing the New Jersey Department of Environmental Protection's Priority Climate Action Plan

A summary report from the New Jersey Climate Change Resource Center at Rutgers University
https://njclimateresourcecenter.rutgers.edu/

January 2024

Stakeholder Engagement Informing the New Jersey Department of Environmental Protection's Priority Climate Action Plan

A summary report from the NJ Climate Change Resource Center at Rutgers University

Summary Report Content

Background

The New Jersey Department of Environmental Protection (NJDEP) engaged the New Jersey Climate Change Resource Center at Rutgers University to provide support to its stakeholder engagement efforts contributing to development of New Jersey's Priority Climate Reduction Plan (PCAP) pursuant to the United States Environmental Protection Agency's Climate Pollution Reduction Grant (CPRG) program. The CPRG program is a nationwide, two-phase grant funded via the federal Inflation Reduction Act. Phase one provides $250 million in noncompetitive planning grants to states, local governments, tribes and territories to develop and implement climate action plans for reducing greenhouse gas emissions and other harmful air pollution. Phase two provides $4.6 billion in competitive implementation grants to carry out the greenhouse gas reduction measures proposed in the climate action plans. The State of New Jersey received $3 million from the United States Environmental Protection Agency (USEPA) to updated and enhance the state's existing climate action plans. The NJDEP, in partnership with the Governor's Office of Climate Action and the Green Economy and the Board of Public Utilities will spearhead three initiatives part of the CPRG program:

- Development of a Priority Climate Action Plan (PCAP) that will be a highly focused, near-term list of implementation-ready measures to help the state achieve its 2030 goal of a 50% reduction in greenhouse gas emissions. The PCAP is focused on a set of five sectors of the economy.
- Development of a Comprehensive Climate Action Plan that will be an all-encompassing strategy outlining a holistic framework for how the state will reduce greenhouse gas emissions across all sectors to achieve its 2050 goal of an 80 percent reduction. This report will serve as an update and refinement to the NJDEP's Global Warming Response Act report.
- Development of a status report that will track the state's progress in implementing the PCAP and the CCAP ensuring accountability and transparency in the state's climate mitigation efforts.

The purpose of this report is to summarize stakeholder engagement efforts that were undertaken through a collaborative effort of NJDEP and the CCRC to inform development of the PCAP.

Stakeholder Participation

This report provides an overview of input received from stakeholders regarding priorities, challenges and opportunities, potential impacts on low-income and disadvantaged communities, and workforce development opportunities of potential priority climate actions that are under consideration for inclusion in New Jersey's Priority Climate Action Plan (PCAP). The focus of this stakeholder input was on six sectors identified by the New Jersey Department of Environmental Protection (Box 1) as well as input from Environmental Justice and municipal stakeholders. This report is informed by the following:

- five sector-specific webinars (one of which covered 2 sectors);
- NJDEP received 41 written comments via the portal on its Climate Pollution Reduction Grant Program (CPRG) website and another 18 written comments sent directly by stakeholders to various NJDEP team members via email.
- two webinars hosted by Sustainable Jersey on October 26, 2023, and November 2, 2023 with municipalities engaged in the Sustainable Jersey Urban Sustainability Hub and municipalities that have received Sustainable Jersey Community Energy Planning Grants, respectively;
- a dedicated in-person community dialogue with environmental justice stakeholders; and
- two virtual meetings with business leaders involved in operations associated with halogenated gases.

Box 1: Stakeholder Engagement Focused Sectors

- Buildings
- Electric Generation
- Food waste
- Halogenated Gases
- Natural and Working Lands
- Transportation

Additionally, the members of the Rutgers team also reviewed relevant documents related to climate pollution reduction priorities in New Jersey that were informed by stakeholder input, including:

- A response to comments document provided by NJDEP pursuant to the agency's adoption of its Greenhouse Gas Monitoring and Reporting Rule (N.J.A.C. 7:27E, subchapter 2: Registration and Reporting for Refrigeration Systems);
- New Jersey's Global Warming Response Act Report: Evaluating Our Progress and Identifying Pathways to Reduce Emissions 80% by 2050. October 15, 2020. New Jersey Department of Environmental Protection;
- Natural and Working Lands Strategy. New Jersey Department of Environmental Protection. https://dep.nj.gov/climatechange/mitigation/nwls/
- Brown, A., Heckler, A. & Youngster, T. 2022. Support provided by Jeanne Herb, Marjorie Kaplan, and Gary Sondermeyer. Advancing the New Jersey Sustainable Organic Material Management Plan: Opportunities to Increase Food Security and Reduce New Jersey's Organic Waste. Prepared for the New Jersey Climate Change Alliance. New Brunswick, NJ: Rutgers University, and in partnership with the New Jersey State Policy Lab. Available at: https://njadapt.rutgers.edu/images/NJSPL-OrganicWasteManagement-March2022.pdf
- Forest Resource Considerations for Natural and Working Lands. NJ Climate Change Alliance. 2022. Available at: https://njadapt.rutgers.edu/images/Forest_Resource_Considerations_for_a_NJ_NWL_Strategy_2.pdf
- Sustainable Organic Waste Management Plan. New Jersey Climate Change Alliance. October 2021. Available at: https://njadapt.rutgers.edu/images/Organics-Workgroup-SOMMP-Final-Sept-2021.pdf

For each of these sectors, a targeted webinar was hosted to gather input from stakeholders on priority climate actions related to each sector. Two-hour webinars were hosted on the dates listed below. Each of the sector-specific five webinars included a simultaneous Spanish translation element with registration materials for the webinar also translated into Spanish and available on the NJDEP CPRG website. All recordings of webinars and presentation materials were uploaded in a timely manner on the NJDEP CPRG website at: https://dep.nj.gov/climatechange/mitigation/cprg/.

- Buildings & Electric Generation – November 22, 2023
- Food waste – November 9, 2023
- Halogenated Gases – November 13, 2023
- Natural and Working Lands – November 8, 2023
- Transportation – November 28, 2023

In addition to these sectoral targeted stakeholder engagement efforts, NJDEP provided an opportunity for stakeholder comments to be submitted via a portal on its website through December 8, 2023. NJDEP also conducted an Environmental Justice (EJ) Community Dialogue for the CPRG Grant on December 12, 2023, which was attended by 21 residents, including members of Newark Water Coalition, New Jersey Environmental Justice Alliance, South Ward Environmental Alliance, Ironbound Community Corporation, City of Newark Office of Sustainability, and Clean Water Action. Rutgers team members were not present at this event but were provided notes by NJDEP. Rutgers team members also participated in two webinars hosted by Sustainable Jersey on October 26, 2023, and November 2, 2023 that included municipalities engaged in the Sustainable Jersey Urban Sustainability Hub and community energy planning grant program. Additionally, two virtual meetings were held in December 2023 with targeted business stakeholders from the halogenated gas sector to add to feedback received during the November 13, 2023, webinar.

Considerable outreach was conducted to encourage stakeholder participation in the development of the PCAP as outlined below:

- General listserv emails
    - NJDEP sent general emails on October 30, 2023, to 4,483 recipients with a 36% open rate to promote the food waste, natural and working lands and halogenated gas webinars.
    - NJDEP sent general emails on November 13, 2023, to 4,507 recipients with a 37% open rate to promote the transportation and buildings/electric generation webinars.
    - NJDEP also sent emails to its *Stop the Soot* email listserv of 3,832 people with a 34% open rate. as well as 47 personal emails on 11/21 to stakeholders not on the Stop the Soot email listserv announcing the buildings/electric generation and transportation webinars.
- Targeted direct emails were sent to recipients that were identified by NJDEP and/or the Rutgers team as having particular interest in individual sectors as follows:
    - Email sent to 605 recipients on 10/30 for targeted NWLs stakeholders
    - Email sent to 1,016 recipients on 10/30 for targeted food waste stakeholders
    - Email sent to 420 recipients on 10/30 for targeted halogenated gases stakeholders
    - Email sent to 47 recipients on 11/21 for targeted transportation & buildings/electric generation stakeholders
- Social media posts issued through NJDEP social media channels on October 5, November 15 and November 27 and these posts were supplemented by social media and newsletter posts from the Rutgers Climate and Energy Institute.

A summary of stakeholder engagement outcomes is outlined below:

Sector	Registrants	Webinar/Meeting attendees
Halogenated gases	43	16
Food Waste	133	81
Natural and working lands	95	66

Buildings and electric generation	79	52
Transportation	103	56
Environmental Justice Community Dialogue[1]		21
Sustainable Jersey webinar with Community Energy Planning Municipal Grantees[2]		18
Sustainable Jersey webinar with Urban Sustainability Hub municipalities[3]		7

EJ Cross-cutting issues

Several topics were raised at the Environmental Justice (EJ) Community Dialogue that cuts across the individual sectors that were the focus on targeted webinars, including:

- EJ stakeholders identified workforce development as a very promising benefit that can result from strategic investment of CPRG resources in the needs of LIDAC communities. They pointed out that workforce development training programs, such as for installation of solar technologies, need to provide compensation for youth participants to encourage participation and they also need to guarantee job placement after training. Stakeholders urged a focus in workforce training programs on development of key transferrable skills, such as math literacy and interpersonal communication. Stakeholders stressed that such training programs need to be culturally appropriate and provide offerings in Spanish, Creole, and other languages, that trainings should be union-eligible so that hours in training can count as union service, and that targeted efforts need to be made to attract undocumented and formerly incarcerated people. Stakeholders stressed that any workforce development efforts need to lead to "good jobs" that include benefits and living wages. Several stakeholders encouraged inclusion of teachers in development of workforce training and education programs because teachers can provide input on effective programming as well as identify opportunities to intersect workforce training with middle and high school career development programs.
- EJ stakeholders encouraged investment in place-based "eco-villages" that are designed to give communities ownership of climate goals. They urged adoption of pilot eco-village projects which could include climate resilience and mitigation action in different neighborhoods or wards that, when combined, can be scalable across a larger community. They indicated that these efforts could include formation of resident "task forces," including youth, to monitor and implement specific climate action (air monitoring, compost pickup, etc.). Stakeholders discussed how the concept of eco-villages could include multiple sectors (i.e., transportation, food waste, etc.) and could be connected to local workforce development and community beautification. An idea raised by EJ stakeholders was for PCAP investments to be put into eco-village pilot projects.

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[1] 21 residents participated including those from: from Newark Water Coalition, New Jersey Environmental Justice Alliance, South Ward Environmental Alliance, Ironbound Community Corporation, City of Newark Office of Sustainability, and Clean Water Action

[2] 18 municipalities participated including local officials from: Prospect Park Borough, Paterson, Morris Plains Borough, City of Orange, Maplewood Township, Hoboken, Union City, Summit, Madison Borough, Plainfield, Highland Park Borough, New Brunswick, Brick Township, Cherry Hill Township, Evesham Township, Egg Harbor City, Egg Harbor Township, Wildwood

[3] 7 participants attending including those representing Hoboken, Jersey City, Camden, Newark, Woodbridge, Paterson, Trenton and the NJ Urban Mayors Association (NJUMA)

- EJ stakeholders focused on documentation of benefits to LIDAC and overburdened communities as a priority for selection of where and how PCAP funds will be invested. They indicated that priority should be given to those projects that are identified as delivering the greatest benefit to LIDACs.

Transportation

Priorities identified by stakeholders

Stakeholders identified a set of priority climate actions for the transportation sector within six general categories:

1. **Expand current incentives for EV adoption**

Stakeholders identified a set of specific actions that would expand current funding programs for supporting purchases of electric vehicles (EVs), including:

- Allow purchase and repowering of off-road and nonroad mobile sources to be eligible costs for state and federal funding programs such as agricultural equipment, aircraft and airport equipment, commercial marine vessels and marina/port ground support equipment, construction equipment, locomotives, commercial and industrial equipment such as forklifts and sweepers;
- Specifically dedicate funding for all EV incentive programs to benefit LIDAC and overburdened communities, for example, by prioritizing and guaranteeing a minimum of funding to such locations;
- Increase funding to existing oversubscribed programs, including NJZIP that offers funding incentives to commercial, industrial, and institutional operators for the purchase of new medium and heavy duty zero emission vehicles and Charge Up NJ that offers financial incentives for the purchase or lease of new EVs and the purchase of eligible EV chargers;
- Launch new electric micro mobility incentive programs to include electric motorbikes, scooters and pedelecs that can offer particular benefits to residents that do not own automobiles, urban residents, and other residents of LIDAC communities;
- Expand current programs to cover 100% of costs of local governments to purchase/repower their fleets, especially in LIDACs;
- Expand current incentives for adoption of electric school buses to go beyond purchases to also include costs of leases and repowering especially in LIDAC communities that may have less available resources;
- Establish a dedicated commitment to provide funding to offset costs to small operators at the Port Authority of NY and New Jersey for adoption of EVs. Participants in the EJ Community Dialogue emphasized that, in addition to prioritizing electrification of trucks and other emissions sources at the port, it is important for efforts to consider the needs of truck drivers who may be faced with changes in work operations as a result of electrification of operations. Some stakeholders at the EJ Community Dialogue called for the establishment of zero emissions zones in the port region and establishment of an advisory committee that includes compensation for the involvement of long shoreman and other port workers to inform emissions reductions efforts of the Port Authority of New York and New Jersey.

2. **Expand current EV charging infrastructure**

- Increase funding levels in oversubscribed existing programs (i.e., *It Pay$ to Plug In)* for installation of charging stations;
- Allow financial incentives for charging infrastructure (residential, community-level, public) to cover full, rather than partial, costs associated with installation;
- Undertake pilot projects in collaboration with local officials in regions with a large number of LIDAC to demonstrate community benefit of public and community-level charging stations;

- Develop a strategic plan that prioritizes locations for proactive engagement of local governments to promote community-level and public charging based on gaps in current charging infrastructure, community benefit, presence of disadvantaged and overburdened communities, opportunity for micro mobility options to expand access to transportation, etc.

3. Expand resources for reducing travel demand

- Support initiatives that align with policies that result in the reduction of travel demand for which the goal is reduction of vehicle miles traveled (VMT);
- Expand current safe routes to school and bicycle/pedestrian technical assistance programs to local governments. Conduct proactive outreach to provide assistance to LIDACs.
- Support analysis that will support adoption of a 2050 VMT reduction goal with concomitant emissions reductions;
- Expand technical assistance programs to municipalities to allow for better quantification of emissions reductions resulting from land use and smart growth strategies;
- Provide financial support to establish a monitoring system to ensure that federal investments in transportation infrastructure (i.e., Bipartisan Infrastructure Law) are directed to infrastructure projects that reduce VMT;
- Participants in the EJ Community dialogue indicated that New Jersey's goals to reduce emissions from the transportation sector are at odds with current practices such as expanding the turnpike and fighting congestion pricing.

4. Expand zero and low-carbon transit options

- Establish a dedicated funding source for New Jersey Transit that includes specific funding for electrification initiatives, service upgrades, maintenance of current operations and planning for Transit Oriented Development;
- Support free zero and low-carbon community rideshare programs, such as the EV pilot GOTrenton! hosted by the nonprofit, Trenton-based community organization Isles which is a priority that was also identified by municipalities participating in the Sustainable Jersey webinars;
- Offer free and reduced fares for transit and bus services for residents of LIDAC populations;
- Municipalities participating in the Sustainable Jersey webinars also pointed to the need for greater amounts of funds to electrify municipal fleets;
- Stakeholders at the EJ Community Dialogue pointed to the need for e-bike and e-scooter rebates or other form of financial incentives to offset their initial purchase especially for residents of LIDACs.

5. Support local planning that leads to measurable emissions reductions

- Establish funding that can be used by local agencies (county, municipal, regional, etc.) to fill current resource gaps that hinder efforts to apply for active transportation and smart growth-type projects that result in measurable reductions of emissions;
- Municipalities participating in the Sustainable Jersey webinars pointed to the need for funding for local governments to have greater capacity to lead and implement projects related to complete streets, transportation planning that leads to emissions reduction and walkable/bikeable communities.
- Provide funding that establishes a technical assistance program to provide resources and direct planning and technical assistance to local agencies to develop and adopt land use and other initiatives that result in measurable reductions of emissions;
- Create a funding opportunity that supports proactive establishment of community and regional corridor and community EV charging networks, including with a focus on providing benefits to LIDACs;

- Participants in the EJ Community Dialogue suggested that DEP and other environmentally like-minded agencies be involved in the planning of truck routes in LIDACS to ensure that truck routes are directed away from neighborhoods, that charging stations for medium and heavy-duty trucks do not burden residential areas. They called for greater use of environmental impact studies by NJDOT and transportation planning agencies with specific standards for consideration of impacts in overburdened communities and LIDACs.
- When focusing on LIDACs, overburdened communities, densely populated and urban communities, participants in the EJ Community Dialogue emphasized the need for community charging stations near service agencies, shopping centers, bookstores, cafes, public buildings, public housing, and local businesses;
- Support a reinvigoration of the New Jersey Department of Transportation's Transit Oriented Development (TOD) and Transit Village programs, including: funding to develop guidance for established minimum development densities in TOD areas; funding to revise current requirements to remove minimum parking standards in TOD areas; funding to develop guidance on strategies to promote infill land use patterns for TOD; and to prioritize expenditures of funding for TOD that includes inclusionary zoning and infrastructure investment.
- Stakeholders who participated in the EJ Community Dialogue raised concerns about how traffic makes streets unwalkable and unsafe, reducing the potential adoption of e-bikes and e-scooters. They called for whole community planning strategies that seek to advance adoption of micro mobility strategies through redesign of streetscapes resulting in safer and less invasive transportation infrastructure. They urged adoption of community design standards that are specifically aimed at building micro mobility opportunities in urban and densely developed communities.

6. <u>Support deployment of strategic education programs</u>

- Funding is needed for public outreach and education programs that are focused on:
    - Effectively teach and inform the public about the value (including economic value) of EVs and that dispel common myths;
    - Informing the public about the availability of financial incentive programs for EV vehicle purchases, leases and charging;
    - Educating the public about the value, safety and cost benefit of e-mobility including micro mobility options

  The need for education programs about the benefits of EVs was echoed by municipalities participating in the Sustainable Jersey webinars.
- Strategic outreach is needed to targeted audiences including municipalities, fleet operators, school districts, etc. regarding benefits of electrification and available financing programs;
- Training programs need to be established to create a workforce that is prepared to repair and maintain EVs, medium and heavy duty zero emission vehicles, and other new technologies; programs can be developed in a way to recruit residents of LIDACs for training in these emerging jobs.

Challenges and Opportunities identified by Stakeholders

- Stakeholders identified several general and specific challenges, barriers, and opportunities for advancing transportation initiatives designed to advance measurable reduction of emissions, including:
- The cost of electric school buses and heavy and medium duty trucks is prohibitively expensive;
- The limited current availability and adequate supply chain to supply needed EV equipment and technology, including that related to charging;
- The insufficient amount of funds that are available in current financial incentive programs as evidenced by the fact that funding for these programs routinely is spent before the program period expires;

- Lack of understanding of the benefits of EVs, including economic and safety benefits
- Urban municipalities involved in the Sustainable Jersey webinars pointed to limited space and the need to upgrade public parking garages prior to investment in EV charging infrastructure.
- Existing dominant culture in the U.S. that is reliant on single occupancy vehicles
- Stakeholders identified opportunities for development of small businesses owned by residents of LIDACs that can support a transportation electrification economy but that doing so would involve strategic business and workforce development planning and removal of potential obstacles (i.e., access to required insurance, access to training to receive necessary certifications, etc.)
- One stakeholder group (New Jersey Clean Cities Coalition) indicated that many school districts are not prepared to handle the high cost of electric school buses as well as their maintenance and, as such, CPRG funds should be used to promote other renewable bio-based fuels especially for school buses.
- Urban municipalities involved in the Sustainable Jersey webinars pointed to the need for technical assistance, especially to LIDACs, to ensure that they have sufficient capacity to lead projects. For example, municipalities talked about possible procurement challenges to electrifying their fleets and installing EV charging infrastructure which would benefit from CPRG funding being used to develop strategies to address these challenges that can be used by multiple municipalities.

Benefits/disbenefits to low income and disadvantaged communities

Stakeholders identified many diverse benefits to residents of LIDACs which would result from dedicated and increased funding for emissions reduction initiatives in the transportation sector in the six areas outlined above, including:

- Improved air and noise quality as a result of electrification of the transportation sector, especially in and around LIDACs, urban and densely developed population centers;
- Increased resilience to natural hazards and climate change through adoption of land use patterns that not only reduce vehicle miles traveled but that also strategically expand natural systems to deliver ecosystem benefits such as protection from climate impacts;
- Greater physical activity for residents of LIDACs as a result of adoption of land use and smart growth patterns and transit-oriented development that promote walkable, bikeable mobility options;
- Greater mobility, especially for residents of LIDACs who may not have access to personal vehicles, through availability of electric micro mobility options, greater transit options and electric community rideshare programs;
- Greater beautification of communities, especially LIDACs, through planning, design and development of communities that follow smart growth strategies, use of nature-based infrastructure, and low carbon land use patterns.

Benefits/disbenefits to workforce development

- Stakeholders indicated that there is a need to establish programs to provide a "just" transition for workers that are currently in jobs such as gas station attendants, fossil fuel vehicle repair technicians, etc.;
- Specialized training is needed to prepare electricians, mechanics, and other workers to support electric and zero emission vehicles;
- Specialized training is also needed to prepare workers to install charging systems and to educate owners and operators about use of charging stations;
- Stakeholders emphasized that all training programs associated with workforce development and jobs creation and retention should be designed to recruit residents of LIDAC and that doing so should be done in collaboration with trusted local organizations within LIDACs;

- Training is also needed for workers who can lead and be engaged in planning and design of land use, smart growth, and transit-oriented development efforts that result in measurable reductions of emissions.

Projects ready for funding

- Specific projects that participating stakeholders identified as ready to go and can be implemented in the short-term include:
- Investment of additional resources in current financial incentive programs for EV purchase, leasing and charging such as NJZIP and Charge Up NJ;
- Establishment of electric community ride share programs such as the recently adopted one in Trenton; advancing such programs would involve proactive outreach on the part of the state to LIDACs to encourage interest and participation in development and implementation of additional pilot programs;
- Investment in design and implementation of the Waterfront Reclamation and Redevelopment Project in Trenton, NJ;
- The Atlantic County Utilities Authority (ACUA) is prepared to incorporate a component of using electric and natural gas garbage trucks and waste-to-energy technologies as part of its current initiative to convert landfill gas to renewable natural gas to fuel garbage trucks;
- Investment in current projects/systems that, with additional funds, can be expanded to contribute to measurable reductions of emissions in the transportation sector, including:
    - Having the state launch a funding call for projects that are “ready to go” that are focused on active transportation infrastructure including complete streets, bicycle infrastructure, off-road recreational trails and electrified transit services; couple this effort with funded technical assistance to provide the support needed by project sponsors to take projects that are almost “ready to go” past the finish line to design and implementation;
    - Invest in grants for planning establishment, enhancement and expansion of local trails that link trails to parks and other destinations projects; focus on investments in LIDACs and provide technical assistance designed to take projects that are almost “ready to go” past the finish line to design and implementation. Expand staffing of New Jersey’s Trails Program with additional staff focused on efforts in LIDACs.
    - Establish grant programs and technical assistance support to local and regional agencies’ adoption of green and complete street programs with a focus on LIDACs.
    - Establish grant programs and technical assistance support to local and regional agencies’ adoption of Vision Zero initiatives that intersect with efforts resulting in measurable reduction of emissions with a focus on LIDACs.
    - The state Department of Transportation also suggests emphasizing grant programs that promote signal synchronization and investment in air quality modeling (i.e. CMAQ) to track and monitor reductions in exposures to emissions as a result of CPRG transportation initiatives.

Key insights

Key insights from the stakeholder engagement are noted below.

- Stakeholders stressed that current financial incentive programs for transportation electrification (purchasing, leasing, installation of charging infrastructure) are insufficient to meet demand and that immediate actions to be taken can involve investing more funds in these programs especially with a focus on investment in LIDACs;

- Stakeholders emphasized the need for education and outreach programs that are aimed both at the general public to increase willingness to adopt EVs, but that are also aimed at strategic audiences such as school districts and municipalities to promote use of available funds especially in LIDACs;
- Stakeholders also emphasized that, since funding for smart growth-type, TOD and other land use related projects have been insufficiently funded in the past, there is a need to strategically fund efforts now to update projects that are in the conception phase to undertake the design and planning needed to have them "shovel ready." These efforts would include:
    - supporting "pre-funding" of local agencies to be able to apply for additional "shovel ready" funding, technical assistance to local agencies to take conceived projects and get them "ready to go;" and
    - Funding of a technical assistance resource center to be available to work with local agencies to take projects from conception phase to "ready to go" phase.

Recommendations for future outreach efforts for the Comprehensive Climate Action Plan and Status Report

- These most recent stakeholder efforts identified considerable interest associated with investments in capacity building (funding for design and planning, technical assistance support, etc.) to take conceived projects associated with land use, smart growth, and transit-oriented development to prepare them to be "shovel ready." To this end, future stakeholder engagement efforts that will be undertaken to support development of the CCAP would benefit from targeted engagement of local agencies (county, municipal, regional) that have a strong interest in advancing such approaches to community design to better understand the nature of their funding and technical assistance needs;
- Stakeholders pointed to the electrified community rideshare pilot effort in Trenton as one that can be targeted for replication in other communities. Future stakeholder efforts for development of the CCAP would benefit from engagement with the organizational leaders of the Trenton pilot project to inform interest and input from other communities as to funding needs and potential challenges;
- Stakeholders identified opportunities to create jobs and workforce development opportunities, especially for residents of LIDACs, to support the emerging electrified transportation sector. They pointed to the need for training and education of workers to be prepared to, for example, repair and maintain electric vehicles, charging infrastructure as well as to support smart growth community planning. Future stakeholder to support development of the CCAP would benefit from engagement work agencies involved in workforce development and training programs to ensure development of such programs in ways that deliver benefits to residents of LIDACs;
- Stakeholders involved in the EJ Community dialogue strongly oppose any effort to advance renewable natural gas and biofuels in LIDACs and overburdened communities. Further engagement on this issue is needed to allow stakeholders more opportunity to provided more detailed comments on their concerns.
- Further engagement with the EJ community is also needed to more comprehensively plan a dedicated spending plan for CCAP funds in EJ communities including building capacity of those communities.

Natural and Working Lands

(Includes Forested Lands, Developed Lands including Urban Forestry, Agricultural Lands, Aquatic Habitats, Tidal Wetlands and Non-Tidal Wetlands)

Priorities identified by stakeholders

In summary, stakeholders identified approximately 20 priority actions across land use types, while one key area (acquisition, preservation, restoration of natural undeveloped land or inactive farmland) was identified across land use types. Priority climate actions for Natural and Working lands to reduce greenhouse gas emissions and/or sequester carbon include the following organized across land use types and by land use type:

Acquisition/Preservation/Restoration

- Prevent development of natural undeveloped land or inactive farmland to preserve existing carbon sinks and prevent further greenhouse gas (GHG) emissions from construction and car-dependent development and re-nature vacant, flood-prone and dilapidated properties to enhance sequestration.

Agriculture

- Prioritizing perennial crops and agroforestry.
- Increase approved USDA NRCS Agroforestry practices and increase support for agroforestry practices which are expensive to implement and have a long lead time for farmers to benefit from implementing such practices. Stakeholders stressed the need to increase support and make it affordable for farmers to implement agroforestry.
- Support funding for holistic transition of farms from conventional to organic farming by weaving agricultural incentive programs together into one program.
- Support more programs to transition more open preserved land from conventional to organic farming including technical assistance.

Tidal Wetlands

- Addressing tidal wetlands, including transgression opportunities and coordination between NJDEP and New Jersey Dept of Agriculture.

Lawn/Landscaped areas

- Replace grass with mixed planting of trees, bushes, flowers.
- Replace gas-powered landscaping equipment with electric equipment through rebates, other incentives or regulation of professional landscapers.

Forests/Forestry

- Identify "primary forests" and prioritize for protection: New Jersey forests never cleared for agriculture store twice as much soil carbon as forests previously cleared for agriculture.[4]
- Support proforestation.
- Support no logging on public lands.
- Develop market for New Jersey Forest products.
- Support deer management on forest lands important for forest regeneration on public and private land (private land includes forest farms that conduct maple sugaring).
- Establish grant program to support funding for deer management on forest lands.
- Improve access to tree seedlings from local sources at a reduced cost compared to costs from private sources.

Urban/Community Initiatives

- Support urban forestry programs.
- Support green infrastructure and green streetscapes (trees, bioswales), and free shade tree programs for businesses and residents that include funds for trees, installation, design consultancy, sidewalk demolition and repair.

Challenges and Opportunities identified by Stakeholders

One challenge common across land types is the high property value of New Jersey land and therefore access to land, leasing land, and transitioning land face real estate pressures and high costs. The largest barriers and challenges, as well as opportunities stakeholder noted in implementing measures to reduce greenhouse gases and/or sequester carbon on Natural and Working Lands by land type are:

Agriculture

- Agroforestry practices are expensive, require long lead times to implement (and therefore long time for farmers to reap benefits) and NRCS practices do not include enough agroforestry practices.
- NRCS EQIP programs do not provide funding in an amount adequate to address the real cost of doing business in New Jersey.
- NRCS programs are piecemeal by program for individual practices but do not provide an incentive for conventional farms to convert to organic farms.
- Leasing land is expensive for underserved farmers.
- Resources need to be expanded to supplement soil remediation work underway for urban agriculture and factor in soil testing costs to ensure safe for farming.

Tidal Wetlands

- Permitting time and expense is a challenge.
- A need is better understanding and accounting of sea level rise in tidal wetland projects.

Urban Land

- Community access to urban land is a challenge.
- Soil contamination is a challenge.

[4] Kelly, J. and Ray, J., 2023. Regional impacts of agricultural land use history on forest vegetation and soils: Comparing primary and post-agricultural forests in Northern New Jersey. Forest Ecology and Management Volume 549. Article 121427. https://doi.org/10.1016/j.foreco.2023.121427.

Benefits/disbenefits to low income and disadvantaged communities

Stakeholders identified the following benefits and disbenefits of priority actions on Natural and Working Lands with respect to low income and disadvantaged communities:

- Improve soil, water, air quality by incentivizing regenerative farming. For example, the South Jersey Farmers, Equity and Sustainability Taskforce (SJ FEAST) is a project of the Pinelands Preservation Alliance (PPA) and partners to create a collaboration of farmers and nonprofits to improve soils, water and air quality by incentivizing regenerative farming practices through new and improved market systems and support for local growers and bringing locally produced foods to new and underserved consumers.
- Since urban access to land is a challenge any support to help communities access urban lands is useful.
- Providing low-cost leases to underserved farmers (an example of this is a partnered project of the New Jersey Conservation Foundation and Foodshed Alliance).
- Increase urban tree planting.
- Food security: sovereignty, access to fresh, nutritious & ethnically appropriate food is a benefit.
- Expanded resources for soil remediation benefits disadvantaged communities.
- Potential disbenefit for low income and disadvantage communities (LIDAC): if CPRG program requires a match/leveraging of other funds.

Benefits/disbenefits to workforce development

Stakeholders identified the following benefits and disbenefits of priority actions on Natural and Working Lands with respect to workforce development:

- Technical assistance and mentorship provide benefits to workforce challenges.
- Enhancement of New Jersey Agricultural Experiment Station (NJAES) ag extension staffing would be a benefit.
- Losing staff w/ extensive knowledge to retirement (e.g., Upper Delaware Soil Conservation District) is a challenge in workforce development.
- Shortage of foresters is a workforce challenge.
- Salary enhancement is needed to ensure beginning farm workers have a living wage.
- Apprenticeship and training for careers in underserved communities are available but not geared toward agriculture: thus, stakeholder recommend developing a statewide apprenticeship program to train people and conduct outreach to let them know agriculture is a viable career path.

Projects ready for funding

Specific projects that participating stakeholders identified as ready to go and can be implemented in the short-term on natural and working lands include:

- New Jersey Conservation Foundation (NJCF) and Sourlands Conservancy could expand tree plantings in the Sourlands region on the new Rainbow Hill Preserve which includes fencing islands of areas with good native forest regeneration, continuing to identify these smaller areas where native forest regeneration can be beneficial, and where fencing is financially feasible.
- Increased Atlantic White Cedar restoration on Franklin Parker Preserve by New Jersey Conservation Foundation.
- Pinelands Preservation Alliance (PPA) has several South Jersey municipalities ready to plant 50-100 trees.
- PPA coordinates New Jersey Landscape Makeover Program and has more than 40 municipalities interested in green stormwater infrastructure projects which include naturalization of basins,

removal of lawns and converting to bioswales, and other projects that reduce carbon due to reduction of mowing.

- Municipalities involved in the Sustainable Jersey webinars pointed to projects that could be ready to go with some additional funding to support project planning and design, including projects related to tree planting, reforestation of public lands, tidal marsh restoration, living shorelines and land preservation.

Key insights

While time constraints and the format of the engagement limited a more robust dialogue and therefore the ability to prioritize among the actions identified, planting trees was supported by multiple stakeholders as applied to agriculture, urban areas, replacing lawns, and as shade trees.
Deer management was also cited by several stakeholders related to forest regeneration including its importance for public and private lands.

While time constraints in this process favors resourced advocates for "projects ready to go," intermediaries like Northeast Organic Farming Association of New Jersey (NOFA-NJ) noted their hosting a community forum on conservation forum which could be a way in to identify other ready projects.
Discussion with USDA Natural Resources Conservation Service would be helpful on reconciling their programs, as well as work to address Emerald Ash Borer issues referenced by several stakeholders (including one facing this challenge with their sugarbush).

There could be a difficult balance between stakeholders who oppose logging and those who propose creating a market for New Jersey Forest products. The comments were not specific enough to know if the pro-logging was for public land but the comments against logging focused on public land so this may provide for a possible distinction.

There was less emphasis on coastal and aquatic natural and working lands than upland forests and agriculture among the participants. While aquatic habitats are identified by NJDEP as included in this sector, there was no mention of actions related to Submerged Aquatic Vegetation (SAV).

Stakeholders from the buildings and energy sector engagement mentioned the need to think holistically across sectors and couple carbon sequestration strategies along with priority actions for energy and buildings (see more details in the Buildings and Energy Sector summary). The notes from the EJ community dialogue echo a similar sentiment in terms a community eco-plan from transportation to buildings to energy to food waste with local work force training and hiring to green the neighborhood and the idea of an Eco-village pilot project inclusive of the six priority areas.

Recommendations for future outreach efforts for the Comprehensive Climate Action Plan and Status Report

NJDEP might consider more intentionally targeting stakeholders specific to priority actions for tidal and nontidal wetlands and coastal aquatic habitats as these did not appear to be as well represented as other land use types in the engagement opportunities. NJDEP might also want to probe stakeholders regarding distinctions between forest product market development on public vs. private land. Lastly, NJDEP and partner agencies might want to explore in the future fleshing out additional ways to integrate these priority actions with other sectors as mentioned by the Buildings and Electric Generation and EJ engagements.

Buildings (Commercial and Residential) and Electric Generation

Priorities identified by stakeholders

These two sectors were combined by NJDEP into one stakeholder engagement webinar. In summary, numerous priorities regarding incentives and incentive programs and a wide array of technologies for the Building and Electric Generation sectors were identified. Further, "out of the box" integrative approaches that focused beyond one technology within a sector and across these and other sectors were emphasized by several stakeholders. These approaches included support for project scale and campus scale planning, development and implementation; integrative approaches across all PCAP sectors as demonstration projects, and technology synergies for high impact to decarbonization.

Below are priority climate actions for buildings and electric generation sectors to reduce greenhouse gas emissions broken out by these two sectors and then by cross-sector priority approaches emphasized by several stakeholders:

BUILDINGS (COMMERCIAL AND RESIDENTIAL) PRIORITIES

Incentives and Incentive Programs

- Increase Incentives: other states (Massachusetts, New York, Maine) have bigger incentives than New Jersey for these sectors.
  - Cover weatherization and converting space heating of low-income residences to heat pumps.
  - Higher rebates for heat pumps for moderate income residents and small business.
  - Incentivize new construction affordable housing be built to weatherization standards and be fully electric.
  - Quickly roll out the Inflation Reduction Act Home Rebate program.
  - Incentivize heat pump water heaters, electric ranges, heat pump dryers, electric lawn equipment. and necessary electric service and panel upgrades to support electrification.

- Focus on equitable access:
  - Provide incentives for low-income housing and measures that avoid passing costs to affordable housing residents.
  - Scale consumer incentives for energy efficiency HVAC based on household income.

- Outreach/Communication/Assistance for Consumers
  - Train and bring tradespeople, HVAC service people, and vendors up to speed regarding incentive programs and options for electric appliances/alternatives to natural gas.
  - Develop better vendor rating system: New Jersey's vendor list does not differentiate who does what best.
  - Differentiate messaging approaches for commercial vs. large residential vs. single family homes as well as for low- and moderate-income residents.
  - Communicate that making buildings electrification ready in areas w/ older home stocks is highly dependent on weatherization, making the homes safe, a solid roof, no lead pipes or fixtures, removing asbestos.
  - Develop a one-stop shop repository across agencies: NJDEP, New Jersey Board of Public Utilities (NJBPU), and New Jersey Economic Development Authority (NJEDA) for all federal, state, county, local funds/incentives for residents and commercial businesses to understand the opportunities and eligibility.

- Develop a Local Volunteer Community-Based Energy Coaching Program under supervision of “New Jersey Energy Office” (presuming NJBPU) to work with residents to recommend energy audit, weatherization, heat and water upgrades. (e.g., New York Energy Coaches, Mass HeatSmart Alliance) tailored to their unique situation.
- Create demand through a tagging system to identify houses that have had home energy audits, been electrified, etc. to demonstrate healthier homes and lower utility costs.

Technology Priorities

- Heat pumps for residential properties but PCAP should also explicitly support heat pumps for commercial properties. Even a relatively small number of commercial heat pump energy users can have a disproportionately large impact especially when combined with decarbonized electricity. Can also have synergy with EVs.
- Municipalities involved in the Sustainable Jersey webinars prioritized installation of new technologies in municipal buildings, including heat pumps and energy storage systems. This can include public housing, senior centers, etc.
- Community scale thermal systems.
- Campus scale thermal and campus scale electricity systems.
- Thermal systems coupled with heat pumps.
- Building Electrification (consider existing buildings a priority rather than new construction which has lower emissions).
- Building Efficiency retrofits.
- Municipalities involved in the Sustainable Jersey webinars pointed to the need for greater funding for weatherization and energy efficiency programs in local government buildings which could also be highlighted as use cases to educate residents about benefits.

ELECTRIC GENERATION PRIORITIES

Technology Priorities

- **Solar**
  - Distributed solar
  - Solar+storage “importance cannot be overstated.”
  - Community scale renewable energy planning and community solar; PCAP should also explicitly include wholesale utility scale solar. Yes, these solar projects can benefit from existing incentives, but economics can be a challenge for local government; therefore, CPRG funds could be used for additional rebates to developers upfront to buy-down capital costs for construction or for low-cost loans, loan guarantees, or other financing structures to provide public access. Municipalities participating in the Sustainable Jersey webinars similarly called for great levels of funding to support community-level and localized solar initiatives.
- Regional Scale Microgrids that use multiple Renewable technologies.
- Off-shore Wind; Waste to Energy, Hydrogen.
- Include repair and replacement of Renewable Energy (e.g., panels, geothermal parts).
- Wave Energy at the shore holds promise.
- Energy Storage Systems: Storage critical and should address short term storage (renewable intermittency, diurnal and peak shifting) and long-term storage issues (seasonal variations from summer generation to support winter loads). The need for funding for storage projects was echoed by municipalities participating in the Sustainable Jersey webinars.

- Address Grid Modernization which includes both Interconnection issues to meet demands for solar/renewables and Congestion.
- Include grid supportive strategies (e.g., early trials of bi-directional EV charging).
- Focus on Demand-Response to remotely control load on the grid (e.g., heat pump water heaters).
- Align timing of renewable with real-time power consumption vs. ensuring renewable energy delivery on a "net annual basis; i.e., enable renewable energy on an hourly basis (matched to load).

CROSS-SECTOR PRIORITY APPROACHES ACROSS BUILDINGS (COMMERCIAL AND RESIDENTIAL) AND ELECTRIC GENERATION AND OTHER SECTORS

- Support Project-Scale Planning, Development, Feasibility Studies and Capital Costs explicitly as eligible costs.
    - Offer favorable financing terms (low-interest loans to ease high capital costs, and/or loan-guarantees for higher risk projects which can leverage CPRG funds).
    - Develop financing modeling tools that provide transparency to full life cycle costs and returns.
    - Municipalities participating in the Sustainable Jersey webinars pointed to the need for funding for local energy storage projects.

- Support Holistic Cross-Sector Integrative Approaches and Use as Demonstration Projects
    - Support Campus Scale "Natural Systems Energy Planning" e.g., @ Duke Farms coupling on-site natural carbon sequestration with 100% clean electricity via renewables, energy storage, heat pumps and EVs.

    - Pilot An Integrated Place-based Neighborhood Approach
        - Support municipal organic waste source separation and energy aggregation via delivery to an energy facility to generate renewable gas or biomass electricity delivered to residents under municipal wide energy aggregation (provides sustainable renewable energy resource and helps address food waste/Food Waste Act implementation).
        - Develop neighborhood by neighborhood pilot in Disadvantaged Community/urban area to upgrade building shell measures of homes and small businesses (insulation, building wrap, windows, doors, weatherstripping) followed by HVAC contractor to test and install right sized cold climate heat pumps and simultaneously upgrade the electric panel and install upgrades of on-site solar and storage and EV charging.
        - Fund neighborhood tree planting, urban forestry planning for carbon sequestration.
        - Develop an Eco-village to promote a pilot project inclusive of 6 Priority Climate Action Plan areas/build a community eco-plan from transportation to buildings to energy to food waste with local workforce training and hiring to green the neighborhood was mentioned at the EJ meeting. This concept was identified by stakeholders participating in the EJ Community Dialogue. Additionally, the concept of creating zones within municipalities as a focused area for emissions reduction and delivering benefits was raised during the Sustainable Jersey hosted webinars.
        - Municipalities participating in the Sustainable Jersey webinars also pointed to the need for efforts in LIDAC communities to make funding available to support home repairs (i.e. mold, roofing, asbestos, exterior shell issues, lead) that must be taken care of before a home is eligible for current federal weatherization funds.

- Prioritize synergies across sectors for high impact to decarbonization: Decarbonized electricity, electric vehicles, heat pumps, energy storage.

Challenges and Opportunities identified by Stakeholders

The largest barriers and challenges, as well as opportunities stakeholders noted in implementing measures to reduce greenhouse gases in the Buildings and Electric Generation sectors are as follows.

BUILDINGS (COMMERCIAL AND RESIDENTIAL) CHALLENGES AND OPPORTUNITIES

- Consumers and vendors/contractors lack knowledge on incentives and providers.
- Messaging needs to be tailored appropriately to different audiences.
- Capital costs, and planning and project development costs for integrated projects (renewable, energy storage, energy efficiency) are challenging without understanding holistic value proposition.
- Supply chain issues necessitating grant period flexibility is a challenge.
- Precursor steps needed to make housing stock more weather efficient before sizing and installing heat pumps. HVAC vendors are not incentivized to address these critical steps.
- Significant local permitting barriers and other regulatory issues. Towns are limited in what they can do through zoning to promote green buildings: can towns use CPRG grant funds as part of a pilot program to reduce or eliminate permit and application fees for proposed LEED buildings?
- Support for municipal resource centers or community-based organization resource centers as locations for Low and Moderate Income (LMI) residents and small businesses to learn about incentives to increase participation.
- Difficult to access information regarding workforce opportunities.
- New Jersey could use one comprehensive hub/website regarding opportunities and eligibility for training, apprenticeships, and wrap around services that would be available for participants.
- Working with vocational schools could be effective to address workforce development needs.
- Municipalities involved in the Sustainable Jersey webinars reiterated the issue that small local governments lack sufficient capacity to apply for large grant programs as well as to do the pre-planning needed to become eligible for grant programs so additional resources and support are needed, especially for LIDACs. Similarly, they pointed to the need for grant programs to provide low-capacity municipalities with funds upfront rather than via reimbursement.

ELECTRIC GENERATION CHALLENGES AND OPPORTUNITIES

- Funding is a challenge for residents, gov, private sector, NGOs, including construction and repair of renewable energy systems for municipalities and utility authorities; other states provide bigger incentives than New Jersey.
- Capital costs, and planning and project development costs for integrated projects (renewable, energy storage, energy efficiency) are challenging without understanding holistic value proposition.
- Supply chain issues necessitating grant period flexibility is a challenge.
- Interconnection to utilities for solar projects is a challenge.
- Community buy-in is a challenge.
- Difficult to access information regarding workforce opportunities.
- New Jersey could use one comprehensive hub/website regarding opportunities and eligibility for training, apprenticeships, and wrap around services that would be available for participants.
- Working with vocational schools could be effective to address workforce development needs
- Hydrogen (H) is controversial. Several stakeholders emphasized negatives about pipeline safety risks, methane leakage, co-pollutant formation especially if from natural gas; even “green H” from zero

emission electricity can result in ozone formation and if used in Internal Combustion Engines form NOX. Stakeholders suggest that hydrogen's best use is for hard to decarbonize industry sectors (concrete, fertilizer and aviation) and if CPRG supports hydrogen projects, NJDEP should require best practices and lifecycle assessment "to ensure that hydrogen generated by and for CPRG projects is truly clean."

Benefits/disbenefits to low income and disadvantaged communities

Stakeholders identified benefits and disbenefits of priority actions in the Building and Electric Generation sectors with respect to low income and disadvantaged communities. These are discussed below broken out by sector.

BUILDINGS (COMMERCIAL AND RESIDENTIAL) BENEFITS/DISBENEFITS TO LOW INCOME AND DISADVANTAGED COMMUNITIES

- Length of time to implement long-term projects can be a disbenefit.
- Low-cost energy provides benefits.
- Incentive program upgrades could be used by landlords to price out tenants (should tie incentives to tenant retention mechanisms to slow down gentrification).
- Location of facilities that implement climate actions in a disadvantaged community where employees are community residents provides economic/jobs benefits.

ELECTRIC GENERATION BENEFITS/DISBENEFITS TO LOW INCOME AND DISADVANTAGED COMMUNITIES

- Low-cost energy provides benefits.
- Zero emissions provide benefits.
- Resiliency and power to critical facilities provide benefits.
- Length of time to implement long-term projects can be a disbenefit.
- Energy transition may leave stranded assets that may become more costly (e.g., natural gas) for LMI households.
- Hydrogen if made from natural gas contributes to global warming (CO_2 emissions and has risk of methane leakage). Even if made from renewable electricity, leaked H can be a precursor to ozone formation and when used in an Internal Combustion Engine can result in NO_x emissions.
- Location of facilities that implement climate actions in a disadvantaged community where employees are community residents provides economic/jobs benefits.

Benefits/disbenefits to workforce development

Stakeholders identified the following benefits and disbenefits of priority actions in the Buildings and Electric Generation sectors with respect to workforce development broken out by Sector.

BUILDINGS (COMMERCIAL AND RESIDENTIAL) BENEFITS/DISBENEFITS TO WORKFORCE DEVELOPMENT

- Education and technical knowledge are needed.
- Tradespeople, Technicians and Engineers are needed.
- Technical Training in heat pump technology and usage is needed.

ELECTRIC GENERATION BENEFITS/DISBENEFITS TO WORKFORCE DEVELOPMENT

- Education and technical knowledge are needed.
- Tradespeople, Technicians and Engineers are needed.

Projects ready for funding

Specific projects that participating stakeholders identified as ready to go and can be implemented in the short-term in the Buildings and Electric Generation sectors include those below by sector as well as those across these two sectors and other sectors.

BUILDINGS (COMMERCIAL AND RESIDENTIAL) PROJECTS READY FOR FUNDING

- DRM Architects has municipal clients who are interested in funding energy efficiency projects as part of their own municipal building improvements.
- Gabel Associates has a long list of potential projects to conduct this work - the challenge is going to be getting these projects to scale (potentially through aggregation) suitable for funding through CPRG. Doing groups of projects is likely to be key to effectiveness.
- Passaic Valley Sewerage Commission: Beneficial reuse of wastewater for building electrification. Heat pumps coupled with wastewater can be used to replace fossil fueled equipment at very high efficiencies. PVSC wastewater would be used as heat sink to replace cooling towers, boilers and refrigerant condensing units. "Potential capacity to put a large dent in the NJDEP goals on building electrification. (400,000 homes & 20,000 commercial properties for low-income residents)."
- Several municipalities involved in the Sustainable Jersey webinars pointed to solar projects on public spaces/buildings that are ready for implementation.

ELECTRIC GENERATION PROJECTS READY FOR FUNDING

- Gabel Associates has a long list of potential projects to conduct this work - the challenge is going to be getting these projects to scale (potentially through aggregation) suitable for funding through CPRG. Doing groups of projects is likely to be key to effectiveness.

CROSS-SECTOR PROJECTS: BUILDINGS (COMMERCIAL AND RESIDENTIAL) AND ELECTRIC GENERATION AND OTHER SECTORS READY FOR FUNDING

- Duke Farms campus scale planning to drive down emissions reductions while maximizing carbon sequestration across their 2,700 acres.
- In Newark, MnM consulting notes there is conversation with PVSC on developing a thermal network in collaboration with the long-term stormwater control plan which would be a distributed energy opportunity for downtown Newark.
- Municipalities involved in the Sustainable Jersey webinars encouraged NJDEP to prioritize funding for renewable and energy efficiency projects at affordable and public housing locations.
- The Stavola Companies are looking at a structure /project in Newark that will not only reduce natural gas consumption but include 30,000 sq.ft. of solar panels to reduce energy consumption and feed back into the grid as well.
- Atlantic County Utilities Authority: Hydrogen pilot project with DOE and partner funding uses wastewater effluent to create O_2 (to aeration basin) and H_2 (to utility pipelines) but needs additional funds. ACUA also has several energy efficiency projects: conversion of mechanical mixer to air diffuser for aeration; geothermal repair, waste conversion system.
- Municipalities involved in the Sustainable Jersey webinars encouraged NJDEP to consider projects that involve energy upgrades to wastewater treatment plants.

Key insights

The following Key Insights are identified from the stakeholder engagement pertinent to Buildings (Commercial and Residential) and Electric Generation Sectors, and for Cross-Sector projects involving these sectors and others.

KEY INSIGHTS FOR BUILDINGS (COMMERCIAL AND RESIDENTIAL)
Stakeholders stressed the need for sufficient opportunity to review the draft PCAP before submission; "while the DEP/BPU presentation was a good start, stakeholders could provide more helpful targeted comment if they had more specific details."

Stakeholders suggested DEP can identify top priorities for these sectors based on:
- Scope of emissions reduction (e.g., % of total emissions)
- Proven feasibility.

Stakeholders emphasized a need to improve incentive programs to facilitate electrification coupled with building shell upgrades, equitable access to avoid passing costs onto lower income residents, and improved program outreach and assistance.

The energy transition has the potential to leave stranded assets (e.g., natural gas) that may become more costly for LMI households.

KEY INSIGHTS FOR ELECTRIC GENERATION
Stakeholders stressed the need for sufficient opportunity to review the draft PCAP before submission; "while the DEP/BPU presentation was a good start, stakeholders could provide more helpful targeted comment if they had more specific details."

Stakeholders suggested DEP can identify top priorities for these sectors based on:
- Scope of emissions reduction (e.g., % of total emissions)
- Proven feasibility.

The energy transition has the potential to leave stranded assets (e.g., natural gas) that may become more costly for LMI households.

Hydrogen is controversial and stakeholders encouraged where CPRG funds are used for hydrogen projects, New Jersey should require best practices and full lifecycle emissions accounting assessment.

KEY INSIGHTS FOR CROSS SECTOR PROJECTS: BUILDINGS (COMMERCIAL AND RESIDENTIAL) AND ELECTRIC GENERATION AND OTHER SECTORS
Stakeholders stressed the need for sufficient opportunity to review the draft PCAP before submission; "while the DEP/BPU presentation was a good start, stakeholders could provide more helpful targeted comment if they had more specific details."

Stakeholders suggested DEP can identify top priorities for these sectors based on:
- Scope of emissions reduction (e.g., % of total emissions)
- Proven feasibility.

Several stakeholders challenged NJDEP and NJBPU to think campus wide, holistically across all PCAP sectors, synergistically, and fund pilot approaches and demonstrations of integrated and innovative projects including private public partnerships.

Stakeholders emphasized that capital costs, and planning and project development costs for renewable, energy storage, energy efficiency are challenging when potential project developers do not understand the holistic value proposition and full lifecycle costs and returns. They suggest New Jersey should offer favorable financing (e.g., low interest loans or loan guarantees) to ease costs or higher risk projects to leverage funds.

Hydrogen is controversial and stakeholders encouraged where CPRG funds are used for hydrogen projects, New Jersey should require best practices and full lifecycle emissions accounting assessment.

Recommendations for future outreach efforts for the Comprehensive Climate Action Plan and Status Report

As noted already, stakeholders who participated in engagement related to both Buildings (Commercial and Residential) and Electric Generation Sectors stressed the need for sufficient opportunity to review the draft PCAP before final submission to provide more helpful targeted comments if they had more specific details beyond the presentation made during the state engagement webinar.

Halogenated Gases

Priorities identified by stakeholders

Stakeholders broadly agreed that a shift to sustainable refrigerant practices are important and that an ongoing dialogue between stakeholders and NJ DEP should continue as further rulemaking and policy decisions are made at the state level. While refrigerant equipment owners should be responsible for a portion of the costs of upgrading to low-GWP equipment, NJDEP should also offer financial incentives and assistance to help offset the cost of replacing equipment.

- NJ DEP should provide incentives to businesses for upgrading refrigerant equipment to low-GWP equipment similar to other Energy Savings Programs. This would help companies that manage multiple facilities (ex: grocery stores) that all require varying degrees of upgrades to meet NJ DEP requirements.
- NJ DEP can make it easier for businesses to recycle refrigerant equipment by providing a list of certified recycling businesses within the state. This list should be accessible online, so stakeholders have easy access to updated information.

Challenges and Opportunities identified by Stakeholders

Challenges:

- There is not much public knowledge about what halogenated gases are and their ability to contribute to climate change.
- New refrigerant equipment and upgrading to low-GWP refrigerants costs more money, especially if the old equipment that is getting replaced is still considered operational. Refrigerant compliance is phasing out faster than the equipment itself.
- An additional challenge that has not directly been identified by these New Jersey stakeholders but by other states include the concern that small businesses who have older facilities and/or cannot afford to upgrade to low-GWP equipment will be forced to close their business. This is of particular concern for grocery stores in locations with limited food options, leading to the creation of a food desert if they were to close.

Opportunities:

- NJ DEP can start to produce promo materials, infographics, and a website with information on halogenated gases and refrigerant equipment.
- There is a need for more workers in the halogenated gas industry. Workers are not required to have a college degree, making jobs accessible to a broader portion of the workforce.
- Environmental commissions and municipal organizations are interested in better understanding halogenated gas impacts so they can better implement actions at the local level.

Benefits/disbenefits to low income and disadvantaged communities

- The transition to low-GWP equipment is a very direct action to producing less emissions that will directly benefit local communities.
- Some refrigerant businesses will recruit within the community they're located in, so if they're located in a disadvantage community they will pull directly from the area.
- People with high school degrees have the ability to make up to six-figure salaries working in the refrigerant-industry.

Benefits/disbenefits to workforce development

- Businesses will always need employees who are willing to work and can be trained in handling refrigerants.
- Employers are understaffed and only a small number of employees know how to operate and repair low-GWP refrigerant systems.
- Employers prefer employees with technical and hands-on training (through trade school, high school vocational program, or community college). Computer skills are highly valued for potential employees. HVAC training is an additional bonus.

Projects ready for funding

N/A

Key insights

- Low engagement in stakeholder meetings could be due to a lack of awareness, low stakeholder capacity that prevents participation during the workday, or a lack of desire to engage on the subject area.
- There is a desire from environmental commissions/municipalities to learn more about halogenated gases as indicated in the NJ DEP comment portal.
- Refrigerant stakeholders should be further engaged with to better understand challenges with low-GWP policies.
- NJ DEP should model incentives program for refrigerant industry off of any kind of energy saving program (ex: Clean Energy NJ or PSEG Rebates).
- New refrigerant policies render current equipment obsolete. This contributes to additional costs and labor for businesses to dispose of or upgrade operational equipment.

Recommendations for future outreach efforts for the Comprehensive Climate Action Plan and Status Report

Stakeholders should be further engaged with to better understand challenges with low-GWP policies. Stakeholders that participated in past outreach events and future events should be asked to suggest other potential participants.

Food Waste

Priorities Identified by Stakeholders:

Stakeholders identified five priority climate actions for the food waste sector.

- **Statewide Education/Awareness Campaign**: Development of a campaign to educate local governments and residents about the contribution that food waste makes to climate change and feasible actions that can be taken to reduce household food waste.
- **Community-Scale Compost Systems**: Establishment of low-tech, cost-effective, community-scale food waste compost systems.
- **Surplus Meal Recovery**: Inclusion of surplus prepared meals in food recovery and distribution programs.
- **Permitting Clarification**: Clarification and science-based revamping of permitting requirements for farms and other entities involved in composting.
- **Guideline Development for Farms**: Creation of better guidelines for local farms to manage food waste composting efficiently.

Challenges and Opportunities Identified by Stakeholders:

Stakeholders identified several general and specific challenges, barriers, and opportunities for advancing food waste initiatives designed to advance measurable reduction of emissions. Stakeholders discussed current challenges as being legacies of historic environmental regulatory strategies that did not promote sustainable organic waste management and that such strategies have not "kept up" with the latest science regarding sustainable organic waste management. Stakeholders also discussed the promising partnerships that can be formed through collaboration with organizations aiming to recover food waste, organizations aiming to address food insecurity, and organizations seeking to advance sustainable organic waste management. Stakeholders pointed to synergies from these intersections that can have particular benefits to LIDACs. Challenges identified by stakeholders include:

- **Regulatory Obstacles**: Stakeholders report that the current DEP regulatory system is a legacy system from a period when science and practices supporting sustainable organic waste management were not well developed. Stakeholders report that the current regulatory system is a tremendous barrier that will continue to hinder statewide efforts to recover food waste and manage it in ways that are sustainable and that result in measurable reductions of emissions. In particular, stakeholders indicate that the current regulatory system does not incorporate any incentives for sustainable organic waste management practices, including small scale composting and food waste recycle, such as reduced permit application fees and less onerous permit application requirements. In particular, stakeholders called for: a tiered regulatory system that favors sustainable organic waste management, food waste recycling and composting; a differential fee structure that requires minimal or no permit fees for small scale composting applicants; and a reform of the permit structure for Research, Development and Demonstration (RD&D) projects to promote streamlining for sustainable organic waste management project innovation and to offer clarity as to operations that may be included in RD&D permits.

- **Limited Refrigeration at Pantries and food recovery operations**: Stakeholders pointed to chronic challenges associated with inadequate refrigeration capacity within food recovery organizations including lack of access to refrigerated trucks to facilitate collection and recovery of food wastes. Stakeholders also indicated that there is current no database of surplus and/or available refrigeration and food-handling equipment for schools and food recovery operations to promote off-site redistribution of excess food. Furthermore, stakeholders indicated that there is a lack of clarity as to sources of funds that are available to food recovery and food rescue operations to obtain refrigeration and other equipment. Stakeholders point to the improvement in food recovery efforts in Bergen County when refrigeration was provided to 24 food pantries across the County during the COVID-19 pandemic.
- **Solid Waste Management System Gaps**: Stakeholders point to outdated requirements for county level solid waste planning that lacks any requirements for food waste plans and challenges in food waste facility approvals. Stakeholders called for a restricting of rules and guidance that direct county solid waste management planning that promotes or even requires incorporation of food waste recovery planning in county plans.
- **Legal Limitations**: Current laws do not support post-consumer food waste recovery (scraps), which creates significant obstacles for large institutions such as hospitals, schools and universities).
- **Education Gaps**: Stakeholders discussed that most people do not understand that food waste is a contributor to climate change, nor do they understand the technologically feasible and economically benefit options available that are associated with food waste recovery, composting, recycling and other forms of sustainable organic waste management.
- **Technological Advancements**: Stakeholders recounted the technological advances that have occurred over the past decade that allow for efficient, clean and cost-effective recovery and sustainable management of food waste. They identify current, cost effective and technologically feasible opportunities to undertake pilot projects at wastewater treatment facilities to install anerobic digester vessels to process good waste. Some stakeholders urged funding support for research into technologies that turn food waste into energy.
- **Impact of New Jersey EJ Law**: Because New Jersey's 2020 Environmental Justice law regulates certain solid waste facilities, stakeholders discussed the need for analysis to understand whether actions under the EJ law will hinder innovative sustainable organic waste management efforts.
- **Food packaging**: Stakeholders pointed to a need for further analysis of New Jersey's plastics law and whether its provisions can be used to reduce and recycle plastic packaging associated with food waste. Stakeholders also called for research on best practices for food packaging in order to develop guidance on proper management (recycling, light-weighting, compostables, biodegradables) as well as for ease of food waste recovery.
- **Incentivization of Programs**: Stakeholders stressed the need for funding support for comprehensive programs that: encourage food scrap drop-off and pickup programs, engage and incentivize large institutions in food recovery efforts, and develop more comprehensive guidelines for local farms and community gardens to compost food waste. Additionally, they encouraged funding support be given to food recovery operations and pantries to undertake a comprehensive needs assessment of food recovery organizations to prioritize areas and funding needs.
- **Pilot programs**: Stakeholders urged that funding be made available for implementation of innovative programs related to food recovery, recycling, composting and sustainable organic waste management. Examples provided include: pilot efforts that provide funding for local farms that are ready to accept viable food scraps for livestock feed with the intent of documenting outcomes to inform scale up statewide; pilot efforts that involve operations of local small-scale composting

operations that integrate use of renewable and other technologies such on-site renewable energy; pilot projects that promote food recovery using EVs and that are in proximity to transit corridors.

Benefits/Disbenefits to Low-Income and Disadvantaged Communities:

Stakeholders identified several benefits to residents of LIDACs stemming from acting on food waste.

- **Community Composting**: Benefits of community-based composting include improvement of soil quality and erosion control, community beautification and expansion of open spaces, educational opportunities for residents and youth and a reduction of contributions to landfills which may translate to less transport of wastes to landfills through residential areas. Participants in the EJ Community Dialogue emphasized the need for DEP to remove barriers to community composting which could be an important economic opportunity for residents of LIDACs. Several stakeholders on the sectoral webinar emphasized that community-based composting should not be advanced at the expense of disbenefits to LIDACs. For example, stakeholders indicated that promoting community composting should not contribute to worsened air quality, neighborhood smells and/or emissions in LIDAC communities regardless of whether those disbenefits are the result of direct (composting) or indirect (transportation to/from composting centers) actions.
- **Food Recovery**: Recovery and redistribution of recovered food can contribute to enhanced food security, cost savings on food, and creation of local jobs for workers involved in food recovery and redistribution efforts.
- **Community improvement**: Stakeholders in the EJ Community Dialogue emphasized the need for food recovery and distribution efforts as well as collection of food waste in LIDACs to be sensitive to the impact of “big amazon trucks” on streets and to, instead, create funding opportunities to support deployment of less polluting and less noisy electrified vehicles to be the technology used for food recovery, distribution and food waste systems. Additionally, stakeholders in the EJ Community Dialogue pointed to the economic, community and food security value of local community gardens that can be leaders in composting and which were tremendously affected by the COVID-19 pandemic; stakeholders recommended that funding priorities should include reinvigoration of community gardens in LIDACs that also are involved in local composting of wastes including but not limited to garden outputs.

Benefits/Disbenefits to Workforce Development:

Stakeholders indicated that there is a need to establish programs to provide a just transition for workers to become successfully employed in the food waste sector.

- **Job Creation and Economic Growth**: Benefits can include the creation of local jobs related to food recovery and composting, food recycling. Training workers to be engaged in these fields can create opportunities for residents of LIDACs.
- **Training and Labor Requirements**: Training is currently available for large scale composting operations, but similar training is not available for smaller scale composting, institutional food recovery efforts, and innovative programs that recovery and redistribute food. Training is needed with regard to current and emerging technologies for composting including small scale composting efforts.
- **Support Services**: Wraparound services are needed to encourage workers from LIDACs to participate in workforce development programs related to food recovery, food recycling and sustainable organic waste management. Opportunities also exist for workforce development in large institutions to lead food recovery and sustainable organics waste management efforts. Necessity of additional support for workers from disadvantaged backgrounds.

Projects Ready for Funding:

Actions that participating stakeholders identified as ready to go and can be implemented in the short term include:

- **Replication of Successful Models**: Stakeholders discussed innovative programs in Ridgewood, NJ focused on food waste recovery and the strong interest of other municipalities to learn from and replicate these efforts. Stakeholders discussed the value that having a blanket RD&D permit for such operations can contribute to immediate replicability in other communities.
- **Infrastructure Support**: Immediate needs include procurement of and distribution of containers for food waste recovery in communities that want to immediate initiative food recovery projects. Support is needed for "match making" communities recovering food waste and distribution centers and facilities (i.e., wastewater treatment) that can sustainably process such waste. For example, Waste Management Inc., runs the Monmouth County landfill and is engaged with county commissioners on an initiative to collect and transfer out food waste to facilities that can treat it sustainably. As another example, stakeholders pointed to the 24 wastewater treatment facilities in the state that currently have excess capacity and to undertake pilot programs with willing partners to direct food waste to their operations.
- **Best Practices Study**: There can be important lessons learned from an examination of exemplary food recovery and composting programs in other states.
- **Use of communication technology**: Stakeholders talked about the ready availability of apps and other communication technologies that can immediately be deployed to connect food generators (restaurants, large institutions, etc.) with food recovery operations.
- **Capacity Building**: A more comprehensive and definitive assessments of the needs for food recovery operations in the state (i.e., pantries) to document specific funding needs.
- **Technical assistance program**: A statewide technical assistance program is needed that can provide on-demand support to communities working to advance sustainable organic waste management efforts and to design efforts in a way that will meet regulatory standards. For example, Ridgewood is ready to launch a static pile composting project but is encountering regulatory hurdles.
- **Awareness Campaigns**: Immediately needed is support for awareness and education campaigns that can be used by municipalities to educate residents about: the importance of food recovery and its contribution to climate change, practical use of composted materials, availability of resources and technical assistance to support food waste and sustainable organic waste expansion and interest on the part of the state to engage sets of municipalities in pilot efforts.
- **Innovative Pilots and Expansion**: Testing new processes for food waste management and expanding existing programs. Stakeholders discussed the need for resources to convene innovative technology developers to promote new technologies.

Key Insights:

- Stakeholders stressed that, without reform of NJDEP regulations, New Jersey will not make significant advances with regard to recovery of food waste and advancement of sustainable organic waste management.
- Stakeholders emphasized the necessity of funding for innovative pilot projects to promote and replicate innovation.

Recommendations for Future Outreach Efforts:

- These most recent stakeholder efforts identified considerable interest associated with furthering stakeholder involvement and exploring regulatory flexibility to enable innovative approaches to food waste management. Additionally, they pointed to immediate funding needs that would support the intersection of food recovery efforts, sustainable organic waste management and recycling. A valuable opportunity to inform development of the Comprehensive Climate Action Plan is convening diverse stakeholders involved in food recovery, sustainable organic waste management, large food generators (i.e., institutions), waste treatment facilities (wastewater treatment facilities), sustainable organic waste management operations, etc. to find shared solutions that can be collaboratively addressed.

- Stakeholders in the EJ Community Dialogue also pointed to the importance of proactively involving seniors and youth in discussions about strategies to address food recovery, food recycling and sustainable organic waste management because there is very strong interest among those populations in leading efforts on those issues.

APPENDIX 7.4

LOW-INCOME AND DISADVANTAGED COMMUNITIES BENEFITS ANALYSIS REPORT

LOW-INCOME AND DISADVANTAGED COMMUNITY (LIDAC) BENEFITS ANALYSIS FOR THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION'S PRIORITY CLIMATE ACTION PLAN PROCESS

– February 29, 2024 –

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Low Income and Disadvantaged Community (LIDAC) Benefits Analysis Executive Summary

A team at Rutgers, the State University of New Jersey's Bloustein School of Planning and Public Policy conducted a Low Income and Disadvantaged Community (LIDAC) Benefits Analysis and identified possible benefits, disbenefits, and considerations to avoid disbenefits to LIDACs when implementing the State's priority measures and enabling actions within the State's Climate Pollution Reduction Grant (CPRG) Priority Climate Action Plan (PCAP). LIDACs, for the purposes of this analysis, are comparable to the White House's CEJST DACs. EPA guidance indicated that LIDACs could be identified using the White House's CEJST on its own or in combination with EPA's Environmental Justice Screening and Mapping Tool (EJScreen) (USEPA, 2023, April 27). New Jersey chose to use CEJST alone and then to compare those findings to New Jersey's AIOBCs.

Applying these parameters concerning CEJST alone, 540 census tracts in New Jersey were found to be LIDACs. These LIDACs cover 399,596.7 acres of land (i.e., 8.5% of all state land) with a population of 2,218,361 (24.0% of the state population). A total of 256 New Jersey municipalities contained census tracts classified as LIDACs. While 111 of the 256 municipalities with LIDACs are in urbanized areas (NJDEP 2023), by population, 87.9% of individuals living in LIDACs are in urban areas. Other LIDACs are located in the state's rural southwest, in the Pinelands (a 1.1-million-acre area of central/southern New Jersey under special conservation regulations), and in other scattered non-urban locations.

The search to identify benefits, disbenefits, and considerations to avoid disbenefits when implementing priority measures focused on the impact the PCAP priority measures would likely have on public health (including physical and mental health), access to smart transportation alternatives, housing quality, access to greenspaces, energy costs, workforce development opportunities, and the overall resilience of LIDACs to climate change. LIDACs are often disproportionately impacted by environmental stressors (*e.g.,* flood events, temperature extremes, pollution) because these communities live in areas that are more vulnerable to the environmental stressors and these communities have been subject to historic inequities that hinder their ability to adapt to said stressors.

The LIDAC analysis consisted of three primary tasks:

- GIS Analysis: CEJST and ArcGIS were used to identify LIDAC census groups and municipalities.
- Literature Review: A literature review was conducted to identify likely outcomes and impacts of the priority measures[1] to LIDACs, including both primary impacts and coincidental/indirect impacts. The literature review yielded 538 possible sources (including guidance documents and

[1] Analysis and stakeholder comments originally conducted using a list of 17 draft measures, which was later revised to 12 measures with a set of enabling actions. The original and revised measures did not differ significantly in content/scope or in potential impact to LIDAC communities.

peer reviewed articles) which were narrowed down to 129 based on a review of the abstracts of each resource for relevance.

- Stakeholder Engagement: Stakeholder feedback on the priority measures was collected between September and December 2023 and has been integrated into this analysis. Stakeholders provided input through: comments submitted online to the New Jersey Department of Environmental Protection (NJDEP) CPRG website and in direct emails, five virtual CPRG Topical Stakeholder Sessions; two virtual stakeholder engagement sessions facilitated by Sustainable Jersey; one in-person stakeholder engagement session with residents and advocacy groups in a municipality with LIDACs (*i.e.,* Newark, New Jersey), and one-on-one survey phone calls with two industrial facilities.

The Bloustein School identified three cross-cutting insights that are relevant to any of the PCAP priority measures and may enhance the positive impact the enabling actions will have on LIDACs. These opportunities are listed below:

- Siting more energy-saving and pollution-reducing infrastructure in or near LIDAC communities would help to mitigate the disproportionate impacts to (and vulnerabilities of) these populations to greenhouse gas pollution and co-pollutants.
- Long-term planning will be essential to avoiding unintended disbenefits from implementing priority measures. Enabling actions may offer short-term benefits to LIDACs (*e.g.,* community beautification, energy savings, increased resilience) but renters/homeowners in LIDACs may be at risk of future displacement due to the increase in value of their home.
- Sustained funding, proactive outreach to communities, and proactive technical assistance are important for ensuring LIDACs know (1) what CPRG programs they have access to and (2) the benefits of engaging in the enabling actions.

Below is a summary of the priority measures' impact to LIDACs (Table 1). The table assigns each priority measure with a low, medium, and high ranking where "high" indicates a measure with a high positive impact on LIDACs. As mentioned above, if an emphasis were put on siting energy-saving and pollution reducing infrastructure in or near LIDAC communities, that would increase the positive impact of these priority measures on LIDACs. As such, the Bloustein School expects that the impact ranking for each measure would become higher if this emphasis was implemented. Specifically, all "mediums" would become "high", and the food system priority measure would become "medium"[2].

[2] The benefits to LIDACs under the halogenated gas priority measure would remain low given the energy savings from switching from high-GWP to low-GWP refrigerants would likely not be realized by LIDACs and the minimal number of jobs created.

Table 1. Rankings indicate the level of positive impact a priority measure may have on LIDACs. Each priority measure below is dependent on the implementation of enabling actions to achieve the measure.

	Priority Measure	Ranking	Implications for LIDACs
Transportation			
1	Achieve 30% zero-emission medium- and heavy-duty vehicle (MHDV) sales by 2030 and 100% by 2050	High	Reducing the number of diesel-powered MHDV will improve local air quality which will result in many physical and mental health benefits in nearby areas. Benefits will be maximized if this transition to electric removes some diesel-powered trucks and buses from the road, rather than simply adding electric vehicles to existing diesel fleets.
2	Achieve light duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c. 362).	Medium	Multi-unit dwellings (MUD) are common in LIDACs, and studies have shown the most important infrastructure in convincing consumers to purchase EVs is access to charging. This measure makes progress toward addressing the hurdles for LIDAC individuals to own electric vehicles and promotes green transportation for individuals not owning EVs, but not all actions are focused on LIDACs.
3	Reduce emissions in and around ports	High	New Jersey ports are in and around LIDAC areas that are disproportionately exposed to emissions. Cleaner ports would cause human health and socioeconomic benefits.
4	Reduce vehicle miles traveled	Medium	Enabling actions are an important precursor to green transportation for individuals but are not solely focused on LIDACs. Moreover, some enabling actions like expanding work from home programs, raise equity concerns due to a dearth of LIDAC individuals with jobs that could be performed from home.
Buildings			
5	Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties	Medium	Enabling actions under this priority measure will provide physical and mental health benefits to LIDACs if enabling actions are completed in LIDAC households or municipal buildings that individuals from LIDACs utilize, including recreation centers and senior centers. However, enabling actions must be implemented safely to avoid disbenefits mentioned for priority measure 6 below.
6	Make at least 10% of all low-to-moderate income properties electrification ready by 2030	Medium	Electrifying LIDAC homes could have a significant positive effect on the physical health and energy security of LIDAC if funding is focused on LIDAC homes and disbenefits are avoided. Potential disbenefits include "green gentrification" and make renters/homeowners at risk of displacement due to the increase in value of their home. Additionally, if homes are sealed for efficiency purposes, it could reduce ventilation and increase indoor pollutants causing health problems for families.
Electric Generation			
7	Achieve 12.2 GW of solar in-state by 2030	Medium	This is an important action for a green grid (which other priority measures rely on). Moreover, solar arrays could be implemented at the local LIDAC level. However, some components of the enabling actions in this priority measure do not directly benefit LIDACs.
8	Facilitate the integration of clean distributed energy resources into the grid	Medium	This is an important precursor to ensuring a green and resilient grid. For LIDACs, this priority measure ensures LIDACs could use solar arrays and adopt other energy efficiency measures to augment their energy supply costs.
9	Support development of 11.0 GW offshore wind by 2040	Medium	This is an important precursor action for other benefits to be realized but is not directed to LIDACs specifically.
Food Waste			
10	Achieve a 50% reduction in food waste by 2030	Low	Enabling actions do not target LIDAC communities, but if done properly, could greatly benefit LIDACs. For example, food could be diverted to food pantries via enhanced waste and composting programs to (1) feed those in need or (2) be used as digestor feedstock that fuels LIDACs homes.

Halogenated Gases			
11	Reduce halogenated gas emissions from refrigeration equipment	Low	The impacts to LIDACs are low because energy savings from switching from high-GWP to low-GWP refrigerants would benefit the owners of industrial facilities, not LIDACs, and because there would be a risk of exposing refrigerant workers (while low in numbers) to toxic chemicals during the transition process.
Natural and Working Lands			
12	Maintain, protect, and enhance New Jersey's natural carbon sinks.	Medium	Planting trees and restoring natural landscapes can provide health benefits (both physical and mental) and foster resilience of LIDACs to flood events. However, these efforts may trigger property value increases that could escalate residential displacement of lower-income residents.

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Section I. Introduction and Methods

A. Introduction

This report summarizes the results of a Low-Income and Disadvantaged Community (LIDAC) Benefits Analysis to determine the potential benefits and disbenefits of twelve proposed priority measures to LIDACs in New Jersey. LIDACs are defined by the parameters set by the United States Environmental Protection Agency (EPA) for this analysis and are based on the White House's Climate and Economic Justice Screening Tool (CEJST).

The State has identified twelve priority measures that are grouped by the following priority action areas for the State: transportation, buildings, electric generation, food waste, halogenated gases, and natural and working lands. The priority measures and enabling actions therein have been selected and refined through a robust stakeholder engagement process.

B. Methods

The LIDAC Benefits Analysis consisted of three parts: a geographic information system (GIS) analysis, a literature review, and stakeholder engagement.

GIS Analysis:

- CEJST and ArcGIS were used to identify the census groups and municipalities with LIDACs. (See Section II below).

Literature Review:

- The team conducted a thorough literature review to identify likely outcomes of proposed priority measures and impacts to LIDACs, including both primary impacts and secondary/indirect impacts. The search was limited to articles published after 2017 except for select, highly relevant or seminal studies from prior years. Databases used for this literature review included: EBSCO, Google Scholar, Pew Trust HIA Database, and the World Health Organization's Epidemiological Repository on Particulate Matter and Mortality.
- The team used 97 key words/phrases to identify literature related to the target populations, the priority measures, and the impacts of concern (see Appendix A for list of search terms).
- The literature review yielded 566 possible sources which were narrowed down to 157 based on a review of the abstracts of each resource for relevance. The possible benefits and disbenefits supported by the literature are summarized in Sections II and III of this report. Section II provides a narrative summary of the LIDAC Benefits Analysis while Section III provides both an "at-a-glance" summary ranking table, and a table with additional detail. The ranking schema of "high" "medium" and "low" identifies priority measures according to their expected positive impact on LIDACs.

Stakeholder Engagement:

- Stakeholder feedback was collected between September and December 2023 through various mediums, including: comments submitted online to the New Jersey Department of Environmental Protection (NJDEP) Climate Pollution Reduction Grant Program (CPRG) website, five virtual CPRG Topical Stakeholder Sessions; two virtual stakeholder engagement sessions facilitated by Sustainable Jersey; one-on-one survey phone calls with two industrial facilities; and one in-person stakeholder engagement session with residents and advocacy groups in Newark, New Jersey, a city with an estimated 274,237 individuals living in LIDAC census blocks representing 90% of Newark's population. The feedback generated from this stakeholder engagement has been integrated into Sections II and III of this report.

Section II. LIDAC Benefits Analysis – Summary

The White House's Climate and Economic Justice Screening Tool (CEJST) identifies 540 census tracts in New Jersey as disadvantaged. These census tracts encompass 399,596.7 acres of land (i.e., 8.5% of all state land) with a population of 2,218,361 (24.0% of the state population). A total of 256 New Jersey municipalities contain census tracts classified as Low Income and Disadvantaged Communities (LIDACs) through the parameters set by EPA for this analysis (Figure 1a).

It is important to note that NJDEP has not preselected the locations where it will implement each proposed measure and enabling action or the specific LIDACs that will be affected by a proposed measure: the enabling actions in this PCAP are not location specific. As such, the priority measures in this analysis could potentially affect any LIDAC. The requirements of this PCAP include identification of a Census tract ID from CEJST that may be affected by a proposed measure. Please refer to Appendix B for a list of Census tracts that may be affected by all of the proposed measures.

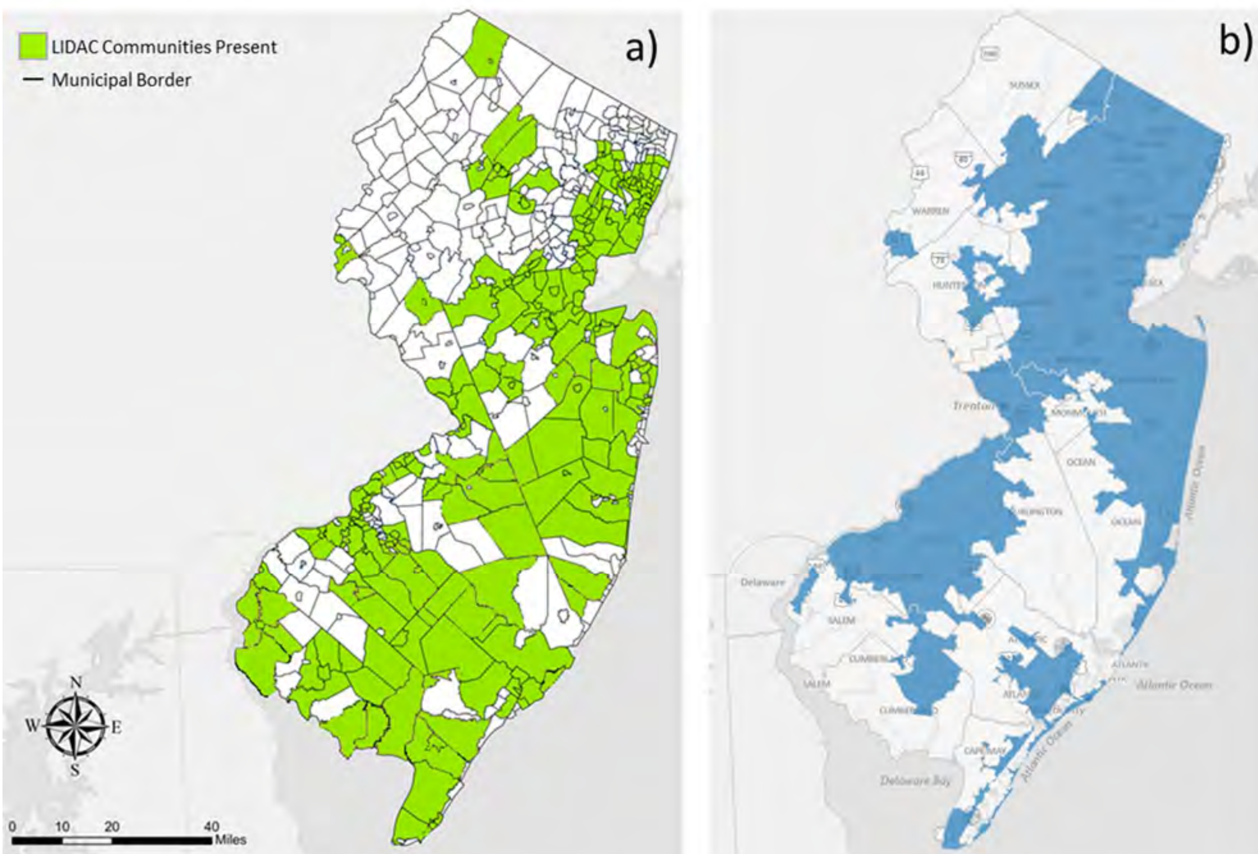

Figure 1. (a) Municipalities in New Jersey that have LIDACs consistent with the census tracts identified by the White House's CEJST screening tool are shown in green. (b) New Jersey's urbanized areas are shown in blue consistent with the U.S. Census definition of an urban area (NJDOT 2022).

New Jersey is the most densely populated state in the United States with 1,260 people per square mile (Statista 2024). New Jersey's urban areas (cities, towns, and suburbs) radiate from the metro regions of

Philadelphia and New York in the east and west of the State, respectively (Lathrope and Hasse 2020). Municipalities with LIDACs largely coincide with the State's urban areas such that of the 256 municipalities with LIDACs, 111 of those municipalities are in urbanized areas (NJDEP 2023). By population, 87.9% of individuals living in LIDACs are in urban areas. Other LIDACs can be found in the State's rural southwest, in the Pinelands (an area of central/southern New Jersey spanning 1.1 million acres consisting of forested lands, wetlands, and residential areas under special conservation regulations), and in other non-urban locations.

New Jersey's priority measures will focus on reducing emissions through enabling actions related to transportation, buildings, electric generation, food waste, halogenated gases, and natural and working lands. Below are the key possible benefits, disbenefits, and considerations to mitigate disbenefits to LIDAC that the State will consider when prioritizing enabling actions. For a more exhaustive list of possible benefits, disbenefits, and other considerations, please refer to Section III of this report.

A. Transportation

1. ***Priority Measure 1 – Achieve 30% zero-emission medium- and heavy-duty (MHDV) vehicle sales by 2030 and 100% by 2050:*** This priority measure will reduce the number of diesel-powered trucks and buses on New Jersey roads. Diesel powered trucks and school buses frequently traverse areas with LIDACs, especially in urban areas. Reducing the number of diesel-powered MHDV and school buses is expected to be generally beneficial to any LIDAC as air quality improvements created by this action will benefit local LIDACs and likely LIDACs in surrounding areas. The transition from diesel to electric transportation has been shown to have many physical and mental health benefits which will be maximized to the extent that the transition to electric MHDV actually removes some diesel-powered trucks and school buses from the road, rather than simply adding electric MHDVs to existing diesel fleets. LIDACs will also benefit from the workforce development from the jobs created for installing MHDV charging stations under this priority measure.
2. ***Priority Measure 2 – Achieve light duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c.362):*** This priority measure will increase the number of light-duty electric vehicles (EVs) on the road, improve the infrastructure for charging those vehicles (especially in multi-unit dwellings or "MUDs"), and increase access of low- and moderate-income residents to e-mobility programs such as e-ride sharing, ride hailing, and similar services. Multi-unit dwellings (MUD) are common in LIDACs, and studies have shown the most important infrastructure in convincing consumers to purchase EVs is access to charging. While this measure makes progress toward addressing the hurdles for lower income individuals to own electric vehicles and promotes green transportation for individuals not owning EVs, it is worth noting that people of all income levels could also benefit from these enabling actions which could dilute the positive impact on LIDACs. Additional State policies may be necessary to ensure benefits are realized by LIDACs.
3. ***Priority Measure 3 – Reduce emissions in and around ports:*** This priority measure will reduce the number of diesel-powered port equipment and vessels. New Jersey ports are in and around LIDACs that are disproportionately exposed to emissions (Kotz et al. 2022,

Meng and Comer 2023). Reducing emissions from ports would provide numerous health benefits to downwind LIDACs and provide good paying jobs to create and manage the electric infrastructure.

4. ***Priority Measure 4 – Reduce vehicles miles travelled:*** This measure will reduce the number of trips in personal vehicles and increase trips using public transit and active transportation such as bicycling and walking; expand work-from-home and ridesharing programs for people. The enabling actions for this measure are an important precursor to achieve sustainable transportation for LIDACs, but the enabling actions are not solely focused on LIDACs. Moreover, some enabling actions, like expanding work-from-home programs, raise equity concerns that could further exacerbate the socioeconomic inequities between blue- and white-collar workers.

B. Buildings

5. ***Priority Measure 5 – Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties:*** Enabling actions under this priority measure will provide physical and mental health benefits to LIDACs if enabling actions are completed in LIDAC households or municipal buildings that individuals from LIDACs utilize, including recreation centers and senior centers. However, enabling actions must be implemented safely to avoid disbenefits mentioned for priority measure 6 below.
6. ***Priority Measure 6 – Make at least 10% of all low-to-moderate income properties electrification-ready by the year 2030:*** Electrifying LIDAC homes could have a significant positive effect on the physical health and energy security of LIDACs if funding is focused on LIDAC homes, and if disbenefits are avoided. Potential disbenefits include "green gentrification" that could make renters/homeowners at risk of displacement due to the increase in value of their home from these electrification projects. Additionally, if homes are sealed for efficiency purposes, it could reduce ventilation and increase indoor pollutants and possibly cause health problems for families.

C. Electric Generation

7. ***Priority Measure 7: Achieve 12.2 GW of solar in-state by 2030:*** This measure will increase the amount of solar energy accessible to industry (via the Competitive Solar Incentive program, Administratively Determined Incentive, and Dual Use Solar program), State and local government facilities, and residential communities (via the Community Solar Energy Program). This priority measure has important enabling actions for a green grid (which other priority measures rely on). Several of the programs that could receive funding under this priority measure can generate solar energy for industry, as opposed to solely residential use. If the renewable energy from solar arrays under these programs is indeed used to power LIDACs and reduce home energy bills, the impacts to LIDACs will be high. Moreover, solar energy is the most modular source of green energy being suggested in this PCAP and are thus the most easily implemented in areas that benefit LIDACs directly. As such, the opportunity for positive benefits is high if solar arrays directly benefit LIDACs.
8. ***Priority Measure 8 – Facilitate the integration of clean distributed energy resources into the grid:*** This measure will modernize the NJ electric grid and distribution system to support increased distributed energy resources (DER). This includes but is not limited to

modernizing the grid and creating additional storage for DER, and piloting vehicles' ability to support the grid (e.g., vehicle-to-everything "V2X", including vehicle-to-grid or V2G, vehicle-to-building or V2B, and vehicle-to-storage or V2S).This priority measure is an important precursor to ensuring a resilient grid powered by renewable energy. For LIDACs, this priority measure ensures LIDACs could use solar arrays and adopt other energy efficiency measures to augment or reduce energy supply costs. To ensure benefits under this measure are realized, safety measures or policies should be enacted to protect LIDACs from harm.

9. ***Priority Measure 9 – Support development of 11.0 GW offshore wind by 2040:*** This measure will expand the offshore wind industry in New Jersey by awarding New Jersey's fourth offshore wind solicitation, develop and implement New Jersey State Agreement Approach 2.0 to generate 11 GW of wind energy by 2040, and supporting construction of the New Jersey wind port. Offshore wind is an important source of renewable energy, and this measure is an important precursor for other benefits in this PCAP to be realized. If possible disbenefits are avoided in the construction and maintenance of these windfarms' offshore and onshore infrastructure (*e.g.,* LIDACs *not* targeted for transmission lines and substations, existing LIDAC jobs like fishing *not* negatively impacted) then this measure will have a high positive impact to LIDACs.

D. Food Waste

10. ***Priority Measure 10 – Achieve a 50% reduction in food waste by 2030:*** This measure will decrease food waste from entities generating more than 52 tons of food waste per year; increase local and regional composting operations; increase food supply into food recovery systems including (1) people without access to fresh food and (2) energy generating digestors (anaerobic and co-digestion) at wastewater treatment facilities (WWTF); reduce food waste at the local level (including schools); and reduce food-ware waste at a local level. These enabling actions will have positive environmental and socioeconomic impacts to LIDACs however, the enabling actions do not specifically target LIDAC areas. If the enabling actions were focused on LIDACs (*e.g.,* creating a food waste infrastructure that diverted high quality food waste to food pantries, generating electricity from food waste that could be used by LIDACs to lower their energy bills), the positive impact on LIDACs would be higher.

E. **Halogenated Gases**

11. ***Priority Measure 11 – Reduce halogenated gas emissions from refrigeration equipment:*** This measure will include piloting a low-GWP incentive program for refrigeration systems and developing programs for private businesses, institutions, and local governments to switch their existing high-GWP refrigerant systems to low-GWP refrigerants. The process of replacing refrigerants would require workers to potentially be exposed to toxic (and flammable) chemicals from industrial facilities and then dispose of those materials in a sustainable manner. Refrigerant handling and disposal are highly regulated to ensure the safety of both the environment and workers, many of whom live in LIDACs. However, there is always a risk of harm to individuals handling these chemicals. As such, the positive impacts to LIDACs are low because there would be a limited number of individuals who may be exposed to toxic and harmful refrigerant chemicals, even in the event that safety protocols are not followed during the transition

to low-GWP refrigerants. The positive impact is also low because any energy savings from switching from high-GWP to low-GWP refrigerants would be realized by the owners of industrial facilities not the LIDACs themselves.

F. Natural and Working Lands

12. ***Priority Measure 12 – Maintain, protect, and enhance NJ's natural carbon sinks:*** This measure will result in more trees planted on public and private lands (including urban environments). This measure will also lead to enhanced/restored habitats focused on improved natural flow of waters, creating living shorelines, and other sustainable activities (e.g., silvopasture). Planting trees and restoring natural landscapes can provide health benefits (both physical and mental) and foster resilience of LIDACs to flood events. However, a potential disbenefit can occur if these efforts trigger property value increases that could escalate residential displacement of lower-income residents. A possible solution to this problem could be enacting State regulations or policies (or offering template ordinances for local municipalities to adopt) that safeguard existing residents of LIDACs from excessive rent, property taxes, or related increase in fees.

Section III. LIDAC Benefits Analysis – Ranking Tables

This section includes two tables: the "Priority Measure LIDAC Ranking Table at a Glance" and the "Detailed LIDAC Ranking Table." The former is intended to be a concise summary table, and the latter contains the extensive results from the full LIDAC Benefits Analysis. In both tables, the team has assigned each priority measure with a low, medium, or high ranking, where "high" indicates a measure with a high positive impact on LIDACs. The document has been reviewed by the authors and study team, and an overview of findings was shared with the NJDEP Office of Environmental Justice for their input.

The ranking in this document is based on the team's best judgement, after conducting the analysis, re: (1) potential positive impacts to LIDACs and (2) hurdles to implementation (*i.e.,* priority measures with many potential hurdles to implementation in LIDACs are ranked lower than other measures). Moreover, ***the authors have provided two sets of low, medium, and high rankings***. The column called "EJ40 Ranking" is based on the team's understanding of each measure as currently written (*i.e.,* assuming no more than 40% of funding would go toward LIDACs unless otherwise specified, consistent with the White House's Justice40 initiative). The column called "Ranking if Increased LIDAC Focus" refers to ranking if an increased and significant proportion of resources (*e.g.,* a majority or vast majority) go toward benefiting LIDACs. The authors have included various caveat statements throughout the ranking tables to help readers interpret the assessment and to recommend paths forward in the implementation grant stage of this process that mitigate disbenefits and provide the greatest benefit to LIDACs in New Jersey.

List of Tables

Table 1. Priority Measure LIDAC Ranking Table at a Glance

	Priority Measure	EJ40 Ranking	Increased LIDAC Focus	Enabling Actions
Transportation				
1	Achieve 30% electric medium- and heavy-duty vehicle sales by 2030 and 100% by 2050	High	High	Implement Advanced Clean Trucks rule; Implement technical assistance program(s) to help fleet owners transition to electric vehicles and provide workforce training programs; Electrify NJ TRANSIT Access Link paratransit, local service and rail; Purchase zero emission buses and modify and build depots in the NJ TRANSIT system to achieve Electric Vehicle Law goals; Incentivize replacement of diesel medium and heavy-duty vehicles with battery electric vehicles (EVs), or green hydrogen powered electric vehicles, including school buses; and expand medium and heavy-duty charging infrastructure.
2	Achieve light duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c. 362.)	Medium	High	Implement Advanced Clean Cars II rule; Electrify State and local government fleets to achieve EV Law goals; Ensure low- and moderate-income (LMI) residents have access to clean transportation by expanding eMobility programs that provide e-ride sharing, ride hailing and similar services; and Expand publicly available EV charging infrastructure with specific focus on charging for multi-unit dwellings
3	Reduce emissions in and around ports	High	High	Electrify drayage trucks; Electrify cargo handling equipment; and Electrify marine vessels and ferries.
4	Reduce vehicle miles travelled	Medium	High	Expand active transportation infrastructure and complete streets; Increase NJ Transit ridership and expand development of transit villages; and expand work-from home and ridesharing programs.
Buildings				
5	Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties	Medium	High	Launch a digital "One Stop Shop" summarizing federal and state energy rebate funding; Offer training grants for residential energy contractors; Work with utilities to launch building decarbonization start-up programs; Develop a renewable heating and cooling web calculator tool for New Jersey residents; Develop a ground source heat pump siting tool for New Jersey stakeholders; Adopt the 2024 International Energy Conservation Code for residential buildings and ASHRAE 90.1-2022 for Commercial Buildings; Explore the adoption of a stretch code to maximize energy efficiency in new construction; Implement the appliance standards law and develop the appliance standards recommendations report; Pilot community/campus/neighborhood scale district geothermal system decarbonization demonstration projects; Explore the adoption of a clean heat standard; Continue energy benchmarking efforts and explore building performance standards; Develop building decarbonization for local government lead by example efforts; Pilot building decarbonization efforts at state facilities and at local government facilities (via NJBPU's community energy plan implementation (CEPI) program); Seek grants and funding to pilot beneficial reuse of wastewater for building electrification at wastewater treatment facilities; and Seek grants and funding to implement NJBPU's Higher Education Decarbonization Pilot Program.
6	Make at least 10% of all low-to-moderate income properties electrification ready by 2030	Medium	High	Expand NJBPU's Whole House Pilot Program to enable energy efficiency for low- and moderate-income residential buildings; Expand electrification and efficiency programs for low- and moderate-income residential buildings; and Expand NJBPU's multifamily pilot program which offers energy audits and installation of energy efficiency measures at multifamily properties.
Electric Generation				
7	Achieve 12.2 GW of solar in-state by 2030	Medium	High	Implement Competitive Solar Incentive , Administratively Determined Incentive and Dual Use Solar Programs; Expand the Community Solar Energy Program; Site solar infrastructure at state and local government facilities, and Release revised Solar Siting Analysis.
8	Facilitate the integration of clean distributed energy resources into the grid	Medium	High	Improve the hosting capacity of the New Jersey electric distribution system through grid modernization efforts; Support implementation of FERC 2222 to help support distributed energy resources; Support development of 2.0 GW of energy storage by 2030 through the creation of an Energy Storage Incentive Program; Pilot grid supportive technologies such as vehicle-to-everything "V2X" and microgrid systems; Implement storage component of Competitive Solar Incentive program; and support Resilient Local Governments.

Table 1. Priority Measure LIDAC Ranking Table at a Glance

	Priority Measure	EJ40 Ranking	Increased LIDAC Focus	Enabling Actions
9	Support development of 11.0 GW offshore wind by 2040	Medium	High	Launch and award New Jersey's fourth offshore wind solicitation; Develop and implement State Agreement Approach 2.0 for the goal of 11 GW of wind energy by 2040; Support construction of the New Jersey wind port.
Food Waste				
10	Achieve a 50% reduction in food waste by 2030	Low	High	Develop regulations to implement Food Waste Recycling and Food Waste-to-Energy Act; Develop guidance and toolkit to encourage local governments to implement food waste management programs; Develop tools to connect food waste generators with potential recipients to support food recovery; Raise awareness about food waste reduction; Encourage Counties to update district solid waste management plans to include food waste reduction; Implement state-wide waste composition audits; Implement a community-scale reusable food-ware system pilot; Support food waste recovery systems such as anaerobic digesters and co-digestion of food waste at wastewater treatment facilities; continue to pursue revisions to the Recycling Rules (N.J.A.C 7:26A); encourage wastewater treatment facilities to reduce landfilling of residuals; Implement local and regional composting programs; Encourage schools to adopt the New Jersey School Food Waste Guidelines and institute a food waste reduction curriculum in K-12 schools; address opportunities for food waste reduction at state-owned buildings; and Continue to pursue revisions to the Recycling Rules (N.J.A.C. 7:26A).
Halogenated Gases				
11	Reduce halogenated gas emissions from refrigeration systems	Low	Low	Pilot a low-GWP incentive program for refrigeration systems, and replace high-GWP refrigerant equipment.
Natural and Working Lands				
12	Maintain, protect, and enhance New Jersey's natural carbon sinks.	Medium	High	Plant 250,000 street trees/shade trees by 2030; Identify and restore 800 degraded acres of forested lands by 2030; Develop a nursey supply and production initiative; Complete one tidal reconnection project per year (total of 6) by 2030; Install 7,800 linear feet of living shoreline per year by 2030; and Relaunch conservation cost share program.

Table 2. Detailed LIDAC Ranking Table

	Priority Measure	EJ40 Ranking	Ranking if Increased LIDAC Focus	Direct Impacts/Changes	Explanation	Benefits to LIDAC	Disbenefits to LIDAC and Roadblocks to Implementation of Measure	Recommendations to Mitigate Disbenefits to LIDAC
1	Achieve 30% electric medium- and heavy-duty (MHDV) vehicle sales by 2030 and 100% by 2050	High	High	Reduced number of diesel-powered trucks (both private fleets and State fleets) and buses.	Diesel powered trucks and buses frequently traverse areas with LIDACs. Reducing the number of diesel-powered MHDV will reduce air pollution and is expected to be generally beneficial to any LIDAC. Moreover, air quality improvements created by this measure will benefit LIDACs along the routes the trucks normally take as well as in surrounding areas (Olawepo and Chen 2019). Air quality benefits will be maximized if the transition to electric MHDV actually removes some diesel-powered trucks and buses from the road, rather than simply adding electric MHDVs to existing diesel fleets. Additional benefits will be realized under the workforce training programs that could lead to good paying jobs for individuals living in LIDACs.	Physical Health - Emissions from MHDV disproportionately harms low- and moderate-income households (Huether 2021) - Reduced air pollution from diesel exhaust (Mac Kinnon et al. 2021) which can be experienced locally as well as in surrounding counties (Olawepo and Chen 2019). - Turning school buses from diesel to electric can have meaningful and cost-effective impacts on student health and cognitive function (Austin et al. 2019) - NJ in the top 5 of states that will experience the greatest health benefits from electric HDV (Turk 2020). The long-term health benefits of switching to EVs outweighs the cost of EV infrastructure (House and Wright 2019) - Lithium batteries and hydrogen fuel are largely considered safe given proper transport and handling (Singla et al. 2021, Tae 2021) **For additional information regarding the benefits to LIDACs from reduced air pollution, please see the footnote at the end of this table on page 27. Workforce Development - Being employed in a field related to community health and environmental protection (like a job installing EV stations) can improve health and the economics of disadvantaged individuals and communities, thus improving social well-being and mental health (Freudenberg and Tsui 2011) - Employment positively impacts health (Ross and Mirowsky 1995) Mental Health - Electric buses make less noise and make less vibrations than diesel buses making for a more comfortable riding experience (Adheesh et al. 2016). - Electric MHDV are less noisy than traditional models which can reduce stress and improve mental health. Increased Financial Security - When considering automated diesel heavy-duty trucks and automated electric heavy-duty trucks, the health impact costs resulting from the diesel are two times higher than electric (Sen et al. 2020). Less illness means fewer doctor visits for LIDAC individuals which, in turn, saves LIDAC households' money.	Physical Health - Electric trucks are notably quieter than diesel engine trucks at lower speeds (Pallas et al. 2014). Electric vehicles have a 30% higher pedestrian traffic safety risk, under high ambient sound environments, than traditional combustion engines (Karaaslan et al. 2018). No studies have assessed the likelihood of pedestrian collisions with electric MHDV trucks, but it is reasonable to assume any vehicle on the road may at some point experience an accident with a pedestrian. Moreover, minority populations experience death and injuries in traffic accidents at disproportionate rates (Adams 2021) so it is reasonable to expect individuals in LIDACs may disproportionately experience collisions with electric MHDVs.	Stakeholder Input - Stakeholders had many ideas regarding how to improve workforce development opportunities in the renewable energy field including the following: o Soft skills and math training to accompany these apprenticeship programs can have an impact, along with developing infrastructure to sustain these jobs. o These trainings and jobs should be union-eligible, so the hours spent in the training program could count as union-service. o Even school-aged children (including middle-schoolers) can be introduced to these careers, through involving teachers and educators, and existing programs such as debate. - Stakeholders also recommended there be better incentives for truck drivers to transition to electric, as that can be expensive. The burden on electrifying shouldn't be on individuals. Training Programs Should not be limited to Electric Vehicle Charging Ports - Training programs at the community college, technical college, and university level are lacking and are important for ensuring alternative fuels are integrated quickly and efficiently into the grid (Freeman et al. 2018). Training programs for EV stations is welcomed but should not detract from the larger need to have wide reaching training programs for an entirely green energy grid. Scrap Programs - Current state programs like NJZIP do not require scrapping of diesel-powered trucks in the transition to electric MHDV. As such, the addition of electric MHDVs to the road may increase the number of large vehicles on roads in LIDAC areas. To protect pedestrians and non-truck drivers, the State may consider priority funding through the CPRG for entities that include an environmentally friendly scrappage replacement requirement to preclude the number of vehicles on New Jersey roads from dramatically increasing.

	Priority Measure	EJ40 Ranking	Ranking if Increased LIDAC Focus	Direct Impacts/Changes	Explanation	Benefits to LIDAC	Disbenefits to LIDAC and Roadblocks to Implementation of Measure	Recommendations to Mitigate Disbenefits to LIDAC
2	Achieve light duty electrification goals in P.L. 2019, c. 362.	Medium	High	More EVs on the road (both State and personal vehicles); piloted ridesharing and ride-hailing program with EVs in multi-unit dwellings and/or overburdened communities; expanded EV charging infrastructure with a focus on MUDs.	Studies have shown the most important infrastructure in convincing consumers to purchase EVs is home charging (Funke and Plötz 2017; Nicholas and Tal 2017). As such, having charging options within multi-unit dwellings is important (Canepa et al. 2019). This action is ranked medium because it focuses on (1) multi-unit dwellings which are abundant in LIDAC areas and (2) ridesharing and ride-hailing programs: both of which are beneficial to LIDACs. Additional conversations with DEP have indicated this action will create "supportive services to lessen the non-financial burden of electrification and help these entities become aware of the existence of financial incentives." However, the benefits of this action depend on LIDAC individuals being able to afford/own an EV or for there to be an eligible EV ride share option: LIDACs largely do not have the funds to purchase an EV (Hardman et al. 2020). Additionally, there are multiunit dwellings in non-LIDAC areas that would be eligible for funding under this action. Ultimately, this action does address a key hurdle (*i.e.,* access	Physical Health - More EVs in LIDAC areas will improve air quality. A study by Garcia et al. 2023 found air quality improvements in California as they are in an early-stage transition into EVs but showed evidence of an adoption gap in low-income communities which "threatens the equitable distribution of possible co-benefits," (Garcia et al. 2023). See disbenefits for additional discussion. Mental Health - EVs, particularly Teslas, are less likely to be stolen than traditional internal combustion cars, in part due to enhanced security features (Edelstein 2023) Improved Housing Quality - An EV charging port is a high-end amenity that would likely increase property values. It also provides the necessary infrastructure for LIDACs to purchase EVs, especially given the alternative is a charging station far from home which tends to be more expensive than at home charging. Workforce Development - New jobs for individuals to transport elderly, disabled etc. to their destination (*e.g.,* grocery store, hospital) - Opportunity for a workforce training program to create a pathway for people to become electricians for installing EVs charging stations. Increased Climate Resilience	Financial Insecurity - There are existing incentives for LIDAC community members to buy EVs and for multi-unit dwellings/EV fleets to install EV charging stations, however many LIDACs are not using these incentives. Other barriers to using EVs still exist in LIDACs like the perceived higher transportation costs with an EV and others (Hardman et al. 2020). The "supportive services" provided by this action may be able to help address this education gap re: the available incentives and costs of owning an EV. Gentrification - EV charging stations can increase the cost of rent in some buildings as that is an attractive amenity to renters.	Stakeholder Input: - Stakeholders asked for urban charging stations to be placed near non-profits, shopping centers, bookstores, cafes, public buildings, public housing, and local businesses to prioritize residents who live in cities, rather than people who don't live in cities. Incentivize eMobility Programs involving Ridesharing for non-Traditional Users - Because ridesharing tends to be used by commuters, it is recommended the implementation of this action take steps to ensure access to EVs is not monopolized by more affluent community members outside of LIDAC. - Through consultation with LIDACs, use funding to create high-level LIDAC owned and LIDAC run programs. Create Robust "Supportive Services" and Policies - The "supportive services" created by this action may consider integrating used EVs into LIDACs. This would create a more affordable EV option to reduce LIDAC financial burden. - (1) install EV charging in new construction, (2) create multi-unit dwelling-specific incentives (and educate building owners), (3) utilities focus grid improvements and infrastructure for MUDs and recover those costs through a utility bill charge to the impacted multi-unit dwellings (this is called a "tariffed on-bill", (4) expand workplace and public charging (Baldwin et al. 2021) - Minimize financial burden - Minority communities in the UK were more receptive to emission reduction activities in their neighborhoods if those actions did not directly affect individuals financially (Rashid et al. 2021) - Rather than making it easier for people to buy EVs, make it financially harder for people to buy traditional vehicles – A study found that carbon and vehicle registration tax policies [i.e., a tax a car buyer pays up front based on the car's expected CO2 emissions] induced a significant shift away from conventional vehicles towards electric vehicles in Austria by 2030 (Miess et al. 2022

					to low-cost home charging for EVs at MUDs), but when more LIDAC individuals can afford to drive EVs there will many benefits. Moreover, when e-mobility programs are designed to support LIDACs there will be increased benefits. (The ranking for this action would be higher if disbenefits mentioned in this column and to the right were addressed.)	- Increased ability to evacuate during and in the aftermath of extreme climatic events creates adaptive capacity enhancement. (Dulal 2016) - Improved accessibility also yields increased savings and capital assets accumulation resulting from improved productivity (Dulal 2016) Increased Energy Security - After initial investment, the cost of owning (Liu et al. 2021) and traveling (Coren 2023) is generally lower for electric vehicles than internal combustion engine vehicles. - EVs can provide lower cost and more reliable transportation to low-income and minority communities (Canepa et al. 2019). Reduced noise - EVs reduce urban car noise (Pardo-Ferreira et al. 2020). Because electric vehicles are relatively quiet at a slow speed these cars can be a threat to pedestrians. A study conducted by the US Department of Transportation in 2017 found hybrid and electric vehicles are 50% more likely to have a pedestrian crash at low speeds than traditional internal combustion cars (DOT 2017)		

	Priority Measure	EJ40 Ranking	Ranking if Increased LIDAC Focus	Direct Impacts/Changes	Explanation	Benefits to LIDAC	Disbenefits to LIDAC and Roadblocks to Implementation of Measure	Recommendations to Mitigate Disbenefits to LIDAC
3	Reduce emissions in and around ports	High	High	Reduced number of diesel-powered port equipment and vessels;	New Jersey ports are in and around LIDACs that are disproportionately exposed to emissions (Kotz et al. 2022, Meng and Comer 2023). Studies have shown that berthing time increases air pollution while the presence of emission control areas (ECAs) and wind speed/direction lower the air pollution (Ducruet et al. 2024). Because the upfront costs of electrifying a port can be substantial, it is important to clearly communicate the long-term benefits of port electrification so the benefits can be realized. Additional benefits will be realized under the workforce training programs if construction is required for the ports' emission reduction strategies (for example: if MHDV charging stations were integrated into port infrastructure).	Physical Health - Electrification of ports has the potential to reduce deaths per year from reduced PM2.5 exposure. A study of the full electrification of the Port of New York and New Jersey, for example, found electrification would avoid 16 premature deaths per year from reduced pollutant exposure and at least $150 million in public health benefits (Meng and Comer 2023). - Electrifying drayage trucks can save a lot of money in terms of health costs and environmental costs to local communities (Ramirez-Ibarra and Saphores 2023) - Reducing the waiting time for ships in harbors and the turn-around time for ships in port to offload their goods would reduce emissions and pollutants (Poulsen and Sampson 2020) Workforce Development - If reducing emissions in and around ports will require construction and manufacturing expertise, which has previously come from other blue-collar industries (Vachon 2019, NJ Council on the Green Economy 2022), this will generate many good paying jobs for LIDACs especially if the State implements	Electricity Costs - A study by Gillingham and Huang (2020) found the long-term cost of electrifying a port can be substantial due to the high cost of electricity compared to diesel or bunker fuel. However, the societal benefits of electrification (as measured by the social cost of carbon) outweighs this increase in cost (Gillingham and Huang 2020). Delays in Supply Chain - Improper charging infrastructure could cause significant delays to the transport operation (Teoh 2022) which could be an inconvenience to LIDACs and other communities. Increased Consumer Costs - Studies show conflicting evidence regarding whether electric MHDV have lower operation and maintenance costs than traditional diesel trucks. Cunanan et al. 2021 indicates EV cost an estimated 20-30% less to maintain than diesel-powered vehicles. However, Teoh (2022) suggests that if the charging infrastructure for electric MHDVs is not planned properly (*e.g.,* locations in strategic/convenient locations for drivers) operation and maintenance may be more costly than for diesel trucks due to ware on batteries. Additional costs in the supply chain may lead to increased costs for consumers, which would negatively impact LIDACs which have a lower average income than the rest of the population.	Engage Local Communities in Charging Infrastructure Planning - Stakeholders have already provided preliminary input on this action saying that there needs to be actions to change "truck routes to direct them away from neighborhoods, and to ensure charging stations for trucks do not burden residential areas." - Hearing additional LIDAC concerns about proposed charging station sites will allow the DEP to share proposed proactive safety measures (if any) to mitigate any influx in crime to the area (*e.g.,* security cameras, increased patrols in the area). Clearly Communicate Long Term Benefits of Electrification - While the upfront costs of electrifying ports may make it difficult to garner support for these actions (Sifakis and Tsoutsos 2021), it will be important to communicate the long-term socioeconomic benefits of electrification to LIDACs. Create Policies for Eco-Labeling Products - Eco-labeling products and services based on their method of freight transportation could help consumers choose products that have been shipped more sustainably than others (Kirschstein et al. 2022) and bolster support for reducing emissions from ports. Consider Expanding Charging Stations for MHDV Beyond Ports - Based on the existing literature, it seems like depots, warehouses, or vehicle yards are the most likely location for MHDV charging ports as they are convenient for trucks to recharge for short haul operations (Borlaug et al. 2021). Identifying locations for MHDV charging stations should be a regional conversation with local communities and MHDV fleets to ensure the state's charging infrastructure has the best coverage (Teoh 2022). - The literature suggests the following opportunities for truck charging: downtime charging (*e.g.,* charging at home, at night, at a truck depot: where slow charging can be used), opportunity charging (*e.g.,* charging during a scheduled stop in route, charging at a destination; or charging using a system like trams do on the road network in urban areas), and intrusive charging (*e.g.,* fast charging during long trips, public charging, battery

						prevailing wage standards or creates project labor agreements for port workers (NJ Council on the Green Economy 2022). - When the state transitions to 100% renewable energy, the 20,000 NJ residents employed in fossil fuel industries will need to find new work (Vachon 2019), and port decarbonization is one industry those workers could transition to.		swapping at neutral location), and emergency charging (Teoh 2022).

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4	Reduce vehicle miles traveled	Medium	High	Reduced trips in personal vehicles and more trips using public transit and active transportation such as by cycling and walking; expanded work from home and ridesharing programs strategies);	Expanded active transportation infrastructure and complete streets, increased NJ TRANSIT ridership, and additional transit villages increase the ability of LIDACs to access transportation which, in turn, influences job accessibility, commute times, and overall economic outcomes. However, special consideration and planning will be necessary to ensure these enabling actions benefit LIDACs. Studies have shown that even if public transit is geographically	Physical Health - Improved cardiorespiratory fitness for those using e-bikes (Bourne et al. 2018). This is a positive feedback loop as offering e-bikes as an alternate mode of transportation can decrease car use and increase intrinsic motivation to cycle (Bjørnara et al. 2019). Even if e-bikes on average take a longer time than cars or public transport to reach the same destination, they may still be preferred, as they allow flexibility in schedule, the opportunity to enjoy the outdoors, and encourage physical activity (Plazier et al. 2017). Mental Health - Using public transportation via expanded active transportation infrastructure increases the accessibility of LIDACs to resources (*e.g.,* jobs, grocery stores). Studies specifically on e-bikes have found this to be true in both less populated (Li et al. 2023) and high population areas (Banerjee et al.	Inequity in eMobility Access - Utilization of dockless e-bikes and e-scooter sharing in Calgary, Alberta showed both dockless e-scooters and e-bikes were distributed in a spatially inequitable manner such that trips concentrated in the least deprived areas. This has been seen in other cities as well (Stehlin and Payne 2021).The authors attributed this to partnering with larger eMobility companies that prioritize profit over access such that the company places e-bikes and e-scooters in areas where trips are guaranteed to happen rather than in socioeconomically depressed areas (Kong and Leszczynski 2022). - Carpooling/ridesharing as part of a e-mobile initiative are most effective for commute trips, individuals that a single or married without children are more likely to participate, most carpools are among family members (Shaheen and Cohen 2019) Bike Theft - A study of bike theft in London, UK showed that proximity of bikes to public amenities (e.g.,	Create Standards for Equitable Transportation Infrastructure in LIDACs - Conduct a pilot program and related survey to measure the equitable availability and utilization of e-mobility options similar to the study conducted by Populus in Washington, DC (Populus 2018) - Invest in micromobility transportation infrastructure (e.g., protected cycle lanes, recreational paths, bikeways, etc.) especially in transportation poor areas and LIDACs so that when dockless vehicles are added to the city, there is equal access and equal rideability throughout the spatial fabric of the city (Kong and Leszczynski 2022). Through consultation with LIDACs, use funding to create high-level LIDAC owned and LIDAC run programs to ensure enabling actions benefit LIDACs.

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					accessible, operating hours may not align with the non-peak-hour work shifts (evenings) when LIDACs could be seeking these services (Sanchez 2008). This is further evidenced by a study conducted by Brumenber and Pierce (2016) that found low-income individuals who had access to cars experienced positive employment outcomes, but low-income individuals with access to public transit did not experience positive employment outcomes. Other inequities are discussed in the disbenefits column to the right. All should be overcome to ensure maximum benefit to LIDACs.	2021). This improves an individual's quality of life, which improves their mental health. Workforce Development - New jobs for individuals managing and monitoring e-bike and e-scooter locations in both dockless and docked systems.	bicycle stands, railway stations, universities, vacant buildings, and pawnshops) is a good predictor of bike theft (Mburu and Helbich 2016). Care should be taken to build the proper storage infrastructure for e-bikes and e-scooters and to educate the public on smart storage and locking strategies. Inequities in "Work From Home" (WFH) Policies - Expanding access to WFH is largely an opportunity for workers in higher paying jobs (*i.e.,* individuals working a desk job) rather than individuals who need to be in-person to accomplish their responsibilities (*e.g.,* essential workers in the food industry, blue-collar jobs). The corresponding enabling action would therefore likely have minimal impact on LIDACs and may even exacerbate the socioeconomic inequities between the blue collar and white-collar workforce (Sanchez et al. 2021).	

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5	Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties.	Medium	High	- New construction and old commercial and residential properties will incorporate additional energy efficiency measures into their buildings (including appliance requirements) and obtain energy from renewable sources (*e.g.,* geothermal at a campus/neighborhood scale). Training for residential contractors will be made available. - State and local government buildings will implement projects that support energy resilience, renewable energy, and energy efficiency. - Colleges and universities will achieve decarbonization goals. - Wastewater facilities will pilot beneficial reuse of wastewater for building electrification at wastewater treatment plants.	This measure will provide funding to decarbonize State/municipal complexes, State/municipal buildings, and colleges. As such, this action will provide physical and mental health benefits to LIDACs if priority measures are completed in municipal, state, and/or college buildings that individuals from LIDACs utilize, including recreation centers and senior centers. This measure's largest disbenefit is that electrifying LIDAC homes may lead to "green gentrification" and make renters/homeowners at risk of displacement due to the increase in value of their home (Rice et al. 2019) Additionally, it is important to note, reporting mechanisms on the benefits of zero emissions buildings and complexes are not unified or consistent such that the benefits of net-zero buildings are often inflated. One study found it is crucial to	Physical Health - Improved indoor air quality from using less harmful building materials (people spend 90% of their time indoors) (Hu 2019) - Improved indoor air quality – LIDAC homes tend to be smaller with more people living in them, so existing indoor air quality issues are more prevalent as pollutants fill a smaller space and can reach higher concentrations in the air (like pollutants from gas stoves [Tan and Jung 2021]) (Seals and Krasner 2020). Disadvantaged communities are generally less inclined to seek medical care, which further exacerbates health mortality and morbidity from air pollution (Zhu et al. 2020). - Electric and fully sufficient homes have been found to increase thermal comfort, reduce heat related illnesses and death, and a reduction in healthcare costs (Dulal 2016) - Carbon neutral buildings (*e.g.,* roof and façade materials, orientation, shading, landscaping) can reduce urban heat islands (Newton and Rogers 2020) Mental Health - Net zero buildings can improve social-well-being and improve quality of life, depending on the use of the building being decarbonized (Rau 2017). - Reduced smell from on-site wastewater reuse for building electrification at WWTP may reduce	Incentive Programs Necessary - Financial support will be key for LIDACs to implement electric measures into homes (Scavo et al. 2016; Miller and Chen 2019) Physical Health - If homes are sealed for efficiency during the "electrification process," it could exacerbate indoor pollutants - LIDACs may experience a lack of housing during construction. Quality of Life - Heat pumps can be exceptionally loud indoors – homeowners/renters should be notified of the pros/cons of installing green heating/cooling systems. Other - Green gentrification (Hays et al. 2021)	Stakeholder Input - Stakeholders have requested "energy-efficient homes and heat pumps that keep them warm in the winter." It should be noted that this comment was received in December 2023, during the winter. Provide Tools to Communicate Measure's Benefits - The trainings and resources the State plans to implement will go a long way in ensuring the benefits under this priority measure are realized by LIDACs. Consider Lessons Learned from Past "Smart City" Development - Lessons learned from "smart city" development may be helpful in targeting the right individuals and skillsets necessary to build green programs that last (van Winden and van den Buuse 2017) Consider using funding to create high-level LIDAC owned and LIDAC run programs to ensure enabling actions benefit LIDACs.

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					report on the impacts on a "per complex" and "per person" unit because the use of the "per square meter" metric is misleading (Lausselet et al. 2019). The authors caution those considering zero-emissions complexes to also report on the entire life cycle of green buildings (*i.e.,* construction including materials and travel, the functional years of the building, and end of life) as the true impact of the action may not be net positive from a reduction of GHG or pollutants (Lausselet et al. 2019) such that the benefits are not fully realized by LIDACs. In conclusion, this measure could have a high positive impact on LIDACs if (1) funding is focused on LIDAC community homes (as opposed to local government buildings that are not used by LIDACs) and (2) disbenefits are avoided.	undesirable smells down-wind of the WWTP (if integrated properly). Improved Energy Security - A successful residential energy efficiency campaign targeted at LIDACs would reduce the energy consumption of homeowners and save them money that can be used on other essentials (DOE 2018) - Going electric can save LIDACs on energy cost and reduce their energy burden (Fenton 2022) - Going electric has also been found to increase productivity at home (Dulal 2016).		

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6	Make at least 10% of all low-to-moderate income properties electrification ready by 2030	Medium	High	Energy efficiency measures will be installed in low- and moderate-income residential buildings and multifamily homes.	Electrifying LIDAC homes could have a significant positive effect on the physical health and energy security of LIDAC if funding is focused on LIDAC homes and disbenefits are avoided. Potential disbenefits include "green gentrification" that could put renters/homeowners at risk of displacement due to the increase in value of their home. Additionally, if homes are sealed for efficiency purposes, it could reduce ventilation and increase indoor pollutants causing health problems for families. This priority measure is ranked as having a medium positive impact on LIDACs because the enabling actions therein pertain to low- and moderate-income residential buildings, so the enabling actions are not solely focused on LIDACs. This priority measure would have a higher positive impact if enabling actions were focused entirely on LIDACs and disbenefits were avoided.	[see relevant benefits highlighted in priority measure 5 above]	[see relevant disbenefits highlighted in priority measure 5 above]	Duplicate Wholistic Approach of Existing State Programs: - The Whole House program coordinates energy efficiency improvements while remediating health and safety hazards that pose a threat to human health (mold, asthma triggers, slip and fall risks, lead-bant, pests, other toxins). If the enabling actions continued this type of wholistic approach to energy efficiency updates, that would help to avoid some disbenefits. Consider using funding to create high-level LIDAC owned and LIDAC run programs to ensure enabling actions benefit LIDACs.

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7	Achieve 12.2 GW of solar in-state by 2030	Medium	High	Increase the amount of solar energy accessible to industry (via the Competitive Solar Incentive program and Dual Use Solar program), state and local government facilities, and residential communities.	Several of the programs that could receive funding under this priority measure can generate solar energy for industry use, as opposed to solely residential use. If the renewable energy from solar arrays under these programs is indeed used to power LIDACs and reduce LIDAC energy bills, the positive impacts to LIDACs will be high. Programs like Community Solar Energy Programs can have immediate benefits to LIDACs once built. However, programs that make it easier for industries to collect solar do not have a direct benefit for LIDACs so reduces the benefits for this priority measure.	Physical Health - Improved air quality from a "green" grid that does not rely predominantly on energy from power plants. Improved Energy Security. - Solar power reduces energy costs for the owners of the solar panels or those participating in a community program. - Solar panels on agricultural land could provide financial support to NJ farmers (Peretzman 2023) as long as the solar panel locations do not block high quality farm land from being farmed (Makhijani 2021).	Roadblocks of Traditional Solar - Older homes may struggle to implement solar because it cannot support the weight of solar panels. A possible solution is community solar gardens (solar arrays are offsite but provide the same metering benefits as if panels were on homes). (Fenton 2022) - Many individuals in LIDACs rent their home, so landlords/apartment owners will need to be receptive to DERs for benefits to be realized by LIDACs.(Miller and Chen 2019) - Complexity of incentive and subsidy programs can preclude access. This is exacerbated by education and language barriers. (Fenton 2022) Disbenefits of Solar Programs - Poorly written solar program policies as well as low-income community's lower ability to participate/be represented in policy making process can alienate low-income communities from receiving funding to obtain solar energy (Si and Stephens 2021) - Solar panels placed on high nutrient agricultural land	Stakeholder Input - Stakeholders have noted that, "Most people are paying more for delivery of electricity rather than electricity usage. People don't understand 30-year leases on solar panels. More community solar is needed, versus company-driven solar." There is an impression among stakeholders of 20 years or so of bad solar policies which the State hopes to correct through education and enhanced community partnerships in the coming years. Through consultation with LIDACs, use funding to create high-level LIDAC owned and LIDAC run programs to ensure enabling actions benefit LIDACs.

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8	Facilitate the integration of clean distributed energy resources into the grid	Medium	High	Modernize the NJ electric grid and distribution system to support increased distributed energy resources (DER). This includes but is not limited to modernizing the grid and creating additional storage for DER, and piloting vehicles' ability to support the grid (*e.g.,* vehicle-to-everything ("V2X"), including vehicle-to-grid or V2G, vehicle-to-building or V2B, and vehicle-to-storage or V2S).	***GRID MODERNIZATION*** Grid modernization consists of supporting DER development, pursuing grid modernization to support additional demand being put on the grid due to increased building electrification and EV infrastructure, and increased energy storage. Grid modernization is an important step toward a strong grid that can handle increased electric demand and, subsequently, ensuring LIDACs can use solar arrays and adopt other energy efficiency actions to augment their energy supply costs. Grid modernization does benefit LIDACs in that it provides the infrastructure to support the electrification of LIDACs (*e.g.,* EVs). However, benefits to LIDACs would be greater if this action was coupled with an investment in supporting LIDAC households/housing with the onsite infrastructure to benefit from the grid (*e.g.,* funding to buy and install solar panels to feed into the grid, action 7) It is anticipated that a modernized grid would not yield a direct impact to LIDACs, unless this action focuses funding on LIDAC residential areas to establish DER, V2G, V2B, or V2S in the near-term. Given current technology in energy storage, battery storage seems to be the most feasible (Behabtu et al. 2020) but is not immune to hazards (*e.g.,* fires, explosions) (Conzen et al. 2023). If safety policies were implemented and if the modernization of the grid reduces the pollution sources near LIDACs (like shutting down power plants that contribute to poor air quality) the ranking for this action would increase. ***UPGRADING GENERATORS*** Literature suggests that diesel may still be important in emergency situations (*e.g.,* it is recommended that diesel, electric battery, and fuel cell generators be in the mix for emergency power sources for a system to withstand long power outage events) (Marqusse et al. 2021a,b). Of note is that fuel cell generators were found to be (1) more cost effective in the long-term than a battery system and (2)	***GRID MODERNIZATION*** Physical Health - Improved air quality from a "green" grid that does not rely predominantly on energy from power plants. Increased Resilience - A grid that can support more DER, and has many sources of DER, makes the grid more resilient and less susceptible to brown outs during peak operating hours. (It could also support additional AC units installed in LIDACs to improve their physical/mental health during extreme weather events). - Brownout prevention precludes the surge in crime, vehicle crashes, psychosocial stress, interruption of communication between emergency services, delivery of water, and waste removal that comes with brown outs (Casey et al. 2020) Improved Energy Security - Going electric can save LIDACs on energy cost and reduce their energy burden. - Lower energy bills can have mental health benefits, including stress reduction (Brown et al. 2019) Workforce Development - If this action increases the number of DER installation, good paying jobs for solar (etc.) installation may be realized. ***UPGRADING GENERATORS*** Physical Health - Improved air quality – diesel generators increase ground PM2.5 concentrations that can create health problems to those living/working nearby, especially in urban environments where tall buildings trap pollutants (Tong and Zhang 2015) - Preclude a surge in crime, car crashes, stress, delivery of clean water and waste removal services that typically come with power outages (Casey et al. 2020) Increased Resilience	***GRID MODERNIZATION*** - Batteries can catch fire or explode and release hydrogen fluoride gas which can be damaging to the lungs if there is prolonged exposure to the gas (Conzen et al. 2023) ***VEHICLES FOR ENERGY STORAGE*** Physical Health - Improper charging of EV batteries can make them more susceptible to "thermal runaway" (or fire) (Sun et al. 2020). Precautions need to be taken (*e.g.,* education, mechanical fail-safes) to ensure homes participating in vehicle-to-grid programs are not at additional risk of fire.	Consider implementing safety measures/policies to avoid health hazards that could be associated with poor handling or maintenance of batteries and generators. ***VEHICLES FOR ENERGY STORAGE*** - It is encouraged for V2G areas using MHDV batteries to be concentrated in LIDAC to bolster the system in those vulnerable areas. Consider Allocating Savings to LIDACs - If this priority measure focuses on MHDVs and school buses, consider a financial scheme where some of the money saved by these groups is put into a LIDAC fund to support other green initiatives in these communities.

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					operate more quietly and have lower emissions than a battery-diesel generator system (DOE 2014). ***VEHICLES FOR ENERGY STORAGE*** School buses and commercial MHDV fleets would be prioritized for programs related to V2G, V2B, and V2S as their batteries are larger than traditional EVs (Ercan et al. 2016). As such, the income generated by selling energy back to the grid would largely provide financial support to the towns/companies that own the buses or truck fleets and not LIDAC community members themselves (unless an EV in a LIDAC community was part of a V2G, V2B, and V2S program). If this technology is scaled in New Jersey, it would create a more reliable grid and would likely prevent brownouts from happening. This would create positive health impacts for everyone, including LIDACs. It is worth noting there are long standing inequities in V2G charging (Sovacool et al. 2018), which highlights implementation grants as an opportunity to address this inequity. This action would have a higher impact if disbenefits were addressed.	- Building peoples' capacity to stay healthy during power outages/emergencies ***VEHICLES FOR ENERGY STORAGE*** Physical Health - Reduced air pollution. Increased Resilience - V2G technology is one of several elements that should be used to create a green grid that can handle peak operating hours and reduce brownouts (other elements include information and communication technologies that regulate the performance of the grid (Rathor and Saxena 2019). Low-income communities can be disproportionately impacted by brownouts (see case study on the Texas 2021 brownout during historic low temperatures by Lee et al. 2022), and low-income communities in New Jersey have been disproportionately impacted by climate driven power outages in the past (*e.g.,* Hurricane Sandy, Burger et al. 2017 and Mitsova et al. 2018). - If V2G technology can preclude LIDAC households from experiencing blackouts or brownouts, this action would have a positive impact on LIDAC physical and mental health. But the positives are only realized if the LIDACs also have the resources to stay healthy during extreme hot and cold conditions. - 13% of households in the US still lack air conditioning and those households are disproportionately poor (Tsoulou et al. 2020). If New Jersey implemented this action in tandem with connecting LIDACs with programs that address this heating/cooling gap, that would be ideal (especially if putting more AC units in homes would not in and of itself contribute to more brownouts). - Reduces the need for backup generators due to high storage capacity (Ali et al. 2020) Increased Financial Security - Vehicle-to-grid provides a source of revenue for electric vehicle owners (Ercan et al. 2016)		

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9	Support development of 11.0 GW offshore wind by 2040	Medium	High	Increased offshore wind turbines and onshore infrastructure to support offshore wind (including a NJ wind port).	The offshore wind industry in New Jersey is capable of generating renewable energy while also generating many jobs, which could provide excellent workforce development opportunities for LIDACs. However, steps must be taken to ensure the wind farm's offshore and onshore infrastructure do not have disproportionately adverse impacts to LIDACs. If disbenefits are avoided, the positive impact of this priority measure will increase.	Workforce Development - If New Jersey generates 7.5GW of offshore wind, the wind farms and accompanying infrastructure investments will result in job growth in the construction, manufacturing and professional services. In 2030, NJ is projected to see approximately 20,000 jobs related to offshore wind, both from in-state and regional demand (BW Research Partnership 2022) Physical Health - Improved air quality from a "green" grid that does not rely predominantly on energy from power plants. Mental Health - Improved coastal amenities (*e.g.,* port facilities) may improve LIDAC connection with nature and access to marine facilities, but opinions are largely driven by individual perception of offshore wind (Walker et al. 2014, Hattam et al. 2015, Glasson et al. 2022)	Physical Health - Effects on view and restorative nature of seascape could affect engagement with coastal communities and ultimately health (Glasson et al. 2022) Community Beautification - Studies have shown wind farms located less than 40km from shore can result in housing price devaluation and tourist activity reduction which could affect the economic value of the region and resale values of homes. This could damage the financial security of homeowners in LIDACs (Alem et al. 2020) - Overhead transmission lines and substation locations in LIDACs can have a negative impact on property values. Decreased Financial Security - It is possible that wind farms could reduce fishermen's access to fishing grounds and/or have negative impacts on fisheries (Atlantic surfclam: Scheld et al. 2022), this could have a negative impact on fishermen who live in LIDACs. But additional research is needed to quantify those impacts (Chaji and Werner 2023).	Engage with Communities Impacted by Offshore Wind Development - Community engagement to inform the shape, position, and onshore elements of a wind farm are pivotal to a project's success, however community funds paid to community members (if implemented) can be viewed as bribes (Glasson et al. 2022). - Implement "good practice community engagement" as highlighted in Glasson et al. (2022).

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10	Achieve a 50% reduction in food waste by 2030	Low	High	- Decreased food waste from entities generating more than 52 tons of food waste per year - Increased local and regional composting operations - Increased food supply into food recovery systems including people without access to fresh food and energy generating digestors (anaerobic and co-digestion) at wastewater treatment facilities - Reduction of food waste at the local level (including schools) - Reduction of food-ware waste at a local level	Food loss and waste are a massive problem, generally, in the United States (Muth et al. 2019). The enabling actions in this priority measure to decrease food waste, increase the food supply for food recovery systems, and use anerobic digestion to turn food waste into energy have positive environmental and socioeconomic impacts to LIDACs. However, the enabling actions do not specifically target LIDAC areas. The exception to this conclusion is the digestors at wastewater treatment facilities (WWTF). Because WWTF are almost exclusively located in LIDACs, the benefits for digestors listed in this table should have a direct impact on LIDACs. However, the GHG reductions realized by installing digestors will generally not directly impact LIDACs (energy is being sold by WWTP back to the grid, which doesn't change the cost of energy to local communities), but there could be reduced truck traffic associated with the digestors which could	Physical Health - Reducing food waste can reduce the production of food which can lead to reduced soil, water, and air quality degradation from the process of transporting, incinerating, recycling, and landfilling waste (Zamri et al. 2020) which, in turn, can improve physical health. - Access to healthy food improves physical health and reduces chronic diseases. (Rudolph et al. 2018, An et al. 2019) - Anaerobic digestors significantly reduce the volume of sludge generated from wastewater treatment plants which (1) reduces disposal costs for the facility (Ge et al. 2013), (2) reduces truck traffic through LIDAC neighborhoods. This improves local air quality for LIDAC individuals. - Anerobic digestors reduce the volume of sludge sent to landfills for disposal because (1) the volume of sludge produced at an anerobic digester is significantly reduced compared to a traditional WWTP (which is where the vast majority of sludge currently ends up from New Jersey WWTPs) and (2) WWTP typically take in additional organic material from outside sources (which would otherwise go to a landfill). This reduces GHG emissions and co-pollutants from the transport and decomposition (*e.g.,* methane, chromium (VI), zinc, nickel, and arsenic, via Wang et al. 2021) of sludge which improves local air quality and has positive health impacts. Workforce Development - Job openings may be created anywhere in the food management and waste sector (*e.g.,* food pantries, industrial composting operations) which could provide LIDAC community members with good paying jobs. - Job creation is possible at anerobic digestor facilities (if facilities are interested in hiring LIDAC members/if any new jobs are created that LIDAC members are qualified for) (Kane 2018) Mental Health - If anerobic digesters are used at WWTFs, evidence suggests an improved quality of life for local LIDACs from reduced smell (Kitson et al. 2019, Zhang et al. 2020) If digestors are not integrated into waste management stream properly, smell can increase for local communities.	Physical Health - Poorly maintained compost operations can attract wildlife, promote conflict with people, and potentially spread diseases (Murray et al. 2016), But small-scale composting (among other techniques) rather than commercial scale composting are more viable for urban environments (de Souza Lima Jr. 2020) - If we assume neighborhoods that have truck traffic from wastewater treatment facilities also have traffic from other large trucks, we can assume that the reduction of wastewater treatment facility truck traffic would not fully ameliorate the full scope of the truck traffic nor the health/noise problems they cause. Mental Health - Digestate from anaerobic digesters can be used as a soil conditioner, however, the digestate needs to undergo proper treatment to ensure the soil is not contaminated which could increase the overall cost of the anaerobic digestion process (Kumar and Samadder 2020) - Construction noise from building digestors and noise from increased traffic to industrial compost facilities may be disruptive to local LIDACs. Capacity to Store Food - To support an increased food supply into a food recovery system, food pantries may need refrigerators and similar equipment to accommodate increased food stocks and to ensure they are able to stock higher quality food, distribute food, and thus reduce food insecurity. Food storage methods should be able to support daily food distribution events	Stakeholder Input - Stakeholders expressed support for residential composting/streamlined permitting process. - "We recommend leveraging the Zero Food Waste Coalition's State Policy Toolkit, which provides examples of policies and actions that can be incorporated into climate action plans to keep food waste out of landfills and reduce associated landfill methane emissions. Together, we can make a significant impact on the reduction of greenhouse gas emissions and the improvement of our state's overall sustainability." - "Policies and programs that disincentivize food from being landfilled or incinerated (such as food donation or recycling mandates) incentivize greater food waste prevention, while new infrastructure (such as food rescue, food hub, or composting facilities) help businesses and communities donate, upcycle, and recycle more of their excess food. These actions additionally support new jobs, help businesses and individuals cut their food purchasing costs, alleviate food insecurity among low-income and disadvantaged communities, and mitigate the longstanding environmental justice impacts of landfills and incinerators on local communities." Build Additional Waste Management Infrastructure - It may be beneficial for funding to be dedicated to building an efficient food waste infrastructure that brings food waste to destination. Whether that destination is (1) additional facilities (beyond the existing facilities in Trenton and Elizabeth) that recycle food waste under the Food Waste Recycling and Food Waste-to-Energy Act, (2) digesters located in areas that provide energy savings to LIDACs (maybe local food pantries), or (3) other locations, it will be

	Priority Measure	EJ40 Ranking	Ranking if Increased LIDAC Focus	Direct Impacts/Changes	Explanation	Benefits to LIDAC	Disbenefits to LIDAC and Roadblocks to Implementation of Measure	Recommendations to Mitigate Disbenefits to LIDAC
					reduce noise pollution for LIDACs living along truck routes. The LIDAC benefits are therefore not energy-related and will depend on the development of programs implemented in parallel with the installation of these digestors (e.g., workforce development programs, community gardens, etc.). If the enabling actions avoid disbenefits to LIDACs are realized, the positive impacts to LIDACs will increase.	- There are opportunities to foster community cohesiveness in the world of food security and energy generation. For example, if the sludge generated from digestors at a wastewater treatment facility could be shared with local organizations, like a community garden program, where the garden may receive free sludge/fertilizer for their garden. However, it is likely the wastewater treatment facility would prefer to sell the processed sludge for a profit, rather than donating to the local community.	and should be able to feed local communities during climate emergencies. Backup generators will be important to ensure food lasts longer during natural disasters or other climate events (*e.g.,* urban heat island power outages). All of this would come at increased cost which could be a barrier to implementation.	important to develop a regional food waste recycling network that is efficient and does not place a disproportionate burden on LIDACs re: heavy truck traffic (increased noise and pollution) and smell. Consider using funding to create high-level LIDAC owned and LIDAC run programs to ensure enabling actions benefit LIDACs.

	Priority Measure	EJ40 Ranking	Ranking if Increased LIDAC Focus	Direct Impacts/Changes	Explanation	Benefits to LIDAC	Disbenefits to LIDAC and Roadblocks to Implementation of Measure	Recommendations to Mitigate Disbenefits to LIDAC
11	Reduce halogenated gas emissions from refrigeration equipment	Low	Low	Replace high global warming potential refrigerants with low GWP refrigerants at facilities with large refrigeration systems	The process of replacing refrigerants would require workers to potentially be exposed to toxic (and flammable) chemicals from industrial facilities and then dispose of those materials in a sustainable manner. Refrigerant handling and disposal are highly regulated to ensure the safety of both the environment and workers, many of which live in LIDACs. However, there is always a risk of harm to individuals handling these chemicals. As such, the positive impacts to LIDACs are low because there would be a limited number of individuals who may be exposed to toxic and harmful refrigerant chemicals, even in the unlikely event that safety protocols are not followed during the transition to low-GWP refrigerants. The positive impact is also low because any energy savings from switching from high-GWP to low-GWP refrigerants would be realized by the owners of industrial facilities not the LIDACs themselves.	Physical Health - Low-GWP alternative refrigerants could remove co-pollutants (Kazakov et al. 2012) from refrigerator system which would benefit the health of repair and maintenance workers who tend to be associated with LIDACs. - Accidental spillage/leakage from refrigerators and recyclers of electronic appliances are the major sources of HFCs for humans (Tsai 2005) Workforce Development Opportunity - Replacing high global warming potential refrigerants would provide entry level mechanic positions. These job opportunities would likely only remain available until the transition to low-global warming potential refrigeration systems was completed. Long-term job opportunities would be most likely if there was a job training element to keep those new employees on the job to do other work/repair/maintenance on refrigeration systems or other appliances. Decreased Energy Costs - Phasing down HFCs could save users on electricity costs if done properly (Purohit et al. 2020)	Physical Health - Certain low-GWP HFCs can be dangerous beyond their toxicity – for example, some HFCs are flammable (Bolaji 2013, Kumma and Kruthiventi 2024). - While OSHA protections are in place, sometimes worker safety/health is not always protected in the workplace. Moreover, individuals from LIDACs are likely the employees who would be replacing the refrigerants. As such, LIDACs may be disproportionately impacted by toxins when the State makes the shift to low-GWP refrigerants.	n/a

	Priority Measure	EJ40 Ranking	Increased LIDAC Focus	Direct Impacts/ Changes	Explanation	Benefits to LIDAC	Disbenefits to LIDAC and Roadblocks to Implementation of Measure	Recommendations to Mitigate Disbenefits to LIDAC

12	Maintain, protect, and enhance NJ's natural carbon sinks.	Medium	High	This measure will result in more trees planted on public and private lands (including urban environments). This measure will also lead to enhanced/ restored habitats focused on improved natural flow of waters, creating living shorelines, and other sustainable activities (*e.g.,* silvopasture).	Planting trees is expected to provide many benefits to LIDACs (if planted properly and in large numbers) especially in urban areas where air pollution is generally higher than suburban and rural areas. Of note is the follow studies that highlight some issues with tree planting which are expanded on in the disbenefits column to the right:
					- The impact of trees on physical health in urban areas is minimal unless tree abundance hits a certain threshold of land cover. Nowak (2020) found the average air quality improvement by trees in cities is typically less than one percent. Moreover, a literature review found there is no scientific consensus that urban trees reduce asthma by improving air quality (Eisenman et al. 2019).
					- Another concern is the role of
						TREE PLANTING BENEFITS
						Physical Health
						- Reduced air pollution.
						  ○ Urban trees that are planted in a high biodiversity pattern (with different tree species adjacent to one another) are associated with lower mortality rates for heart disease and stroke. Authors stress correlation does not mean causation, but could be a cost-effective way to reduce mortality related to cardiovascular disease in urban areas (Giacinto et al. 2021)
						  ○ Living in urban areas with more green spaces was associated with improved cardiovascular health in people free of acute myocardial infarction and heart failure but not among individuals who have already developed these conditions (Chen et al. 2020)
						  ○ Prenatal and perinatal exposure to air pollutants can cause respiratory diseases in children and adults (Kim et al. 2018). While exposure to air pollutants at a young age are strongly associated with asthma exacerbations of children (Tosca et al. 2014), urban forest environments seem to help protect children from respiratory morbidity (e.g., wheezing, sneezing, runny nose, itchy eyes) (Almeida et al. 2020)
						- Reduced heat illness, as trees reduce the frequency of heat island events (Rudolph et al. 2018, Lungman et al. 2023)
						- Faster recovery from illness (because of reduced stress)
						- Reduced gun violence – fewer gunshot assaults have been found in areas of high tree coverage. It is also important to design landscaping with "Crime Prevention Through Environmental Design" techniques in mind (*e.g.,* reduce shrubbery to improve sightlines and sense of security) (Wolf et al. 2010, Kondo et al. 2017, Lee 2021, Nuccitelli er al. 2023)
						- Cancer protection - trees can reduce the risk of skin cancer due to shade protection (Moreno et al. 2015)
						
						Mental Health
						- Stress reduction and social cohesion (sense of safety, beauty) – social cohesion also reduces premature deaths because individuals feel connected to their communities. (Vincent et al. 2017)
						- Trees provide a sense of place – A survey of Sydney, Australia residents with low educational levels (vocational or less) who were asked about their tree planting preferences noted they value trees mainly for their aesthetic value and because of "generational legacy" (Saldarriaga 2020)
						
						Improved Mental Acuity
						- Trees increase a student's ability to succeed in school and are linked to improved student performance, stress reduction, increased concentration, reducing ADD/ADHD
							ROADBLOCKS FOR TREE PLANTING
							- Magnitude of impact – Studies have shown that while beneficial, trees in urban environments have low potential for ameliorating air quality problems in a city environment given various social, ecological, and technological factors, including:
							  - Increase in maintenance costs – trees create leaf litter which must be maintained in the fall. Trees also must be maintained (by homeowners, municipalities, or energy companies) to mitigate the threat of dead/hazardous trees and roots that damage pavement and other infrastructure (Keeler et al. 2019). (Drew-Smyth et al. 2023)
							  - Health– Planting additional trees may introduce pollen that can cause health problems (Sicard et al. 2018). Moreover, trees planted with poor long-term planning can reduce ventilation in cities and trap vehicle emissions at pedestrian levels and exacerbate local air pollution (Keeler et al. 2019)
							- Poor Urban Tree Maintenance
							  - A study of street trees in Boston, MA found that the mean mortality rates of trees is double that of rural trees and has resulted in a net loss
								Stakeholder Input:
								- Stakeholders expressed an interest in additional attention on urban farming initiatives that were tabled during the pandemic, including programs for seniors in urban areas and students in urban schools.
								
								Foster Long-Term Workforce Development:
								- Many of the jobs created through enhancing NJ's natural carbon sinks are not long-term (*e.g.,* construction workers). The positive impact to LIDACs may be enhanced if there were workforce training opportunities to ensure workers (1) develop skillsets beyond manual labor and (2) could carry all skills learned to their next job. For example, empowering/training LIDACs through NJ's Urban and Community Forestry Program to performing municipal tree inventories and conducting tree education could be meaningful additions to a robust tree planting strategy,
								
								TREE PLANTING RECOMMENDATIONS
								- Engage Tree Experts in Planning Process
								  ○ Identify the scale of the desired biophysical effect of planting trees to help identify: i) tree species, ii) locations, iii) density of tree placement to achieve maximum benefits. (Salmond et al. 2016, Barwise and Kumar 2020)
								  ○ Consider the aerodynamics of desired planting area to mitigate the effects of urban street canyons (Abhijith et al. 2017)
								  ○ Plant female trees rather than male because they produce less pollen (Sicard et al. 2018)
								- Engage LIDAC in Tree Planning Process: Previous studies have found low tree canopy coverage was not always associated with typical socioeconomic indicators (*e.g.,* percent minority populations, poverty levels, etc.) (Riley

	Priority Measure	EJ40 Ranking	Increased LIDAC Focus	Direct Impacts/ Changes	Explanation	Benefits to LIDAC	Disbenefits to LIDAC and Roadblocks to Implementation of Measure	Recommendations to Mitigate Disbenefits to LIDAC
					gentrification. Large-scale urban tree planting (especially those that occur as part of broader roadway redesign, park revitalization, etc.) may trigger property value increases that could escalate residential displacement in LIDACs. This priority measure would also support natural habitat enhancement/restoration that could protect LIDACs from flooding from storms/erosion, but it may increase their property values in tandem. This priority measure would also support silvopasture development via the Conservation Cost Share Program, which has the potential to have a high impact on LIDACs if there is an interest among the farming community to adopt these practices Because of the range of benefits available to	symptoms, increase in attention, and increase in self-discipline (Turner-Skoff and Cavender 2020). Exposure to elevated PM2.5 has been shown to reduce student's performance on high-stakes exams (*e.g.,* SATs) and this reduction in performance is more pronounced for students from lower socioeconomic background and students that generally perform poorly in the classroom (Ebenstein et al. 2016). Poor performance on high-stakes exams can affect a student's long-term education attainment (*e.g.,* what college they are able to get into) and, ultimately, their adult wages (Ebenstein et al. 2016). - Prevalence of trees in urban environments are associated with improved academic performance in school aged children (Sivarajah et al. 2018) Increased Resilience - Decreased urban heat island (Kondo et al. 2020) Improved Energy security - Shade extends life of building materials (Vincent et al. 2017) and reduces energy bills. - Trees are a wind break and might help heating bills (but windbreaks are only effective in saving energy in windy climates per Dewalle and Heisler 1988) ***SILVOPASTURE BENEFITS*** Physical Health - Consumers of Farm Products: Access to fresh food can improve health. - Workers at Farms: Silvopasture can reduce the amount of herbicide, pesticides, and antibiotics on the farm (Zhu et al. 2020) which produces safer working conditions for farmers handling these materials. Mental Health - Urban farms bring education, socialization, and companionship (Conway and Nieman 2022) Workforce Development - Job creation – silvopasture requires additional employees for maintenance of fences, debris, gullies, stump removal, etc. (Frey and Fike 2018; Conway and Nieman 2022) Improved Financial Security - Silvopasture can make it easier for first time farmers to acquire land. Prime farmland tends to be expensive while farmland in marginal pasture or a wooded pasture is a more affordable option for new farmers (Smith et al. 2022).	of street tree carbon storage over time (Smith et al. 2019). - Gentrification. - When neighborhoods improve from beautification real estate prices and rents can increase (Nieuwenhuijsen 2020). ***ROADBLOCKS FOR SILVOPASTURE*** Workforce Development Challenges - The number of jobs that would conceivably be created from this effort seems low. Indeed, several farmers identified "increased labor" as a key challenge in implementing silvopasture as increased labor means increased costs (De Jalon et al. 2018, Jara-Rojas et al. 2020). Increases in costs could also occur if farmers need to purchase new or modified equipment to manage their new farming practices (Smith et al. 2022). Farmer Preferences - Farmers generally prefer creating silvopasture by thinning established trees rather than planting trees in open pastures or fields because the former could earn them money from timber sales, while the latter creates financial risk. For example, even fast-growing trees take years to provide shade benefits to livestock and would take time and money to	and Gardiner 2020). As such, it is important to work with communities to understand local social-ecological systems to achieve statewide sustainability goals. Example community organizations are available here. - Prevent Gentrification: When the State undertakes these efforts to plant more trees, it is recommended that DEP (1) monitor the affordability of "improved" neighborhoods under this action and (2) the State take actions to ensure existing communities can afford to live in their current neighborhood if they would like to (*e.g.,* through rent control measures). - Establish Guidelines for Long-Term Management of Urban Trees" Initiatives to aid in the establishment and preservation of tree health are central for mitigating urban tree death and increasing street tree canopy cover such that human health benefits are realized. ***SILVOPASTURE RECOMMENDATIONS*** It would be beneficial for the following considerations to be implemented for silvopasture to have a high impact on LIDACs: - Prioritize silvopasture areas near LIDACs. 46.1% of municipalities that include LIDACs also have agricultural land per the state's Land Use Land Cover Map of 2015: while farmland is more abundant in rural areas of the state, some urbanized areas also have agricultural land (Appendix C). Indeed, of the 256 municipalities with LIDACs, 117 of those Towns have at least one parcel of agricultural land (this accounts for 45.7% of municipalities with LIDACs). - Ensure food from the silvopasture programs are made available to LIDACs to mitigate food insecurities in LIDACs - Ensure this program involves a breadth of livestock (*i.e.,* goats, cows, chickens rather

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					LIDACs through these enabling actions this priority measure is ranked as "medium" but would have a "high" impact if disbenefits were overcome.	- Silvopasture can also save existing farmers money – when farmers convert marginal pasture, forest, or woodland into silvopasture it increases the utility and value of their land and precludes them from having to buy more land and increasing their property taxes. (Smith et al 2022). - Improved aesthetics from silvopasture can improve the marketability of other on-site amenities (*e.g.,* rental house, wedding venue/barn) to help the farmer earn more money (Frey and Fike 2018). ***ENHANCING/RESTORING HABITATS BENEFITS*** Increased Resilience - Living shorelines and restoring hydrologic reconnection to tidal wetlands and floodplains creates storm/flood protection as well as erosion protection. This also creates economic benefits by reducing drainage maintenance costs in the local area and avoiding travel disruptions (Samonte et al. 2017, Smith et al. 2020, Shaw et al. 2021). Workforce Development - Restoration activities create jobs for environmental consultants, engineers, construction workers, geologists, project managers, fishermen, biologists and divers (Samonte et al. 2017).	protect seedlings from animal browse (Smith et al. 2022) Perception of Quality of Life for Urban Silvopasture - There will likely be high levels of public pushback on urban farming due to concerns about smell, noise, waste management, etc. (Conway and Nieman 2022) ***DISBENEFITS FOR HABITATS*** - Restored wetlands and stabilized shoreline can increase property values due to increased resilience and enhanced aesthetics of a coastline (Samonte et al. 2017) which may cause green gentrification in LIDACs.	than a small chicken coop in someone's backyard). - Identify Regulatory Hurdles: Identify any existing state/municipal regulations that restrict the ownership of livestock in certain areas (*e.g.,* urban vs rural areas) and amend those regulations. - Offer Incentives: Offer farmers tax benefits to farmers who hire individuals from LIDACs to work on silvopasture farms. ***HABITAT RECOMMENDATIONS*** - Generate resilience policies that avoid resilience actions that make coastal areas more expensive and more exclusive (Gould and Lewis 2021).

** Pollution from traditional combustion engine vehicles and diesel vehicles are known to contribute to the following physical, mental, and societal issues. This negative physical health, mental health, and societal issues may be mitigated with the implementation of actions within the transportation priority area.

- Physical Health: Exposure to traffic related particles can result in various poor health outcomes, which can disproportionately impact individuals of lower socioeconomic status (yea: Tonne et al. 2008, Fecht et al. 2015, Wang et al.2020; nay: Rodriquez-Villamizer et al. 2016) and the elderly (Ghosh et al. 2016)
    - Poor Birth Outcomes: decreased birth weight (Basu et al. 2014);
    - Increased Asthma: It is estimated that there are approximately 4155 cases of childhood asthma per year in New Jersey that can be attributed to traffic related air pollution (Thurston et al. 2019) and that traffic pollution can exacerbate asthma symptoms in asthmatic children (Pollitt et al. 2016)
    - Cardiac Issues: This includes cardiorespiratory disease (Requia et al. 2018),
    - Cancers: Poor air quality is linked with lung cancer (Hamra et al. 2014) and non-lung cancers (Kim et al. 2019)
    - Poor Cognitive Development and Neurological Disorders: PM2.5 exposure increases the risk of stroke, autism spectrum disorder, Alzheimer's disease, and Parkinson's disease (Fu et al. 2019) as well as prevalence of autism in children when mothers were exposed to the pollutant in their third trimester (Raz et al. 2014); brain aging and acceleration of Alzheimer's in older women (Cacciottolo et al. 2017). Though one article clarifies that residential proximity to major roadways during gestation and early life may affect cognitive development in children, the influences of pollutants and socioeconomic conditions on cognition may be difficult to disentangle (Harris et al. 2015).
- Mental Health: Exposure to air pollution has a negative impact on mental health and anxiety levels.
    - Poor Mental Health: Exposure to elevated levels of PM2.5 is associated with increased levels of anxiety (Power et al. 2015) and increased psychological distress (*e.g.,* depression and other mood disorders which interfere with social functioning and have been associated with increased risk of chronic disease and mortality) (Mehta et al. 2015, Sass et al. 2017).
    - Decreased Life Satisfaction: People interviewed with higher incomes report higher levels of happiness, and people interviewed on days with poor local air pollution report lower levels of happiness (Levinson 2012). Another study conducted in Salt Lake County, Utah found an unsettling correlation: that there is an increased risk of suicide associated with acute exposure (*i.e.,* several days of exposure) to elevated nitrogen dioxide and PM2.5 levels during the days

immediately preceding suicide attempts (Bakian et al. 2015). In contrast, another study found higher air pollution reduces life satisfaction particularly for individuals with poor health status (but this relationship was true for SO_2 concentrations, not for carbon monoxide, nitrogen dioxide, or PM2.5 (Barrington-Leigh and Behzadnejad 2017).

- Social Issues: Studies suggest increased anxiety and diminished mental health driven by air pollutant can foster an environment with more crime (Lu et al. 2018).
    - A study of all counties in Ohio, USA found exposure to traffic related pollutants is associated with an increased risk of adjudication, but the study cautions that correlation does not mean causation and emphasizes that this relationship warrants further examination (Haynes et al. 2011).
    - Long term exposure to PM2.5 (over a period of years) may increase delinquent behavior of urban adolescents, and the neurotoxic effects on behavior are more pronounced in families with unfavorable parent-to-child relationships, increased parental stress, or maternal depressive symptoms (Younan et al. 2018).
    - A study estimates the effect of short term PM2.5 exposure on crime across 99% of counties in the contiguous US and found increases in PM2.5 raise assault crimes (Burkhardt et al. 2019). The biological pathway for this reaction requires more research, but these authors hypothesize the relationship between pollution and aggression is driven by physiological processes and is thus uniform across the US and does not depend on observable sociodemographic such as income or race but may be influenced by age such that older populations may be more susceptible to changes in air pollution (Burkhardt et al. 2019).

Appendix A – List of Literature Review Search Terms

Terms re: the Affected Populations:

- Underserved, underrepresented, disadvantaged, overburdened, low income, older adults, elderly, minority, socioeconomic status, (“SES”)

Terms re: Priority Measures and Enabling Actions:

- greenhouse gas reduction measures, emissions reduction measures, criteria pollution, diesel pollution, transportation emissions, MHDV charging hubs, electric vehicles, ride sharing, ride hailing, EV charging station, multi-unit dwelling (multi-family housing), fleet, workforce, distributed energy resources (DER), pathways + electricians, tree, tree + inventory, tree + database, tree + maintenance, parks, food pantry, food pantry + composter, food pantry + carbon neutral, wastewater treatment + anerobic digester, wastewater treatment + energy recovery

Terms re: Impacts of Concern

- benefit, disbenefit, negative, public health, health, illness, disease, stress, mental health, noise, well-being, socioeconomics, crime, employment, job, training, workforce development, safety, pollutants, pollution, waste, access, beautification, energy cost, energy demand, energy security, capacity building, cancer, acute respiratory symptoms, restricted activity days, minor RAD, asthma, emergency room visits, cardiovascular, hospitalizations

Additional phrases that were searched:

- “workforce training” programs for electric vehicle charging stations; impact of high GWP hydrofluorocarbons on "human health”; health risks of transitioning from using refrigerants with high GWP; planting trees on farmland; "farm" "emission reduction" "tree”; planting trees on "grazing land"; "farm" "emission reduction" "tree" "mental health"; and distributed energy resources, human health impacts, EJ communities.

Appendix B – Concise Summary of Municipalities with LIDACs and/or Adversely Impacted Overburdened Communities

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
ATLANTIC COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34001000100 34001000200 34001000300 34001000400 34001000500 34001001100 34001001200 34001001300 34001001400 34001001500 34001001900 34001002300 34001002400 34001002500 34001010300 34001010600 34001011100 34001011202 34001011300 34001011701 34001011702 34001011900 34001012000 34001012100 34001012200 34001013201				
ATLANTIC	Absecon City	0101	Y	Y
ATLANTIC	Atlantic City	0102	Y	Y
ATLANTIC	Brigantine City	0103	N	Y
ATLANTIC	Buena Borough	0104	Y	Y
ATLANTIC	Buena Vista Township	0105	Y	Y
ATLANTIC	Corbin City	0106	Y	N
ATLANTIC	Egg Harbor City	0107	Y	Y
ATLANTIC	Egg Harbor Township	0108	Y	Y
ATLANTIC	Estell Manor City	0109	Y	N
ATLANTIC	Folsom Borough	0110	N	Y
ATLANTIC	Galloway Township	0111	Y	Y
ATLANTIC	Hamilton Township	0112	Y	Y
ATLANTIC	Hammonton Town	0113	Y	Y
ATLANTIC	Linwood City	0114	N	N
ATLANTIC	Longport Borough	0115	N	N
ATLANTIC	Margate City	0116	N	N
ATLANTIC	Mullica Township	0117	N	Y
ATLANTIC	Northfield City	0118	N	N
ATLANTIC	Pleasantville City	0119	Y	Y
ATLANTIC	Port Republic City	0120	N	N
ATLANTIC	Somers Point City	0121	Y	N
ATLANTIC	Ventnor City	0122	Y	Y
ATLANTIC	Weymouth Township	0123	Y	Y
BERGEN COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34003003500 34003006201 34003006300 34003015400 34003018100 34003018200 34003021200 34003021300 34003021400 34003021500 34003021600 34003023502 34003023602 34003030200 34003036200 34003041100 34003041301 34003057200				
BERGEN	Allendale Borough	0201	N	N
BERGEN	Alpine Borough	0202	N	N
BERGEN	Bergenfield Borough	0203	Y	Y
BERGEN	Bogota Borough	0204	Y	Y
BERGEN	Carlstadt Borough	0205	Y	Y
BERGEN	Cliffside Park Borough	0206	Y	Y
BERGEN	Closter Borough	0207	Y	N
BERGEN	Cresskill Borough	0208	Y	N
BERGEN	Demarest Borough	0209	N	N
BERGEN	Dumont Borough	0210	Y	N
BERGEN	Elmwood Park Borough	0211	Y	Y
BERGEN	East Rutherford Borough	0212	Y	N

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
BERGEN	Edgewater Borough	0213	Y	Y
BERGEN	Emerson Borough	0214	Y	N
BERGEN	Englewood City	0215	Y	Y
BERGEN	Englewood Cliffs Borough	0216	Y	N
BERGEN	Fair Lawn Borough	0217	Y	Y
BERGEN	Fairview Borough	0218	Y	Y
BERGEN	Fort Lee Borough	0219	Y	Y
BERGEN	Franklin Lakes Borough	0220	N	N
BERGEN	Garfield City	0221	Y	Y
BERGEN	Glen Rock Borough	0222	N	N
BERGEN	Hackensack City	0223	Y	Y
BERGEN	Harrington Park Borough	0224	N	N
BERGEN	Hasbrouck Heights Borough	0225	Y	Y
BERGEN	Haworth Borough	0226	Y	N
BERGEN	Hillsdale Borough	0227	N	N
BERGEN	Ho-Ho-Kus Borough	0228	N	N
BERGEN	Leonia Borough	0229	Y	Y
BERGEN	Little Ferry Borough	0230	Y	Y
BERGEN	Lodi Borough	0231	Y	Y
BERGEN	Lyndhurst Township	0232	Y	N
BERGEN	Mahwah Township	0233	Y	N
BERGEN	Maywood Borough	0234	Y	N
BERGEN	Midland Park Borough	0235	N	N
BERGEN	Montvale Borough	0236	N	N
BERGEN	Moonachie Borough	0237	Y	Y
BERGEN	New Milford Borough	0238	Y	N
BERGEN	North Arlington Borough	0239	Y	N
BERGEN	Northvale Borough	0240	Y	N
BERGEN	Norwood Borough	0241	Y	N
BERGEN	Oakland Borough	0242	N	N
BERGEN	Old Tappan Borough	0243	N	N
BERGEN	Oradell Borough	0244	Y	N
BERGEN	Palisades Park Borough	0245	Y	Y
BERGEN	Paramus Borough	0246	Y	N
BERGEN	Park Ridge Borough	0247	N	N
BERGEN	Ramsey Borough	0248	N	N
BERGEN	Ridgefield Borough	0249	Y	Y
BERGEN	Ridgefield Park Village	0250	Y	Y
BERGEN	Ridgewood Village	0251	Y	N
BERGEN	River Edge Borough	0252	Y	N
BERGEN	River Vale Township	0253	Y	N
BERGEN	Rochelle Park Township	0254	Y	N
BERGEN	Rockleigh Borough	0255	Y	N
BERGEN	Rutherford Borough	0256	Y	Y
BERGEN	Saddle Brook Township	0257	Y	N
BERGEN	Saddle River Borough	0258	N	N
BERGEN	South Hackensack Township	0259	Y	Y

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
BERGEN	Teaneck Township	0260	Y	Y
BERGEN	Tenafly Borough	0261	Y	Y
BERGEN	Teterboro Borough	0262	Y	Y
BERGEN	Upper Saddle River Borough	0263	Y	N
BERGEN	Waldwick Borough	0264	Y	N
BERGEN	Wallington Borough	0265	Y	Y
BERGEN	Washington Township	0266	N	N
BERGEN	Westwood Borough	0267	Y	N
BERGEN	Woodcliff Lake Borough	0268	N	N
BERGEN	Wood-Ridge Borough	0269	Y	Y
BERGEN	Wyckoff Township	0270	N	N
BURLINGTON COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34005700703 34005700900 34005701001 34005701204 34005702207 34005702208 34005702603 34005704600 34005704802				
BURLINGTON	Bass River Township	0301	N	N
BURLINGTON	Beverly City	0302	Y	Y
BURLINGTON	Bordentown City	0303	N	Y
BURLINGTON	Bordentown Township	0304	Y	Y
BURLINGTON	Burlington City	0305	Y	Y
BURLINGTON	Burlington Township	0306	Y	N
BURLINGTON	Chesterfield Township	0307	Y	N
BURLINGTON	Cinnaminson Township	0308	Y	Y
BURLINGTON	Delanco Township	0309	Y	Y
BURLINGTON	Delran Township	0310	Y	Y
BURLINGTON	Eastampton Township	0311	N	Y
BURLINGTON	Edgewater Park Township	0312	Y	Y
BURLINGTON	Evesham Township	0313	N	N
BURLINGTON	Fieldsboro Borough	0314	Y	N
BURLINGTON	Florence Township	0315	Y	N
BURLINGTON	Hainesport Township	0316	Y	Y
BURLINGTON	Lumberton Township	0317	Y	Y
BURLINGTON	Mansfield Township	0318	N	N
BURLINGTON	Maple Shade Township	0319	Y	N
BURLINGTON	Medford Township	0320	N	N
BURLINGTON	Medford Lakes Borough	0321	N	N
BURLINGTON	Moorestown Township	0322	N	N
BURLINGTON	Mount Holly Township	0323	Y	Y
BURLINGTON	Mount Laurel Township	0324	Y	N
BURLINGTON	New Hanover Township	0325	N	Y
BURLINGTON	North Hanover Township	0326	Y	Y
BURLINGTON	Palmyra Borough	0327	Y	Y
BURLINGTON	Pemberton Borough	0328	N	N
BURLINGTON	Pemberton Township	0329	N	Y
BURLINGTON	Riverside Township	0330	Y	Y
BURLINGTON	Riverton Borough	0331	N	N
BURLINGTON	Shamong Township	0332	N	N
BURLINGTON	Southampton Township	0333	N	Y

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
BURLINGTON	Springfield Township	0334	N	Y
BURLINGTON	Tabernacle Township	0335	N	N
BURLINGTON	Washington Township	0336	N	Y
BURLINGTON	Westampton Township	0337	Y	N
BURLINGTON	Willingboro Township	0338	Y	Y
BURLINGTON	Woodland Township	0339	N	Y
BURLINGTON	Wrightstown Borough	0340	Y	Y
CAMDEN COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34007600200 34007600400 34007600700 34007600800 34007600900 34007601000 34007601101 34007601102 34007601200 34007601300 34007601400 34007601500 34007601600 34007601700 34007601800 34007601900 34007602000 34007602503 34007602602 34007604100 34007605200 34007607000 34007607701 34007608210 34007608503 34007608600 34007609000 34007609204 34007610300 34007610400 34007610500 34007610800 34007611600				
CAMDEN	Audubon Borough	0401	N	N
CAMDEN	Audubon Park Borough	0402	N	N
CAMDEN	Barrington Borough	0403	N	N
CAMDEN	Bellmawr Borough	0404	Y	Y
CAMDEN	Berlin Borough	0405	Y	Y
CAMDEN	Berlin Township	0406	N	Y
CAMDEN	Brooklawn Borough	0407	Y	Y
CAMDEN	Camden City	0408	Y	Y
CAMDEN	Cherry Hill Township	0409	Y	N
CAMDEN	Chesilhurst Borough	0410	N	Y
CAMDEN	Clementon Borough	0411	Y	Y
CAMDEN	Collingswood Borough	0412	Y	Y
CAMDEN	Gibbsboro Borough	0413	N	Y
CAMDEN	Gloucester City	0414	Y	Y
CAMDEN	Gloucester Township	0415	Y	Y
CAMDEN	Haddon Township	0416	Y	Y
CAMDEN	Haddonfield Borough	0417	N	N
CAMDEN	Haddon Heights Borough	0418	N	N
CAMDEN	Hi-Nella Borough	0419	Y	N
CAMDEN	Laurel Springs Borough	0420	N	N
CAMDEN	Lawnside Borough	0421	Y	N
CAMDEN	Lindenwold Borough	0422	Y	Y
CAMDEN	Magnolia Borough	0423	Y	N
CAMDEN	Merchantville Borough	0424	Y	Y
CAMDEN	Mount Ephraim Borough	0425	Y	Y
CAMDEN	Oaklyn Borough	0426	N	Y
CAMDEN	Pennsauken Township	0427	Y	Y
CAMDEN	Pine Hill Borough	0428	N	Y
CAMDEN	Runnemede Borough	0430	Y	Y
CAMDEN	Somerdale Borough	0431	Y	N
CAMDEN	Stratford Borough	0432	Y	N
CAMDEN	Tavistock Borough	0433	N	N
CAMDEN	Voorhees Township	0434	Y	Y
CAMDEN	Waterford Township	0435	N	Y

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
CAMDEN	Winslow Township	0436	N	Y
CAMDEN	Woodlynne Borough	0437	Y	Y
CAPE MAY COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34009020500 34009020600 34009021400 34009021500 34009022101 34009022102				
CAPE MAY	Avalon Borough	0501	N	N
CAPE MAY	Cape May City	0502	Y	N
CAPE MAY	Cape May Point Borough	0503	N	N
CAPE MAY	Dennis Township	0504	N	Y
CAPE MAY	Lower Township	0505	Y	Y
CAPE MAY	Middle Township	0506	Y	Y
CAPE MAY	North Wildwood City	0507	Y	Y
CAPE MAY	Ocean City	0508	Y	N
CAPE MAY	Sea Isle City	0509	N	N
CAPE MAY	Stone Harbor Borough	0510	N	N
CAPE MAY	Upper Township	0511	N	Y
CAPE MAY	West Cape May Borough	0512	N	N
CAPE MAY	West Wildwood Borough	0513	Y	Y
CAPE MAY	Wildwood City	0514	Y	Y
CAPE MAY	Wildwood Crest Borough	0515	N	Y
CAPE MAY	Woodbine Borough	0516	Y	Y
CUMBERLAND COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34011010200 34011020100 34011020200 34011020300 34011020400 34011020502 34011020503 34011030100 34011030200 34011030300 34011030400 34011040300 34011040500 34011040600 34011040700 34011040902 34011041100				
CUMBERLAND	Bridgeton City	0601	Y	Y
CUMBERLAND	Commercial Township	0602	N	Y
CUMBERLAND	Deerfield Township	0603	Y	Y
CUMBERLAND	Downe Township	0604	N	Y
CUMBERLAND	Fairfield Township	0605	Y	Y
CUMBERLAND	Greenwich Township	0606	N	N
CUMBERLAND	Hopewell Township	0607	Y	Y
CUMBERLAND	Lawrence Township	0608	N	N
CUMBERLAND	Maurice River Township	0609	N	Y
CUMBERLAND	Millville City	0610	Y	Y
CUMBERLAND	Shiloh Borough	0611	N	N
CUMBERLAND	Stow Creek Township	0612	N	N
CUMBERLAND	Upper Deerfield Township	0613	Y	Y
CUMBERLAND	Vineland City	0614	Y	Y
ESSEX COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34013000100 34013000200 34013000300 34013000400 34013000500 34013000600 34013000700 34013000800 34013000900 34013001000 34013001100 34013001300 34013001400 34013001500 34013001600 34013001700 34013001800 34013001900 34013002000 34013002100 34013002201 34013002202 34013002300 34013002400 34013002500 34013002600 34013002800 34013003100 34013003500 34013003700 34013003800 34013003900 34013004100 34013004200 34013004300 34013004400 34013004500 34013004600 34013004801 34013004802 34013004900 34013005000 34013005100 34013005200 34013005300 34013005400 34013005700 34013006200 34013006400 34013006600 34013006700 34013006800 34013006900 34013007000 34013007100 34013007200 34013007300 34013007400 34013007501 34013007502 34013007600 34013007700 34013007800 34013007900 34013008000 34013008100				

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
34013008200 34013008700 34013008800 34013008900 34013009000 34013009100 34013009200 34013009300 34013009400 34013009500 34013009600 34013009700 34013009900 34013010100 34013010200 34013010300 34013010400 34013010500 34013010600 34013010700 34013010800 34013010900 34013011100 34013011200 34013011300 34013011600 34013011700 34013011800 34013011900 34013012000 34013012100 34013012200 34013012300 34013012400 34013012500 34013012600 34013012900 34013013000 34013013100 34013013200 34013013300 34013015700 34013015900 34013017100 34013017700 34013017800 34013018100 34013018300 34013018400 34013018600 34013018700 34013018900 34013022700 34013022800 34013022900 34013023000 34013023100 34013023200 34013980100 34013980200				
ESSEX	Belleville Township	0701	Y	Y
ESSEX	Bloomfield Township	0702	Y	Y
ESSEX	Caldwell Borough	0703	Y	N
ESSEX	Cedar Grove Township	0704	Y	N
ESSEX	East Orange City	0705	Y	Y
ESSEX	Essex Fells Borough	0706	N	N
ESSEX	Fairfield Township	0707	Y	N
ESSEX	Glen Ridge Borough	0708	N	Y
ESSEX	Irvington Township	0709	Y	Y
ESSEX	Livingston Township	0710	Y	N
ESSEX	Maplewood Township	0711	Y	Y
ESSEX	Millburn Township	0712	Y	N
ESSEX	Montclair Township	0713	Y	Y
ESSEX	Newark City	0714	Y	Y
ESSEX	North Caldwell Borough	0715	N	N
ESSEX	Nutley Township	0716	Y	N
ESSEX	City of Orange Township	0717	Y	Y
ESSEX	Roseland Borough	0718	N	N
ESSEX	South Orange Village Township	0719	Y	Y
ESSEX	Verona Township	0720	N	N
ESSEX	West Caldwell Township	0721	N	N
ESSEX	West Orange Township	0722	Y	Y
GLOUCESTER COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34015500400 34015501002 34015501402				
GLOUCESTER	Clayton Borough	0801	N	Y
GLOUCESTER	Deptford Township	0802	Y	Y
GLOUCESTER	East Greenwich Township	0803	N	Y
GLOUCESTER	Elk Township	0804	N	Y
GLOUCESTER	Franklin Township	0805	N	Y
GLOUCESTER	Glassboro Borough	0806	Y	Y
GLOUCESTER	Greenwich Township	0807	Y	Y
GLOUCESTER	Harrison Township	0808	N	N
GLOUCESTER	Logan Township	0809	Y	N
GLOUCESTER	Mantua Township	0810	N	N
GLOUCESTER	Monroe Township	0811	Y	Y
GLOUCESTER	National Park Borough	0812	N	N
GLOUCESTER	Newfield Borough	0813	N	N
GLOUCESTER	Paulsboro Borough	0814	Y	Y
GLOUCESTER	Pitman Borough	0815	N	N

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
GLOUCESTER	South Harrison Township	0816	N	N
GLOUCESTER	Swedesboro Borough	0817	Y	N
GLOUCESTER	Washington Township	0818	Y	Y
GLOUCESTER	Wenonah Borough	0819	N	N
GLOUCESTER	West Deptford Township	0820	Y	Y
GLOUCESTER	Westville Borough	0821	Y	Y
GLOUCESTER	Woodbury City	0822	Y	Y
GLOUCESTER	Woodbury Heights Borough	0823	N	Y
GLOUCESTER	Woolwich Township	0824	Y	N
HUDSON COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34017000100 34017000200 34017000700 34017000902 34017001000 34017001201 34017001202 34017001400 34017001701 34017001800 34017001900 34017002000 34017002700 34017002800 34017002900 34017003000 34017004102 34017004200 34017004400 34017004500 34017004600 34017004700 34017005200 34017005300 34017005500 34017005801 34017006000 34017006100 34017006200 34017006300 34017006700 34017006800 34017007100 34017007800 34017010100 34017010300 34017010600 34017010700 34017010900 34017011100 34017011600 34017012300 34017012500 34017012600 34017012800 34017012900 34017013000 34017013100 34017013200 34017013300 34017013400 34017013500 34017013600 34017013700 34017014000 34017014102 34017014300 34017014501 34017014502 34017014700 34017014800 34017014900 34017015002 34017015100 34017015202 34017015300 34017015500 34017015600 34017015700 34017015802 34017015900 34017016000 34017016100 34017016200 34017016300 34017016400 34017016500 34017016600 34017016700 34017016800 34017016900 34017017000 34017017100 34017017200 34017017400 34017017500 34017017600 34017017700 34017017800 34017019000 34017032400				
HUDSON	Bayonne City	0901	Y	Y
HUDSON	East Newark Borough	0902	Y	Y
HUDSON	Guttenberg Town	0903	Y	Y
HUDSON	Harrison Town	0904	Y	Y
HUDSON	Hoboken City	0905	Y	Y
HUDSON	Jersey City	0906	Y	Y
HUDSON	Kearny Town	0907	Y	Y
HUDSON	North Bergen Township	0908	Y	Y
HUDSON	Secaucus Town	0909	Y	Y
HUDSON	Union City	0910	Y	Y
HUDSON	Weehawken Township	0911	Y	Y
HUDSON	West New York Town	0912	Y	Y
HUNTERDON COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34019011400				
HUNTERDON	Alexandria Township	1001	N	N
HUNTERDON	Bethlehem Township	1002	N	N
HUNTERDON	Bloomsbury Borough	1003	N	N
HUNTERDON	Califon Borough	1004	N	N
HUNTERDON	Clinton Town	1005	N	N
HUNTERDON	Clinton Township	1006	Y	N
HUNTERDON	Delaware Township	1007	N	N
HUNTERDON	East Amwell Township	1008	N	N
HUNTERDON	Flemington Borough	1009	Y	Y

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
HUNTERDON	Franklin Township	1010	N	N
HUNTERDON	Frenchtown Borough	1011	N	N
HUNTERDON	Glen Gardner Borough	1012	N	N
HUNTERDON	Hampton Borough	1013	N	N
HUNTERDON	High Bridge Borough	1014	N	N
HUNTERDON	Holland Township	1015	N	N
HUNTERDON	Kingwood Township	1016	N	N
HUNTERDON	Lambertville City	1017	N	N
HUNTERDON	Lebanon Borough	1018	N	N
HUNTERDON	Lebanon Township	1019	N	N
HUNTERDON	Milford Borough	1020	N	N
HUNTERDON	Raritan Township	1021	N	Y
HUNTERDON	Readington Township	1022	Y	N
HUNTERDON	Stockton Borough	1023	N	N
HUNTERDON	Tewksbury Township	1024	N	N
HUNTERDON	Union Township	1025	N	N
HUNTERDON	West Amwell Township	1026	N	N
MERCER COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34021000100 34021000200 34021000300 34021000400 34021000500 34021000600 34021000700 34021000800 34021000900 34021001000 34021001101 34021001102 34021001200 34021001300 34021001401 34021001402 34021001500 34021001600 34021001700 34021001800 34021001900 34021002000 34021002100 34021002200 34021002400 34021002500 34021002601 34021002800 34021003400 34021003601 34021004403 34021004406				
MERCER	East Windsor Township	1101	Y	Y
MERCER	Ewing Township	1102	Y	Y
MERCER	Hamilton Township	1103	Y	Y
MERCER	Hightstown Borough	1104	Y	Y
MERCER	Hopewell Borough	1105	N	N
MERCER	Hopewell Township	1106	N	N
MERCER	Lawrence Township	1107	Y	Y
MERCER	Pennington Borough	1108	N	N
MERCER	Trenton City	1111	Y	Y
MERCER	Robbinsville Township	1112	N	N
MERCER	West Windsor Township	1113	Y	Y
MERCER	Princeton	1114	Y	N
MIDDLESEX COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34023000200 34023001410 34023001416 34023004200 34023004300 34023004400 34023004500 34023004600 34023004700 34023004800 34023004900 34023005000 34023005100 34023005200 34023005300 34023005500 34023005601 34023005602 34023005700 34023005800 34023006002 34023006101 34023006800 34023006900 34023007103 34023007203 34023007304 34023007908 34023009000 34023009300				
MIDDLESEX	Carteret Borough	1201	Y	Y
MIDDLESEX	Cranbury Township	1202	N	Y
MIDDLESEX	Dunellen Borough	1203	Y	Y
MIDDLESEX	East Brunswick Township	1204	Y	Y
MIDDLESEX	Edison Township	1205	Y	Y
MIDDLESEX	Helmetta Borough	1206	N	N
MIDDLESEX	Highland Park Borough	1207	Y	Y

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
MIDDLESEX	Jamesburg Borough	1208	Y	N
MIDDLESEX	Metuchen Borough	1209	Y	Y
MIDDLESEX	Middlesex Borough	1210	Y	Y
MIDDLESEX	Milltown Borough	1211	Y	N
MIDDLESEX	Monroe Township	1212	Y	N
MIDDLESEX	New Brunswick City	1213	Y	Y
MIDDLESEX	North Brunswick Township	1214	Y	Y
MIDDLESEX	Old Bridge Township	1215	Y	Y
MIDDLESEX	Perth Amboy City	1216	Y	Y
MIDDLESEX	Piscataway Township	1217	Y	Y
MIDDLESEX	Plainsboro Township	1218	Y	Y
MIDDLESEX	Sayreville Borough	1219	Y	Y
MIDDLESEX	South Amboy City	1220	Y	Y
MIDDLESEX	South Brunswick Township	1221	Y	N
MIDDLESEX	South Plainfield Borough	1222	Y	Y
MIDDLESEX	South River Borough	1223	Y	Y
MIDDLESEX	Spotswood Borough	1224	Y	N
MIDDLESEX	Woodbridge Township	1225	Y	Y
MONMOUTH COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34025801700 34025803400 34025805500 34025805600 34025805700 34025805800 34025805900 34025806504 34025807003 34025807200 34025807300 34025807600 34025809903 34025810002 34025810900 34025811000				
MONMOUTH	Aberdeen Township	1301	Y	Y
MONMOUTH	Allenhurst Borough	1302	N	N
MONMOUTH	Allentown Borough	1303	N	N
MONMOUTH	Asbury Park City	1304	Y	Y
MONMOUTH	Atlantic Highlands Borough	1305	N	N
MONMOUTH	Avon-by-the-Sea Borough	1306	N	N
MONMOUTH	Belmar Borough	1307	Y	N
MONMOUTH	Bradley Beach Borough	1308	Y	N
MONMOUTH	Brielle Borough	1309	N	N
MONMOUTH	Colts Neck Township	1310	N	Y
MONMOUTH	Deal Borough	1311	N	N
MONMOUTH	Eatontown Borough	1312	Y	N
MONMOUTH	Englishtown Borough	1313	N	N
MONMOUTH	Fair Haven Borough	1314	N	N
MONMOUTH	Farmingdale Borough	1315	N	N
MONMOUTH	Freehold Borough	1316	Y	Y
MONMOUTH	Freehold Township	1317	Y	Y
MONMOUTH	Hazlet Township	1318	Y	Y
MONMOUTH	Highlands Borough	1319	N	N
MONMOUTH	Holmdel Township	1320	N	N
MONMOUTH	Howell Township	1321	Y	Y
MONMOUTH	Interlaken Borough	1322	N	N
MONMOUTH	Keansburg Borough	1323	Y	Y
MONMOUTH	Keyport Borough	1324	Y	Y
MONMOUTH	Little Silver Borough	1325	N	Y
MONMOUTH	Loch Arbour Village	1326	N	N

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
MONMOUTH	Long Branch City	1327	Y	Y
MONMOUTH	Manalapan Township	1328	Y	Y
MONMOUTH	Manasquan Borough	1329	N	N
MONMOUTH	Marlboro Township	1330	Y	Y
MONMOUTH	Matawan Borough	1331	Y	N
MONMOUTH	Middletown Township	1332	N	Y
MONMOUTH	Millstone Township	1333	N	N
MONMOUTH	Monmouth Beach Borough	1334	N	N
MONMOUTH	Neptune Township	1335	Y	Y
MONMOUTH	Neptune City Borough	1336	Y	N
MONMOUTH	Ocean Township	1337	Y	Y
MONMOUTH	Oceanport Borough	1338	N	Y
MONMOUTH	Red Bank Borough	1339	Y	Y
MONMOUTH	Roosevelt Borough	1340	N	N
MONMOUTH	Rumson Borough	1341	N	N
MONMOUTH	Sea Bright Borough	1342	N	N
MONMOUTH	Sea Girt Borough	1343	N	N
MONMOUTH	Shrewsbury Borough	1344	N	Y
MONMOUTH	Shrewsbury Township	1345	N	N
MONMOUTH	Lake Como Borough	1346	N	N
MONMOUTH	Spring Lake Borough	1347	N	N
MONMOUTH	Spring Lake Heights Borough	1348	N	N
MONMOUTH	Tinton Falls Borough	1349	Y	Y
MONMOUTH	Union Beach Borough	1350	N	Y
MONMOUTH	Upper Freehold Township	1351	N	N
MONMOUTH	Wall Township	1352	N	Y
MONMOUTH	West Long Branch Borough	1353	N	Y
MORRIS COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34027041705 34027043500 34027044800 34027044900 34027045000 34027045100 34027045602				
MORRIS	Boonton Town	1401	Y	N
MORRIS	Boonton Township	1402	N	N
MORRIS	Butler Borough	1403	Y	N
MORRIS	Chatham Borough	1404	N	N
MORRIS	Chatham Township	1405	N	N
MORRIS	Chester Borough	1406	N	N
MORRIS	Chester Township	1407	N	N
MORRIS	Denville Township	1408	N	N
MORRIS	Dover Town	1409	Y	Y
MORRIS	East Hanover Township	1410	N	N
MORRIS	Florham Park Borough	1411	Y	N
MORRIS	Hanover Township	1412	Y	N
MORRIS	Harding Township	1413	N	N
MORRIS	Jefferson Township	1414	N	Y
MORRIS	Kinnelon Borough	1415	N	N
MORRIS	Lincoln Park Borough	1416	Y	N
MORRIS	Madison Borough	1417	Y	N

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
MORRIS	Mendham Borough	1418	N	N
MORRIS	Mendham Township	1419	N	N
MORRIS	Mine Hill Township	1420	N	Y
MORRIS	Montville Township	1421	Y	N
MORRIS	Morris Township	1422	Y	Y
MORRIS	Morris Plains Borough	1423	N	N
MORRIS	Morristown Town	1424	Y	Y
MORRIS	Mountain Lakes Borough	1425	N	N
MORRIS	Mount Arlington Borough	1426	N	N
MORRIS	Mount Olive Township	1427	N	N
MORRIS	Netcong Borough	1428	N	N
MORRIS	Parsippany-Troy Hills Township	1429	Y	Y
MORRIS	Long Hill Township	1430	N	N
MORRIS	Pequannock Township	1431	N	N
MORRIS	Randolph Township	1432	Y	Y
MORRIS	Riverdale Borough	1433	N	N
MORRIS	Rockaway Borough	1434	Y	N
MORRIS	Rockaway Township	1435	Y	Y
MORRIS	Roxbury Township	1436	N	Y
MORRIS	Victory Gardens Borough	1437	Y	Y
MORRIS	Washington Township	1438	N	N
MORRIS	Wharton Borough	1439	Y	Y
OCEAN COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34029715200 34029715301 34029715302 34029715401 34029715402 34029715500 34029715600 34029715700 34029715800 34029720101 34029720102 34029720103 34029722200 34029731201 34029731202 34029731205 34029731206 34029735101 34029739100				
OCEAN	Barnegat Township	1501	N	N
OCEAN	Barnegat Light Borough	1502	N	N
OCEAN	Bay Head Borough	1503	N	N
OCEAN	Beach Haven Borough	1504	N	N
OCEAN	Beachwood Borough	1505	Y	N
OCEAN	Berkeley Township	1506	N	Y
OCEAN	Brick Township	1507	Y	Y
OCEAN	Toms River Township	1508	Y	Y
OCEAN	Eagleswood Township	1509	N	Y
OCEAN	Harvey Cedars Borough	1510	N	N
OCEAN	Island Heights Borough	1511	N	N
OCEAN	Jackson Township	1512	Y	Y
OCEAN	Lacey Township	1513	N	Y
OCEAN	Lakehurst Borough	1514	Y	Y
OCEAN	Lakewood Township	1515	Y	Y
OCEAN	Lavallette Borough	1516	N	N
OCEAN	Little Egg Harbor Township	1517	N	N
OCEAN	Long Beach Township	1518	N	N
OCEAN	Manchester Township	1519	Y	Y
OCEAN	Mantoloking Borough	1520	N	N
OCEAN	Ocean Township	1521	N	N

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
OCEAN	Ocean Gate Borough	1522	N	N
OCEAN	Pine Beach Borough	1523	N	N
OCEAN	Plumsted Township	1524	N	Y
OCEAN	Point Pleasant Borough	1525	N	N
OCEAN	Point Pleasant Beach Borough	1526	N	N
OCEAN	Seaside Heights Borough	1527	Y	N
OCEAN	Seaside Park Borough	1528	N	N
OCEAN	Ship Bottom Borough	1529	N	N
OCEAN	South Toms River Borough	1530	Y	Y
OCEAN	Stafford Township	1531	N	Y
OCEAN	Surf City Borough	1532	N	N
OCEAN	Tuckerton Borough	1533	N	N
PASSAIC COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34031124321 34031124800 34031124900 34031125000 34031125100 34031133701 34031133702 34031175200 34031175301 34031175302 34031175401 34031175402 34031175500 34031175701 34031175703 34031175704 34031175801 34031175802 34031175900 34031180100 34031180202 34031180300 34031180600 34031180700 34031180800 34031180900 34031181000 34031181100 34031181200 34031181300 34031181400 34031181500 34031181702 34031181800 34031181900 34031182000 34031182100 34031182200 34031182301 34031182302 34031182400 34031182500 34031182700 34031182800 34031182900 34031183000 34031183101 34031183102 34031183200 34031203600 34031223900 34031264200				
PASSAIC	Bloomingdale Borough	1601	N	N
PASSAIC	Clifton City	1602	Y	Y
PASSAIC	Haledon Borough	1603	Y	Y
PASSAIC	Hawthorne Borough	1604	Y	Y
PASSAIC	Little Falls Township	1605	Y	N
PASSAIC	North Haledon Borough	1606	Y	Y
PASSAIC	Passaic City	1607	Y	Y
PASSAIC	Paterson City	1608	Y	Y
PASSAIC	Pompton Lakes Borough	1609	N	N
PASSAIC	Prospect Park Borough	1610	Y	Y
PASSAIC	Ringwood Borough	1611	N	N
PASSAIC	Totowa Borough	1612	Y	Y
PASSAIC	Wanaque Borough	1613	Y	N
PASSAIC	Wayne Township	1614	Y	N
PASSAIC	West Milford Township	1615	N	N
PASSAIC	Woodland Park Borough	1616	Y	Y
SALEM COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34033020200 34033020300 34033021900 34033022000 34033022100				
SALEM	Alloway Township	1701	N	N
SALEM	Carneys Point Township	1702	Y	Y
SALEM	Elmer Borough	1703	N	N
SALEM	Elsinboro Township	1704	N	Y
SALEM	Lower Alloways Creek Township	1705	N	Y
SALEM	Mannington Township	1706	N	Y
SALEM	Oldmans Township	1707	N	N
SALEM	Penns Grove Borough	1708	Y	Y

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
SALEM	Pennsville Township	1709	Y	Y
SALEM	Pilesgrove Township	1710	N	N
SALEM	Pittsgrove Township	1711	N	N
SALEM	Quinton Township	1712	N	Y
SALEM	Salem City	1713	Y	Y
SALEM	Upper Pittsgrove Township	1714	N	N
SALEM	Woodstown Borough	1715	N	N
SOMERSET COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34035051100 34035051200 34035051500				
SOMERSET	Bedminster Township	1801	N	N
SOMERSET	Bernards Township	1802	N	N
SOMERSET	Bernardsville Borough	1803	N	N
SOMERSET	Bound Brook Borough	1804	Y	Y
SOMERSET	Branchburg Township	1805	Y	N
SOMERSET	Bridgewater Township	1806	Y	Y
SOMERSET	Far Hills Borough	1807	N	N
SOMERSET	Franklin Township	1808	Y	Y
SOMERSET	Green Brook Township	1809	Y	Y
SOMERSET	Hillsborough Township	1810	Y	Y
SOMERSET	Manville Borough	1811	Y	Y
SOMERSET	Millstone Borough	1812	N	N
SOMERSET	Montgomery Township	1813	Y	N
SOMERSET	North Plainfield Borough	1814	Y	Y
SOMERSET	Peapack-Gladstone Borough	1815	N	N
SOMERSET	Raritan Borough	1816	Y	N
SOMERSET	Rocky Hill Borough	1817	N	N
SOMERSET	Somerville Borough	1818	Y	N
SOMERSET	South Bound Brook Borough	1819	Y	Y
SOMERSET	Warren Township	1820	Y	N
SOMERSET	Watchung Borough	1821	N	Y
SUSSEX COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34037371200				
SUSSEX	Andover Borough	1901	N	N
SUSSEX	Andover Township	1902	N	N
SUSSEX	Branchville Borough	1903	N	N
SUSSEX	Byram Township	1904	N	N
SUSSEX	Frankford Township	1905	N	N
SUSSEX	Franklin Borough	1906	N	N
SUSSEX	Fredon Township	1907	N	N
SUSSEX	Green Township	1908	N	N
SUSSEX	Hamburg Borough	1909	Y	N
SUSSEX	Hampton Township	1910	N	N
SUSSEX	Hardyston Township	1911	N	N
SUSSEX	Hopatcong Borough	1912	N	N
SUSSEX	Lafayette Township	1913	N	N
SUSSEX	Montague Township	1914	N	N
SUSSEX	Newton Town	1915	Y	N
SUSSEX	Ogdensburg Borough	1916	N	N

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
SUSSEX	Sandyston Township	1917	N	N
SUSSEX	Sparta Township	1918	N	N
SUSSEX	Stanhope Borough	1919	N	N
SUSSEX	Stillwater Township	1920	N	N
SUSSEX	Sussex Borough	1921	Y	Y
SUSSEX	Vernon Township	1922	N	N
SUSSEX	Walpack Township	1923	N	N
SUSSEX	Wantage Township	1924	N	Y
UNION COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34039030200 34039030400 34039030500 34039030600 34039030701 34039030702 34039030802 34039030900 34039031000 34039031100 34039031200 34039031300 34039031400 34039031500 34039031601 34039031602 34039031700 34039031801 34039031802 34039031903 34039031904 34039032001 34039032002 34039032100 34039032400 34039034100 34039034400 34039034500 34039034600 34039035100 34039035200 34039035400 34039035800 34039038800 34039038900 34039039000 34039039200 34039039300 34039039400 34039039500 34039039600 34039039800 34039039900				
UNION	Berkeley Heights Township	2001	N	N
UNION	Clark Township	2002	Y	N
UNION	Cranford Township	2003	N	N
UNION	Elizabeth City	2004	Y	Y
UNION	Fanwood Borough	2005	Y	N
UNION	Garwood Borough	2006	N	N
UNION	Hillside Township	2007	Y	Y
UNION	Kenilworth Borough	2008	Y	N
UNION	Linden City	2009	Y	Y
UNION	Mountainside Borough	2010	N	N
UNION	New Providence Borough	2011	Y	N
UNION	Plainfield City	2012	Y	Y
UNION	Rahway City	2013	Y	Y
UNION	Roselle Borough	2014	Y	Y
UNION	Roselle Park Borough	2015	Y	Y
UNION	Scotch Plains Township	2016	Y	N
UNION	Springfield Township	2017	Y	N
UNION	Summit City	2018	Y	N
UNION	Union Township	2019	Y	Y
UNION	Westfield Town	2020	Y	N
UNION	Winfield Township	2021	N	N
WARREN COUNTY: List of Census Tracts Identified via CEJST as LIDACs 34041030700 34041030900				
WARREN	Allamuchy Township	2101	N	N
WARREN	Alpha Borough	2102	N	N
WARREN	Belvidere Town	2103	N	N
WARREN	Blairstown Township	2104	N	N
WARREN	Franklin Township	2105	N	N
WARREN	Frelinghuysen Township	2106	N	N
WARREN	Greenwich Township	2107	Y	N
WARREN	Hackettstown Town	2108	Y	N
WARREN	Hardwick Township	2109	N	N

COUNTY	Municipality	MUN_CODE	Contains AIOBC	Contains DAC
WARREN	Harmony Township	2110	N	N
WARREN	Hope Township	2111	N	N
WARREN	Independence Township	2112	N	N
WARREN	Knowlton Township	2113	N	N
WARREN	Liberty Township	2114	N	N
WARREN	Lopatcong Township	2115	Y	N
WARREN	Mansfield Township	2116	N	N
WARREN	Oxford Township	2117	N	N
WARREN	Phillipsburg Town	2119	Y	Y
WARREN	Pohatcong Township	2120	N	Y
WARREN	Washington Borough	2121	Y	N
WARREN	Washington Township	2122	N	N
WARREN	White Township	2123	N	N

Appendix C – List of LIDAC and Adversely Impacted Overburdened Communities' Municipalities with Land Use Land Cover Information *

Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?	Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?	Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?
Aberdeen Township		Y	Burlington Township		Y	Delran Township		YY
Absecon City		Y	Butler Borough	Y		Dennis Township		Y
Asbury Park City	Y	Y	Caldwell Borough	Y		Deptford Township		Y
Atlantic City City	Y		Camden City	Y		Dover Town	Y	
Bayonne City	Y		Cape May City			Downe Township		Y
Belleville Township	Y		Carlstadt Borough			Dumont Borough	Y	
Bellmawr Borough			Carneys Point Township		YY	Dunellen Borough	Y	
Belmar Boro	Y		Carteret Borough	Y		Eagleswood Township		Y
Bergenfield Borough	Y		Cherry Hill Township		Y	Eastampton Township		Y
Berkeley Township		Y	Chesilhurst Borough			East Brunswick Township		Y
Berlin Borough		Y	Chesterfield Township		YY	East Greenwich		Y
Berlin Township		Y	Cinnaminson Township		Y	East Newark Borough	Y	
Beverly City			City of Orange Township	Y		East Orange City	Y	
Bloomfield Township	Y		Clark Township			East Rutherford Boro.		
Bogota Borough	Y		Clayton Borough		Y	East Windsor Township		Y
Boonton Town		Y	Clementon Borough			Eatontown Borough		Y
Bordentown City			Cliffside Park Borough	Y		Edgewater Borough		
Bordentown Township			Clifton City	Y	Y	Edgewater Park Twp.		YY
Bound Brook Borough	Y		Clinton Township		YY	Edison Township		Y
Bradley Beach Borough	Y		Closter Borough	Y	Y	Egg Harbor City City		Y
Brick Township	Y	Y	Collingswood Borough	Y		Egg Harbor Township		YY
Bridgeton City	Y	Y	Colts Neck Township		Y	Elk Township		Y
Bridgewater Township			Commercial Township		Y	Elizabeth City	Y	
Brigantine City			Cranbury Township		Y	Elmwood Park Borough	Y	
Brooklawn Borough			Cranford Township	Y	Y	Elsinboro Township		YY
Buena Borough		YY	Cresskill Borough	Y		Emerson Borough		Y
Buena Vista Township		YY	Deerfield Township		YY	Englewood City	Y	
Burlington City	Y	YY	Delanco Township		YY	Englewood Cliffs Boro		

Black Text = Both DAC (Fed.) and AIOBC (NJ) Green Text = DAC Only (Fed.) Red Text = Just AIOBC (NJ)

Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?	Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?	Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?
Essex Fells Borough			Haddon Township	Y		Lakehurst Borough		
Ewing Township	Y	Y	Hainesport Township		YY	Lakewood Township	Y	Y
Fair Lawn Borough	Y		Haledon Borough			Lawnside Borough	Y	
Fairfield Township		YY	Hamburg Borough		Y	Lawrence Township		Y
Fairview Borough	Y		Hamilton Twp. (Atlantic)		Y	Leonia Borough		
Fanwood Borough	Y		Hamilton Twp. (Mercer)	Y	Y	Lincoln Park Borough		Y
Fieldsboro Borough		Y	Hammonton Town		YY	Linden City	Y	
Flemington Borough	Y		Hanover Township		Y	Lindenwold Borough	Y	
Florence Township		Y	Harrison Town	Y		Little Falls Township		
Florham Park Borough		Y	Hasbrouck Heights Boro.	Y		Little Ferry Borough		
Folsom Township		Y	Hawthorne Borough	Y		Little Silver Borough		Y
Fort Lee Borough	Y		Hazlet Township			Livingston Township		
Franklin Twp. (Gloucester)		Y	Highland Park Borough			Lodi Borough	Y	
Franklin Twp. (Somerset)		Y	Hightstown Borough	Y	Y	Long Branch City	Y	Y
Freehold Borough	Y		Hillsborough Township		Y	Lopatcong Township		Y
Freehold Township		Y	Hillside Township	Y		Lower Township		
Galloway Township		YY	Hoboken City	Y		Lower Alloways Creek Twp		YY
Garfield City	Y		Holmdel Township		Y	Lumberton Township		
Garwood Borough	Y		Hopewell Township		YY	Lyndhurst Township		
Gibbsboro Borough			Howell Township		Y	Magnolia Borough	Y	
Glassboro Borough	Y	Y	Irvington Township	Y	Y	Mahwah Township		
Glen Ridge Borough	Y		Jackson Township		Y	Manalapan Twp.		Y
Gloucester City	Y		Jefferson Township		Y	Manchester Township	Y	Y
Gloucester Township	Y	Y	Jersey City	Y		Mannington Twp.		YY
Green Brook Township			Keansburg Borough	Y		Manville Borough		
Greenwich Township		Y	Kearny Town	Y		Maple Shade Township	Y	Y
Guttenberg Town	Y		Kenilworth Borough	Y		Maplewood Township		
Hackensack City	Y		Keyport Borough			Marlboro Twp		Y
Hackettstown Town	Y	Y	Lacey Township		Y	Matawan Borough	Y	

Black Text = Both DAC (Fed.) and AIOBC (NJ)   Green Text = DAC Only (Fed.)   Red Text = Just AIOBC (NJ)

Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?	Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?	Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?
Maurice River Twp.		Y	North Arlington Borough	Y		Pine Hill Boro		
Maywood Borough	Y		North Bergen Township			Piscataway Township		
Merchantville Borough	Y		North Brunswick Twp.		Y	Plainfield City	Y	
Metuchen Borough	Y		North Haledon Borough			Plainsboro Township		Y
Middletown Township		Y	North Hanover Twp		Y	Pleasantville City	Y	
Middle Township		Y	North Plainfield Borough	Y	Y	Plumsted Twp		YY
Middlesex Borough		Y	North Wildwood City			Pohatcong Twp		YY
Millburn Township			Northfield City		Y	Point Pleasant Beach Boro	Y	
Millville City	Y	Y	Northvale Borough	Y		Princeton		
Mine Hill Twp			Nutley Township	Y		Prospect Park Borough		
Monroe Township	Y	YY	Oaklyn Boro	Y		Quinton Township		YY
Montclair Township	Y		Ocean City			Rahway City	Y	
Montgomery Township		YY	Ocean Township			Randolph Township		Y
Montville Township			Oceanport Borough		Y	Raritan Borough		
Moonachie Borough			Old Bridge Township	Y	Y	Raritan Twp		Y
Morris Township			Oradell Borough	Y		Readington Township		YY
Morristown Town	Y	Y	Palisades Park Borough	Y		Red Bank Borough	Y	
Mount Ephraim Boro	Y		Palmyra Borough			Ridgefield Borough	Y	
Mount Holly Township	Y		Paramus Borough	Y	Y	Ridgefield Park village	Y	
Mount Laurel Township		Y	Parsippany-Troy Hills Twp.		Y	Ridgewood village	Y	
Mullica Twp		Y	Passaic City	Y	Y	River Edge Borough	Y	
Neptune City Borough	Y	Y	Paterson City	Y		Riverside Township	Y	
Neptune Township	Y	Y	Paulsboro Borough		Y	Rochelle Park Township	Y	
New Brunswick City	Y		Pemberton Twp	Y		Rockaway Township		Y
New Hanover Twp			Penns Grove Borough	Y		Rockleigh Borough		
New Milford Borough	Y		Pennsauken Township			Roselle Borough	Y	
New Providence Boro			Pennsville Twp		YY	Roselle Park Borough	Y	
Newark City	Y	Y	Perth Amboy City	Y		Roxbury Township		Y
Newton Town		Y	Phillipsburg Town	Y		Runnemede Borough		

Black Text = Both DAC (Fed.) and AIOBC (NJ) Green Text = DAC Only (Fed.) Red Text = Just AIOBC (NJ)

Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?	Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?	Municipalities with OBC	Urbanized Municipalities per NJAC 7:15	Agricultural Land?
Rutherford Borough	Y		Toms River Township		Y	Westampton Township		YY
Saddle Brook Township	Y		Totowa Borough			Westfield Town	Y	
Salem City	Y	Y	Trenton City	Y		Westville Borough		
Sayreville Borough			Union Beach			Westwood Borough	Y	
Scotch Plains Township		Y	Union City	Y		Weymouth Twp		
Seaside Heights Borough			Union Township	Y		Wharton Borough		Y
Secaucus Town			Upper Deerfield Township		Y	Wildwood Crest Boro		
Shrewsburg Boro	Y	Y	Upper Twp		Y	Wildwood City	Y	
Somerdale Borough			Ventnor City			Willingboro Township	Y	Y
Somers Point City		Y	Victory Gardens Borough	Y		Winslow Twp	Y	Y
Somerville Borough	Y		Vineland City	Y	YY	Woodbine Borough		Y
South Amboy City	Y	Y	Voorhees Township		Y	Woodbridge Township	Y	
South Bound Brook Boro			Waldwick Borough	Y	Y	Woodbury Heights B		
South Brunswick Township		Y	Wall Twp		Y	Woodbury City	Y	
South Hackensack Twp	Y		Wallington Borough	Y		Woodland Park Borough		
Southampton Twp		Y	Wanaque Borough		Y	Woodland Twp		Y
South Orange Village Twp.	Y		Wantage Twp		YY	Woodlynne Borough	Y	
South Plainfield Borough		Y	Warren Township		Y	Wood-Ridge Borough	Y	
South River Borough			Washington Borough			Woolwich Township		YY
South Toms River Borough			Washington Township (Burlington)		Y	WrightsTown Boro		
Spotswood Borough			Washington Twp. (Gloucester)		Y			
Springfield Township		YY	Watchung Borough					
Stratford Borough			Waterford Township		Y			
Stafford Twp			Wayne Township					
Summit City	Y		Weehawken Township	Y				
Sussex Borough	Y	Y	West Deptford Township		Y			
Swedesboro Borough		YY	West Long Branch Boro	Y				
Teaneck Township	Y	Y	West New York Town	Y				
Tenafly Borough			West Orange Township					
Teterboro Borough			West Wildwood Borough	Y				
Tinton Falls Borough			West Windsor Township	Y	Y			

*This table identifies which municipalities in New Jersey contain census tract(s) with LIDACs and/or adversely impacted overburdened communities (AIOBC). Language in black indicates municipalities that contain both LIDACs and AIOBC, green indicates municipalities that contain LIDACs only, and red indicates municipalities that contain AIOBC only. This table is intended to be a more detailed version of the Table in Appendix D.

Municipalities with a "Y" under the "Urbanized Municipalities" column indicate towns that are urbanized per [NJAC 7:15](). Municipalities with a "Y" under the "Agricultural Land?" column indicate towns that contain at least one parcel of agricultural land per the [NJ Land Use Land Cover Map of 2015](). Municipalities with a "YY" under this column contain an abundance of agricultural land.

Black Text = Both DAC (Fed.) and AIOBC (NJ) Green Text = DAC Only (Fed.) Red Text = Just AIOBC (NJ)

Appendix D – Impacts to LIDACs and Adversely Impacted Overburdened Communities: A Comparison

Purpose Statement:
The intent of the main body of this report is to describe the benefits and disbenefits to LIDACs as defined by CEJST. The NJDEP has a State tool that is used to define overburdened communities that utilizes different criteria and datasets than CEJST. The purpose of this Appendix is to provide an analysis that describes modifications or additions to the above analysis that applies to New Jersey's overburdened communities consisted with EJ MAP.

Background:
New Jersey has three criteria to identify whether a census block has an overburdened community per the 2020 New Jersey Environmental Justice Law. A census block must have at least 35% low-income households OR at least 40% of residents identifying as minority or tribal OR at least 40% of households having limited English proficiency. Census blocks that are next to these areas that do not fit any of these criteria are called "adjacent block groups" or "ABGs" - ABGs are NOT de facto OBCs but are areas of concern given their proximity to other OBCs that the State flags as possibly being subject to the EJ Law pending a case-by-case assessment.

For the purposes of this appendix, NJDEP has asked us to include the following in our assessment (1) census blocks that have OBCs and (2) census blocks that are ABGs if these census blocks are also considered to be "adversely impacted." Adversely impacted, in this instance, means the census blocks are subject to adverse cumulative stressors (both environmental and health stressors) as described in NJDEP's Environmental Justice Mapping, Assessment, and Protection (EJ MAP): Technical Guide. For the purposes of this appendix, these areas will be called Adversely Impacted Overburdened Communities (AIOBC).

The different distribution between LIDACs and AIOBCs can be seen in Figure 1 in which panel (a) shows municipalities with LIDACs, AIOBCs, or both and panel (b) shows census blocks with LIDACs, AIOBCs or both. Panel (b) will have some inherent error as CJEST and EJ MAP use different census block years for their analyses.

Overall, areas with LIDACs and AIOBCs overlap quite a bit geographically (Figure 2), but AIOBC do cover more of New Jersey's population (Table 3). AIOBCs cover more population in 254 municipalities while LIDACs cover more population in only 68 municipalities. In 19 municipalities, the population coverage is essentially equal between AIOBC and LIDACs. AIOBCs do cover more area in 243 municipalities, while LIDACs cover more area in 61 municipalities. In 37 municipalities, the area coverage is essentially equal. Collectively, these values indicate that AIOBCs capture most of the population that LIDACs cover. (See Appendix B for a concise summary of municipalities with LIDACs and/or AIOBCs.)

Due to the similarity in populations that are identified as LIDACs and AIOBCs, and the general nature (*i.e.,* no site-specific plans at this time) of each priority measure, the authors do not have any changes to the LIDAC Benefits Analysis that would apply to New Jersey's AIOBCs.

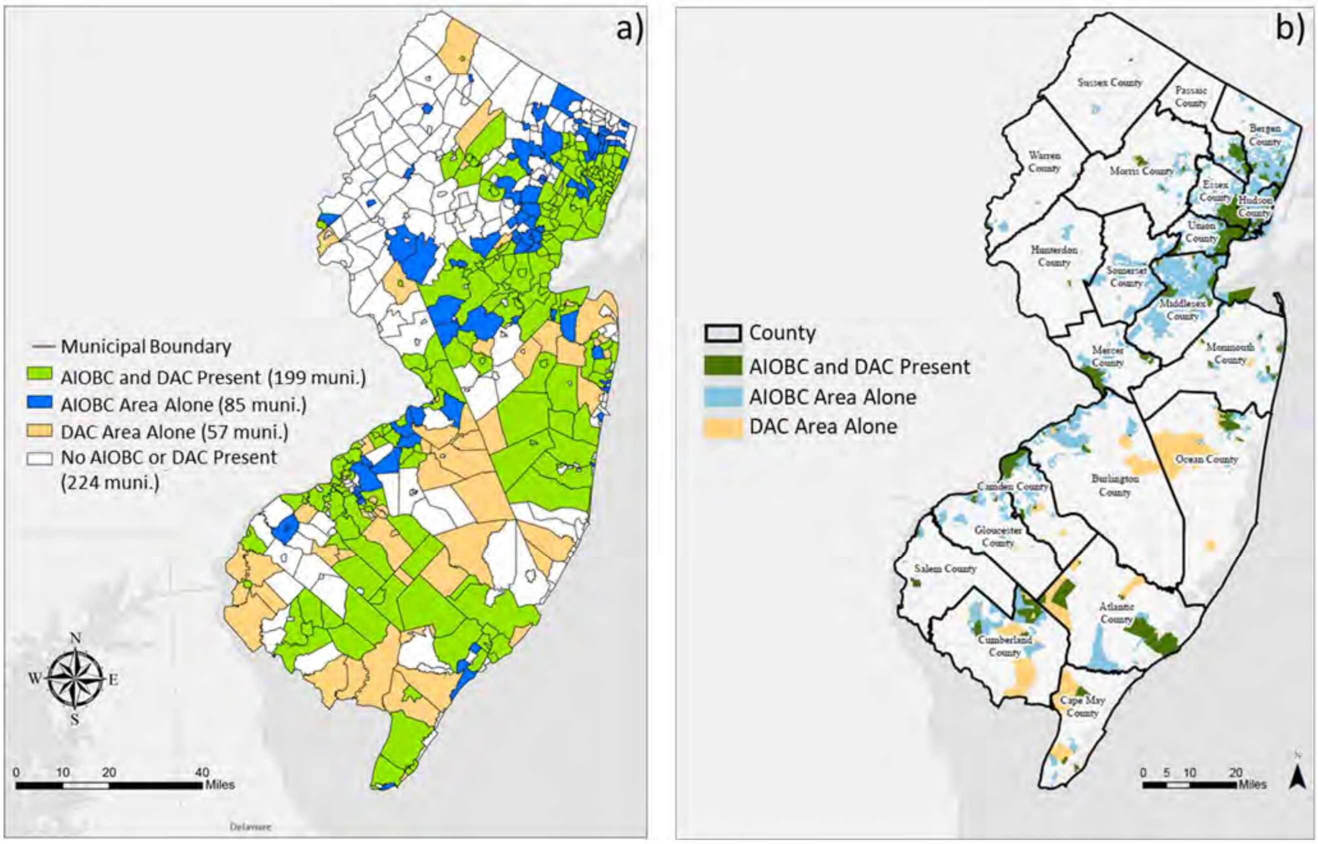

Figure 2. (a) Distribution of municipalities with either LIDACs (in orange), AIOBC (in blue), or both (in green). (b) Distribution of census blocks with either LIDACs (in orange), AIOBC (in blue), or both (in green).

Table 3. Summary of the total acreage and number of individuals identified as either LIDACs or AIOBC through CEJST and EJMAP respectively.

Community Type	Estimated Area Covered by Community in Municipalities (acres)	Estimated Population Covered by Community in Municipalities (individuals)
LIDACs	398,208	2,205,965
AIOBC	633,030	4,282,658

Appendix E – Literature Cited

Abhijith, K.V. et al. 2017. Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments – a review. *Atmospheric Environment,* 162: 71-86.

Adams, C. 2021. Black people are more likely to die in traffic incidents. Covid made it worse. NBC News. Accessed here on January 14, 2024.

Adheesh, S.R., et al. 2016. Air-pollution and economics: diesel bus versus electric bus. *Current Science Association,* 110: 858-862.

Albà, C.G., et al. 2023. Hunting sustainable refrigerants fulfilling technical, environmental, safety and economic requirements. *Renewable and Sustainable Energy Reviews,* 188: 113806.

Alem, M. et al. 2020. A qualitative meta-analysis of the socioeconomic impacts of offshore wind farms. *Sustinere: Journal of Environment and Sustainability,* 4: 155-171.

An, R., J. Wang, J. Liu, J. Shen, E. Loehmer, and J. McCaffrey. 2019. "A systematic review of food pantry-based interventions in the USA." *Public Health Nutrition,* 22(9): 1704-1716.

Ali, H., S. Hussain, H.A. Khan, et al. 2020. "Economic and Environmental Impact of Vehicle-to-Grid (V2G) Integration in an Intermittent Utility Grid." *2nd International Conference on Smart Power and Internet Energy Systems (SPIES):* 345-349.

Austin, W., G. Heutel, and D. Kreisman. 2019. "School bus emissions, student health and academic performance." *Economics of Education,* 70: 109-126.

Avila-Palencia, I. et al. 2018. The effects of transport mode use on self-perceived health, mental health, and social contact measures: a cross-sectional and longitudinal study. *Environment International,* 120: 199-206.

Bakian, A.V. et al. 2015. Acute air pollution exposure and risk of suicide completion. *American Journal of Epidemiology,* 5: 295-303.

Baldwin, S. et al. 2021. Accelerating clean, electrified transportation by 2035: policy priorities. *Energy Innovation Policy and Technology LLC,* Accessed here on January 14, 2024.

Banerjee, A., et al. 2021. Facilitating bicycle commuting beyond short distances: insights from existing literature. *Transport Reviews,* 42: 526-550.

Barrington-Leigh, C. and F. Behzadnejad. 2017. Evaluating the short-term cost of low-level local air pollution: a life satisfaction approach. *Environmental Economics and Policy Studies,* 19: 269-298.

Basu, R., M. Harris, L. Sie, B. Malig, R. Broadwin, and R. Green. 2014. Effects of fine particulate matter and its constituents on low birth weight among full-term infants in California. *Environmental Research,* 128: 42-51.

Behabtu, H.A., et al. 2020. A review of energy storage technologies' application potentials in renewable energy sources grid integration. *Sustainability,* 12: 10511.

Bjørnara, H.B., et al. 2019. From cars to bikes – the effect of an intervention providing access to different bike types: a randomized controlled trial. *PLOS ONE,* 14: e0219304.

Blumenberg, E. and G. Pierce. 2016. The drive to work: the relationship between transportation access, housing assistance, and employment among participants in the welfare and work voucher program. *Journal of Planning Education and Research,* 37: 66-82.

Bolaji, B.O. 2013. Theoretical analysis of the energy performance of three low global warming potential hydrofluorocarbon refrigerants as R134a alternatives in refrigeration systems. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy,* 228: 56-63.

Bourne, J.E. et al. 2018. Health benefits of electrically-assisted cycling: A systematic review. *International Journal of ?Behavioral Nutrition and Physical Activity,* 15:1-15.

Brown, V. et al. 2017. Obesity-related health impacts of fuel excise taxation – an evidence review and cost-effectiveness study. *BMC Public Health,* 17: 1-23.

Brown, M.A., A. Soni, M.V. Lapsa, K. Southworth, and M. Cox. 2019. "Low-income energy affordability in an era of U.S. energy abundance." *Progress in Energy,* 1: 012002.

Burkhardt, J. et al. 2019. The relationship between monthly air pollution and violent crime across the United States. *Journal of Environmental Economics and Policy,* 9: 18-205.

BW Research Partnership. 2022. New Jersey's offshore wind workforce assessment through 2035. Accessed here on February 25, 2024.

Cacciottolo, M. et al. 2017. Particulate air pollutants, APOE alleles and their contributions to cognitive impairment in older women and to amyloidogenesis in experimental models. *Translational Psychiatry,* 7: e1022.

Canepa, K. et al. 2019. An early look at plug-in electric vehicle adoption in disadvantaged communities in California. *Transport Policy,* 78: 19-30.

Casey, J.A., M. Fukurai, D. Hernández, S. Balsari, and M.V. Kiang. 2021. "Power outages and community health: a narrative review." *Current Environmental Health Reports,* 7(4): 371-383.

Chaji, M. and S. Werner. 2023. Economic impacts of offshore wind farms on fishing industries: perspectives, methods, and knowledge gaps. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science,* e10237, 1-21.

Chen, H., et al. 2020. Residential greenness and cardiovascular disease incidence, readmission, and mortality. 128: 1-11.

Conway, A. and C. Nieman. 2022. "Small-scale silvopasture: addressing urban and peri-urban livestock challenges in the United States with agroforestry practices." *Urban Agriculture and Regional Food Systems,* 7(1): e20023.

Conzen, J. et al. 2023. Lithium ion battery energy storage systems (BESS) hazards. *Journal of Loss Prevention in the Process Industries,* 81: 1-8.

Cunanan, C., M.-K. Tran, Y. Lee, S. Kwok, V. Leung, and M. Fowler. "A Review of Heavy-Duty Vehicle Powertrain Technologies: Diesel Engine Vehicles, Battery Electric Vehicles, and Hydrogen Fuel Cell Electric Vehicles." *Clean Technologies,* 3(2): 474-489.

Drew-Smythe, J.J. et al. 2023. Community perceptions of ecosystem services and disservices linked to urban tree planting. *Urban Forestry and Urban Greening,* 82: 1-9.

Ducruet, C. et al. 2024. Ports and their influence on local air pollution and public health: a global analysis. *Science of the Total Environment,* 915: 1-18.

Dulal, H.B. 2016. Making cities resilient to climate change: identifying "win-win" interventions. *Local Environment,* 22: 106-125.

Ebenstein, A., et al. 2016. The long-run economic consequences of high-stakes examinations: evidence from transitory variation in pollution. *American Economic Journal: Applied Economics,* 8: 36-65.

Ercan, T. et al. 2016. On the front lines of a sustainable transportation fleet: applications of vehicle-to-grid technology for transit and school buses. *Energies,* 9: 230.

Fecht, D., et al. 2015. Associations between air pollution and socioeconomic characteristics, ethnicity and age profile of neighborhoods in England and the Netherlands. *Environmental Pollution,* 198: 201-210.

Fenton, L. 2022. "Examining equity in building decarbonization: critical issues and opportunities." *A thesis submitted to Scripps Institution of Oceanography.* Accessed here October 25, 2023.

Freeman, G. et al. 2018. The emerging clean transportation workforce: opportunities and recommendations to support the growing alternative fuels industry. *Northeast Transportation Workforce Center and the University of Vermont in Partnership with CAIT at Rutgers University.* Accessed here on January 13, 2024.

Freudenberg, N. and E. Tsui. 2011. "Training new community health, food service, and environmental protection workers could boost health, jobs, and growth." *Health Affairs,* 30(11).

Frey, G.E. and J.H. Fike. 2018. Silvopasture case studies in North Carolina and Virginia. *United States Department of Agriculture, Forest Service Research and Development, Southern Research Station, General Technical Report* SRS-236. Accessed here on January 12, 2024

Fu, P. et al. 2019. The association between PM2.5 exposure and neurological disorders: a systematic review and meta-analysis. *Science of the Total Environment,* 655: 1240-1248.

Funke, S.A. and P. Plötz. 2017. A techno-economic analysis of fast charging needs in Germany for different range of battery vehicles. *European Battery, Hybrid and Fuel Cell Electric Congress, (March):* 1-7.

Gatto, N.M., et al. 2014. Components of air pollution and cognitive function in middle-aged and older adults in Los Angeles. *NeuroToxicology,* 40: 1-7.

Ghosh, R. et al. 2016. Near-roadway air pollution and coronary heart disease: burden of disease and potential impact of a greenhouse gas reduction strategy in southern California. *Environmental Health Perspectives,* 124: 193-200.

Giacinto, J.J., et al. 2021. Urban forest biodiversity and cardiovascular disease: potential health benefits from California's street trees. *PLOS ONE,* 16:1-23.

Gillingham, K.T. and P. Huang. 2020. Long-run environmental and economic impacts of electrifying waterborne shipping in the United States. *American Chemical Society,* 54: 9824-9833.

Glasson, J. et al. 2022. The local socio-economic impacts of offshore wind farms. *Environmental Impact Assessment Review,* 95: 1-11.

Gould, K.A. and T.L. Lewis. 2021. Resilience gentrification: environmental privilege in an age of coastal climate disasters. *Frontiers in Sustainable Cities,* 3: 1-12.

Hamara, G.B., et al. 2014. Outdoor particulate matter exposure and lung cancer: a systematic review and meta-analysis. *Environmental Health Perspectives,* 122: 906-911.

Harris, M.H., et al. 2015. Prenatal and childhood traffic-related pollution exposure and childhood cognition in the Project Viva Cohort (Massachusetts, USA). *Environmental Health Perspectives,* 123: 1072-1078.

Hattam, C. et al. 2015. Understanding the impacts of offshore wind farms on well-being. 1-77. Accessed here on February 25, 2024.

Hays, J., M. Toloui, M. Rattu, and K. Wright. 2021. "Equity and buildings: a practical framework for local government decision makers." *Urban Sustainability Directors Network.* Accessed here on October 25, 2023.

Haynes, E.N., et al. 2011. Exposure to airborne metals and particulate matter and risk for youth adjudicated for criminal activity. *Environmental Research,* 111: 1243-1248.

Henderson, J. 2020. EVs are not the answer: a mobility justice critique of electric vehicle transition. *Annals of the American Association of Geographers,* 2469-4460.

House, M.L. and Wright, D.J. "Using the health benefits of electric vehicles to justify charging infrastructure incentives." *InderScience,* 11(2).

Hu, M. 2019. Building impact assessment – a combined life cycle assessment and multi-criteria decision analysis framework. *Resources, Conservation, and Recycling,* 150: 104410.

Huether, P. 2021. "Siting Electric Vehicle Supply Equipment (EVSE) with Equity in Mind." *Department of Energy,* Accessed here on October 25, 2023.

Hwang, S., S. Tongsopit, and N. Kitter. 2023. "Transitioning from diesel backup generators to PV-plus-storage microgrids in California public buildings." *Sustainable Production and Consumption,* 38: 252-265.

Iungman, T., M. Cirach, F. Marando, E.P. Barboza, S. Khomenko, et al. 2023. "Cooling cities through urban green infrastructure: a health impact assessment of European cities." *The Lancet,* 401(10376): 577-589.

de Jalón, S.G., et al. 2018. How is agroforestry perceived in Europe? An assessment of positive and negative aspects by stakeholders. *Agroforestry Systems,* 92: 829-848.

Jara-Rojas, R. et al. 2020. Factors affecting the adoption of agroforestry practices: insights from silvopastoral systems of Colombia. *Forests,* 11: 648.

Jha, P. 2023. Investigating crime patterns in a freight-centric neighborhood. *A thesis submitted to the University of Memphis.* Accessed here on January 18, 2024.

Kane, J.W. 2018. "The water workforce opportunity: how Camden is driving collaborative solutions around its infrastructure and economy." *Brookings Commentary.* Accessed here on October 25, 2023.

Kasaeian, A. et al. 2018. Applications of eco-friendly refrigerants and nanorefrigerants: a review. *Renewable and Sustainable Energy Reviews,* 96: 91-99.

Kazakov, A., et al. 2012. Computational design of new refrigerant fluids based on environmental, safety, and thermodynamic characteristics. *Industrial and Engineering and Chemistry Research,* 51: 12537-12548.

Keeler, B.L., et al. 2019. Social-ecological and technological factors moderate the value of urban nature. *Nature Sustainability,* 2:29-38.

Kim, H.B., et al. 2019. Long-term exposure to air pollution and the risk of non-lung cancer: a meta-analysis of observational studies. *Royal Society for Public Health,* 140: 222-231.

Kirschstein, T., et al. 2022. Eco-labeling of freight transport services: design, evaluation, and research directions. *Journal of Industrial Ecology,* 26: 801-814

Kitson, J. et al. 2019. Evaluating urban odor with field olfactometry in Camden, NJ. *Urban Science,* 3: 93.

Kondo, M.C., E.C. South, C.C. Branas, T.S. Richmond, and D.J. Wiebe. 2017. "The association between urban tree cover and gun assault: a case-control and case-crossover study." *American Journal of Epidemiology,* 186(3): 289-296.

Kong, V. and A. Leszczynski, 2022. Dockless micromobility sharing in Calgary: a spatial equity comparison of e-bikes and e-scooters. *Canadian Journal of Urban Research,* 31: 97-110.

Kotz, A. et al. 2022. Port of New York and New Jersey drayage electrification analysis. National Renewable Energy Laboratory. Accessed here on February 11, 2024.

Kumma, N. and S.S.H. Kruthiventi. 2024. Current status of refrigerants used in domestic applications: a review. *Renewable and Sustainable Energy Reviews,* 189: 114073.

Lathrop, R.G. and J.E. Hasse. 2020. Changing landscapes in the Garden State: land use change in New Jersey 1986 through 2015. *Rutgers University.* Accessed here on January 19, 2024.

Lamb, T. 2015. Concepts for ferry propulsion and emissions performance improvement. *Journal of Ship Production and Design,* 3: 170-180.

Lausselet, C. et al. 2019. A life-cycle assessment model for zero emission neighborhoods. *Journal of Industrial Ecology,* 24: 500-516.

Lee, S. 2021. Does tree canopy moderate the association between neighborhood walkability and street crime? *Urban Forestry and Urban Greening,* 65: 127336.

Levinson, A. 2012. Valuing public goods using happiness data: the case of air quality. *Journal of Public Economics,* 96: 869-880.

Li, Q., et al. 2023. Do shared e-bikes reduce urban carbon emissions? *Journal of Transport Geography,* 112: 1-14.

Lu, J.G., et al. 2018. Polluted morality: air pollution predicts criminal activity and unethical behavior. *Association for Psychological Science,* 29: 340-355.

Lu, J.G. 2020. Air pollution: a systematic review of its psychological, economic, and social effects. *Science Current Opinion in Psychology,* 32: 52-65.

Mac Kinnon, M., et al. 2021. Benefits of near-zero freight: the air quality and health impacts of low-NOx compressed natural gas trucks. *Journal of the Air and Waste Management Association,* 71: 1428-1444.

Makhijani, A. 2021. Exploring farming and solar synergies, an analysis using Maryland data. Accessed here on February 25, 2024.

Marquesse, J., S. Ericson, and D. Jenket. 2021(a). "Impact of emergency diesel generator reliability on microgrids and building tied systems." *Applied Energy,* 285: 116437.

Marquesse, J., W. Becker, and S. Ericson. 2021(b). "Resilience and economics of microgrids with PV, battery storage, and networked diesel generators." *Advances in Applied Energy,* 3: 100049.

Mburu, L.W. and M. Helbich. 2016. Environmental risk factors influencing bicycle theft: a spatial analysis in London, UK. *PLOS ONE,* 11: e0163354.

Meiss, M. et al. 2022. Abatement technologies and their social costs in a hybrid general equilibrium framework. *The Energy Journal,* 2.

Mehta et al., 2015. Associations between air pollution and perceived stress: the veterans administration normative aging study. *Environmental Health,* 14.

Miller, C., S. Chen, L. Hu, and I. Sevier. 2019. "Equitable building electrification, a framework for powering resilient communities." *The Greenlining Institute.* Accessed here October 25, 2023.

Moreno, A., J. Tangenberg, B.N. Hilton, and J.K. Hilton. 2015. "An environmental assessment of school shade tree canopy and implications for sun safety policies: the Los Angeles Unified School District." *ISPRS International Journal of Geo-Information,* 4(2), 607-625.

Muth, M.K., C. Birney, A. Cuéller, S.M. Finn, et al. 2019. "A systems approach to assessing environmental and economic effects of food loss and waste interventions in the United States." *Science of the Total Environment,* 685: 1240-1254.

New Jersey Council on The Green Economy (NJ Council on the Green Economy). 2022. Green jobs for a sustainable future, leveraging our strengths to grow an inclusive green economy. Accessed here on February 29, 2024.

New Jersey Department of Environmental Protection (NJDEP). 2023. Urbanized municipalities in accordance with NJAC 7:15. Accessed here on January 19, 2024.

New Jersey Department of Transportation (NJDOT). Urbanized Areas, GIS layer. Accessed here on January 19, 2024.

Newton, P.W. and B.C. Rogers. 2020. Transforming built environments: toward carbon neutral and blue-green cities. *Sustainability,* 12: 4745.

Nicholas, M.A. et al. 2017. Advance plug-in electric vehicle travel and charging behavior. UC Davis Research Report. Accessed here on January 12, 2024.

Nieuwenhuijsen, M.J. 2020. Urban and transport planning pathways to carbon neutral, liveable and healthy cities: a review of the current evidence. *Environment International,* 140: 105661.

Nuccitelli, D. 2023. "The little-known physical and mental health benefits of urban trees." *Yale Climate Connections.* Accessed here on October 25, 2023.

Olawepo, J.O. and L.-W.A. Chen. 2019. Health benefits from upgrading public buses for cleaner air: A case study of Clark County, Nevada and the United States. *International Journal of Environmental Research and Public Health.* 16: 720.

Peretzman, P. 2023. NJBPU approves agreement with Rutgers for dual-use solar pilot program. Accessed here on February 25, 2024.

Plazier, P.A., et al. 2017. "Cycling was never so easy!" an analysis of e-bike commuters' motives, travel behaviour and experiences using GPS-tracking interviews. *Journal of Transport Geography,* 65: 25-34.

Pollitt, G., et al. 2016. Trace metal exposure is associated with increased exhaled nitric oxide in asthmatic children. *Environmental Health,* 15: 1-11.

Populus. 2018. Measuring equitable access to new mobility: a case study of shared bikes and electric scooters. *A Populus Report.* Accessed here on January 10, 2024.

Poulsen, R.T. and H. Sampson. 2020. A swift turnaround? Abating shipping greenhouse gas emissions via port call optimization. *Transportation Research Part D: Transport and Environment,* 86: 102460.

Power, M.C., et al. 2015. The relation between past exposure to fine particulate air pollution and prevalent anxiety: observational cohort study. *BMJ,* 350.

Purohit, P. et al. Electricity savings and greenhouse gas emission reductions from global phase-down of hydrofluorocarbons. *Atmospheric Chemistry and Physics,* 20: 11305-11327.

Rashid, R., et al. 2021. Taking a deep breath: a qualitative study exploring acceptability and perceived unintended consequences of charging clean air zones and air quality improvement initiatives amongst low-income, multi-ethnic communities in Bradford, UK. *BMC Public Health,* 21: 1305.

Ramirez-Ibarra, M. and J.-D. M. Saphores. 2023. Health and equity impacts from electrifying drayage trucks. *Transportation Research Part D,* 116: 1-20.

Rau, C. 2017. Revitalizing low-income communities using carbon neutral buildings. *A thesis submitted to the Rochester Institute of Technology.* Accessed here on January 18, 2024.

Raz, R. et al. 2014. Autism spectrum disorder and particulate matter air pollution before, during, and after pregnancy: a nested case-control analysis within the nurses' health study II cohort. *Environmental Health Perspectives,* 123: 264-270.

Requia, W.J., et al. 2018. Global association of air pollution and cardiorespiratory diseases: a systematic review, meta-analysis, and investigation of modifier variables. *American Public Health Association,* 108: S125-S130.

Riley, C.B. and M.M. Gardiner. Examining the distributional equity of urban tree canopy cover and ecosystem services across the United States. *PLOS ONE,* 15: 1-22.

Rodriguez-Villamizar, L.A. et al. 2016. The role of socioeconomic positions as an effect-modifier of the association between outdoor air pollution and children's asthma exacerbations: an equity-focused systematic review. *Reviews on Environmental Health,* 31: 297-309.

Ross, C.E. and J. Mirowsky. 1995. "Does employment affect health?" *American Sociological Association,* 36(3): 230-243.

Rudolph, L., C. Harrison, L. Buckley, and S. North. 2018. "Climate Change, Health, and Equity: A Guide for Local Health Departments." *Public Health Institute and American Public Health Association.* Accessed here on October 23, 2023.

Saldarriaga, N. et al. 2020. Greening Sydney: attitudes, barriers and opportunities for tree planting. *Australian Geographer,* 51: 469-488.

Salmond, J.A. et al. 2016. Health and climate related ecosystem services provided by street trees in the urban environment. *Environmental Health,* 15: 95-111.

Samonte, G. et al. 2017. Socioeconomic benefits of habitat restoration. NOAA Tech Memo. NMFS-OHC-1, 66p. Accessed here on February 25, 2024.

Sanchez, T.W. 2008. Poverty, policy, and public transportation. *Transportation Research Part A: Policy and Practice,* 42: 833-841.

Sass, V. et al. 2017. The effects of air pollution on individual psychological distress. *Health and Place,* 48: 72-79.

Scavo, J., S. Korosec, E. Guerrero, B. Pennington, and P. Doughman. 2016. "Low-income barriers study, part A: overcoming barriers to energy efficiency and renewables for low-income customers and small businesses contracting opportunities in disadvantaged communities." *California Energy Commission.* Accessed here on October 24, 2023.

Scheld, A.M. et al. 2022. The Atlantic surfclam fishery and offshore wind energy development: 2. Assessing economic impacts. *ICES Journal of Marine Science,* 79: 1801-1814.

Seals, B. and A. Krasner. 2020. "Gas stoves: health and air quality impacts and solutions." *Rocky Mountain Institute: Energy Transformed.* Accessed here October 25, 2023.

Sen, B. et al. 2020. Life cycle sustainability assessment of autonomous heavy-duty trucks. *Journal of Industrial Ecology,* 24: 149-164.

Shaheen, S. and A. Cohen. 2019. Shared ride services in North America: definitions, impacts, and the future of pooling. *Transport Reviews,* 39: 427-442.

Shaw, G.R. and S.J. Dundas. 2021. Socio-economic impacts of the southern flow corridor restoration project: Tillamook Bay, Oregon. Accessed here on February 11, 2024.

Si, Y. and J.C. Stephens. 2021. Energy justice through solar: constructing and engaging low-income households. *Frontiers in Sustainable Cities,* 3: 1-10.

Sicard, P., E. Agathokleous, V. Araminiene, E. Carraria, Y. Hoshika, A. De Marco, and E. Paoletti. 2018. "Should we see urban trees as effective solutions to reduce increasing ozone levels in cities?" *Environmental Pollution,* 243(A): 163-176.

Sifakis, N. and T. Tsoutsos. 2020. Planning zero-emission ports through the nearly zero energy port concept. *Journal of Cleaner Production,* 286: 1-20.

Singla, M.K. et al. 2021. Hydrogen fuel and fuel cell technology for cleaner future: a review. *Environmental Science and Pollution Research,* 28: 15607-15626.

Smith, C.S. et al. 2020. Coming to terms with living shorelines: a scoping review of novel restoration strategies for shoreline protection. *Frontiers in Marine Science,* 7: 1-14.

Smith, I.A., et al. 2019. Live fast, die young: accelerated growth, mortality, and turnover in street trees. *PLOS ONE,* 14: 1-17.

Smith, M.M. 2020. Silvopasture in the USA: a systematic review of natural resource professional and producer-reported benefits, challenges, and management activities. *Agriculture, Ecosystems, and Environment,* 326: 107818.

Sovacool, B.K., L. Noel, J. Axsen, and W. Kempton. 2018. "The neglected social dimensions to vehicle-to-grid (V2G) transition: a critical and systematic review." *Environmental Research Letters,* 13(1): 013001.

Statista. 2024. Population density in the US by federal states including the District of Columbia in 2021. Using data from the US Census. Accessed here on January 19, 2024.

Stehlin, J.G. and W.B. Payne 2021. Mesoscale infrastructures and uneven development: bicycle sharing systems in the United States as "already splintered" urbanism. *Annals of the American Association of Geographers,* 112: 1065-1083.

Sun, P. et al. 2020. A review of battery fires in electric vehicles. *Fire Technology,* 56: 1361-1410.

Tae, C. 2021. Hydrogen safety: let's clear the air. NRDC Expert Blog, Accessed here on February 22, 2024.

Tan, Y.A. and B. Jung. 2021. "Improving health in low-income communities through beneficial electrification." *Rocky Mountain Institute: Energy Transformed.* Accessed here October 25, 2023.

Teoh, T. 2022. Electric vehicle charging strategies for urban freight transport: concept and topology. *Transport Reviews,* 42: 157-180.

Thurston, G.D. et al. 2019. Outdoor air pollution and new-onset airway disease: an official American Thoracic Society Workshop report. *American Thoracic Society Documents.* Accessed here on January 9, 2024.

Tong, Z. and K.M. Zhang. 2015. "The near-source impacts of diesel backup generators in urban environments." *Atmospheric Environment,* 109: 262-271.

Tsai, W.-T. 2005. An overview of environmental hazards and exposure risk of hydrofluorocarbons (HFCs). *Chemosphere,* 61: 1539-1547.

Turk, J.M. 2020. "Health Impacts of Vehicle Electrification in the US with an Emphasis on Heavy-Duty Vehicles." *A thesis submitted to the University of Colorado.* Accessed here on October 25, 2023.

Turner-Skoff, J.B. and N. Cavender, 2019. The benefits of trees for livable and sustainable communities. *Plants People Planet,* 1: 323-335.

Tonne, C. et al. 2008. Air pollution and mortality benefits of the London Congestion Charge: spatial and socioeconomic inequalities. *Occupational and Environmental Medicine,* 65: 620-627.

Vachon, T.E. 2019. The green transition: renewable energy technology, climate change mitigation, and the future of work in New Jersey. *A report prepared for the New Jersey Governor's Task Force on the Future of Work.* Accessed here on February 29, 2024.

van Winden and van den Buuse 2017. Smart City pilot projects: exploring the dimensions and conditions of scaling up. *Journal of Urban Technology,* 1466-1853.

Vincent, A., N. Angus, M. Fernando, S. Cho, H. Reeves, N. Sportiche et al. 2017. "Green Streets, Lawrence, Massachusetts. A Health Impact Assessment of the Lawrence Green Streets Program." Accessed here on October 25, 2023.

Walker, B.J.A. et al. 2014. Community benefits, framing and the social acceptance of offshore wind farms: an experimental study in England. *Energy Research and Social Science,* 3: 46-54.

Wang, P. et al. 2017. Socioeconomic disparities and sexual dimorphism in neurotoxic effects of ambient fine particles on youth IQ: a longitudinal analysis. *PLOS ONE,* 12: e0188731.

Wang, B., et al. 2020. The impact of long-term PM2.5 exposure on specific causes of death: exposure-response curves and effect modification among 53 million U.S. Medicare beneficiaries. *Environmental Health,* 19: 1-12.

Wolf, K. 2010. Crime and public safety. *Urban Greening Research, Cities: Good Health,* Accessed here on November 7, 2023.

Wu, X. et al. 2013. Carbon footprint model for evaluating the global warming impact of food transport refrigeration systems. *Journal of Cleaner Production,* 54: 115-124.

Younan, D., et al. 2017. Longitudinal analysis of particulate air pollutants and adolescent delinquent behavior in southern California. *Journal of Abnormal Child Psychology,* 46: 1283-1293.

Zamri, G.B. et al. 2020. Delivery, impact and approach of household food waste reduction campaigns. *Journal of Cleaner Production,* 246: 1-16.

Zavala-Reyes, J.C., et al. 2019. Studying human exposure to vehicular emissions using computational fluid dynamics and an urban mobility simulator: the effect of sidewalk residence time, vehicular technologies, and traffic-calming devices. *Science of the Total Environment,* 687: 720-731.

Zhang, D., M. Strawn, T. Broderick, J.T. Novak, and Z.-W. Wang. 2020. "Effects of anaerobic digester solids retention time on odor emissions and dewaterability of biosolids subjected to various shear intensities, polymer doses, and storage duration times." *Environmental Science: Water Research and Technology,* 6.

Zhu, X. et al. 2020. Reductions in water, soil and nutrient losses and pesticide pollution in agroforestry practices: a review of evidence and processes. *Plant and Soil,* 453: 45-86.

Zhu, Y., R. Connolly, Y. Lin, T. Mathews, and Z. Wang. 2020. "Effects of residential gas appliances on indoor and outdoor air quality and public health in California." *UCLA Fielding School of Public Health.* Accessed here on October 25. 2023.

APPENDIX 7.5

WORKFORCE PLANNING ANALYSIS

Workforce Planning Analysis

Prepared by the John J. Heldrich Center for Workforce Development

Executive Summary

Rutgers, the State University of New Jersey is assisting the New Jersey Department of Environmental Protection (NJDEP) on the development of a Climate Pollution Reduction Grant (CPRG) Priority Climate Action Plan (PCAP). As part of the development of a Low-income and Disadvantaged Communities (LIDAC) Benefits Analysis, the John J. Heldrich Center for Workforce Development was contracted by the Climate Change Resource Center to conduct a Workforce Planning Analysis that addresses the impacts of the proposed priority climate measures and/or enabling actions on the State's current workforce capacity and the future opportunities the measures present to prepare and supply the climate workforce needed to fulfill the State's PCAP priorities.

The workforce planning analysis consists of four primary tasks:

- Mapping out the state's strengths, weaknesses, and opportunities related to the priority measures;
- Analyzing barriers that underserved communities face in accessing related job opportunities as well as suggesting strategies to overcoming those barriers;
- Identifying opportunities for sector-specific workforce strategies; and
- Modeling anticipated labor changes.

The Heldrich Center examined New Jersey's workforce strengths, weaknesses, and opportunities as they relate to the priority measures for the PCAP by conducting a thorough inventory and examination of the current education and training landscape in the state. In this way, the Heldrich Center's work highlights areas of strength and areas for improvement, ensuring that gaps in the education and training infrastructure can proactively be addressed to maximize support for the priority measures outlined in the PCAP.

The Heldrich Center identified five barriers that underserved communities face in accessing job opportunities, as well as presented a series of workforce development-focused strategies to address these identified barriers. The barriers identified in the research are as follows:

- A lack of job quality and diversity standards.
- A lack of adequate public transit system to get to better quality, healthier jobs.
- A lack of community input and prioritization of community needs.
- The existence of barriers that keep people from education and employment, specifically job availability and pay; qualifications, education, and training; transportation; childcare and family issues; crime and substance abuse; housing instability; disabilities and mental and physical health; and public assistance programs.
- OBCs tend to have poorer education systems, lower career awareness about jobs and job training, and inadequate investment in high quality career and vocational-technical education.

The Heldrich Center identified a series of cross-cutting workforce development strategies that could be deployed in any of the priority sectors identified by NJDEP. Within these cross-cutting strategies, researchers offer supportive evidence and/or examples of each sector strategy to demonstrate the feasibility and impacts of each potential sector strategy. The Heldrich Center also included sector-specific workforce development strategies for each priority sector identified by NJDEP. The sector-specific strategies were informed by the learnings from the previous tasks outlined in this research and are listed below:

- *Transportation:* Create and/or expand specialized workforce training programs for electric vehicles (EVs).
- *Buildings:* Support and strengthen workforce development infrastructure for electrifying residential and commercial buildings.
- *Electric Generation:* Invest in the creation of solar design and installation training programs that provide a clear training-to-career pipeline in New Jersey.
- *Food Waste:* An awareness and education campaign to highlight the development of food waste processing facilities, better food waste practices, and energy recovery efforts from wastewater treatment facilities.
- *Halogenated Gases:* Incentivize low-global warming potential (GWP) refrigerant products to drive demand and transition workforce training programs to support new technologies.
- *Natural and Working Lands:* Develop a federally registered apprenticeship program.

Lastly, researchers estimated the workforce impacts of the priority measures outlined in the PCAP using the R/ECON input-output model. This research provides estimated workforce impacts per $1 million of spending on each type of CPRG-funded priority measure, with the expectation that these estimates can be used in the next stage of the work as a tool to estimate total workforce impacts once the priority measure expenditure amounts have been determined. Workforce impact estimates for each priority measure are provided in terms of job-years supported per $1 million in expenditures.

Taken together, this research offers a comprehensive workforce planning analysis for NJDEP's PCAP.

Introduction

The John J. Heldrich Center for Workforce Development was charged with preparing a workforce planning analysis to evaluate the priority measures and/or enabling actions to be included in the PCAP and/or the State's climate pollution reduction implementation grant application(s) through four different analyses. These analyses aim to understand the workforce and labor market implications of New Jersey's priority climate action plan. The four analyses include:

- Mapping out the state's strengths, weaknesses, and opportunities related to the priority measures;
- Analyzing barriers that underserved communities face in accessing related job opportunities as well as suggesting strategies to overcoming those barriers;
- Identifying opportunities for sector-specific workforce strategies such as upskilling the current labor pool, aligning industry and training programs, employer engagement and sector partnership, career awareness and engagement strategies; and
- Modeling anticipated labor changes.

Through these four analyses, the Heldrich Center offers a comprehensive workforce planning analysis for inclusion in NJDEP's PCAP.

Methodology

This workforce planning analysis has been conducted in alignment with U.S. Environmental Protection Agency (EPA) guidance. The Heldrich Center conducted a series of four analyses examining NJDEP's priority sectors and priority action measures and/or enabling actions from a workforce development perspective. The Heldrich Center approached these analyses using a variety of methodologies.
To **map out the state's strengths, weaknesses, and opportunities related to the priority measures**, the Heldrich Center conducted background research to understand the extent of the emissions reductions efforts currently underway and planned in New Jersey. Specifically, the Heldrich Center team referenced the NJ Council on the Green Economy report *Green Jobs For A Sustainable Future* and *New Jersey's Global Warming Response Act 80x50 Report* as primary guidance. Other relevant literature and resources were consulted to further supplement the Heldrich Center's understanding of the breadth and depth of climate mitigation strategies in the state.

To assess the state's workforce capacity for each priority area, the Heldrich Center developed an inventory of education and training programs. Researchers used Standard Occupational Classification (SOC) codes to identify occupations associated with each priority area and matched each SOC code with its corresponding Classificational of Instructional Program (CIP) code. Using the SOC-CIP crosswalk, researchers collected educational information from various data sources, including the Integrated Postsecondary Education Data System (IPEDS), Consumer Report Card (CRC), Career and Technical Education (CTE), utilities, unions, and other providers. Researchers used these data for the inventory.

The inventory contains information on **priority area** (Buildings, Electric Generation, Food Waste, Halogenated Gases, Natural and Working Lands, Transportation), **institution/organization name**,

occupation (based on Standard Occupational Codes (SOC) from O*NET), **career cluster** (based on two-digit Classificational of Instructional Program (CIP) codes), program **type** (apprenticeship, certificate, degree, grant, internship, training, youth), **award level** (associate degree, bachelor degree, certifications of at least 1 but less than 2 years, certifications of at least 12 weeks but less than 1 year, certifications of at least 2 years but less than 4 years, certifications of less than 12 weeks, doctorate, master's degree, post-master's certification, postbaccalaureate certification), and **county**. There are two maps that display the number of programs and distinct institutions/organizations and the average percentages of limited English proficiency, low income, and minority populations by county.

To **analyze barriers that underserved communities face in accessing related job opportunities and suggest strategies to overcoming them,** the Heldrich Center team consulted relevant literature and research. Moreover, the Heldrich Center consulted with stakeholders and subject matter experts. Additionally, the Heldrich Center participated in the five topical stakeholder sessions held by The New Jersey Climate Change Resource Center at Rutgers University and NJDEP in the Fall of 2023.

For **identifying opportunities for upskilling the current labor pool, aligning industry and training programs, employer engagement and sector partnership, career awareness and engagement strategies**, the Heldrich Center examined relevant research on sector-specific workforce strategies as well as relied on the Heldrich Center's institutional knowledge and subject matter expertise regarding workforce dynamics and sector-based workforce interventions. The Heldrich Center also conducted a limited number of interviews to inform the sector-based workforce strategies outlined in this report. The Heldrich Center team offers action steps and examples for each workforce development strategy proposed in this analysis. The Heldrich Center also offers sector-specific workforce development strategies, where possible, based on the priority action measures identified by NJDEP.

To **model labor changes**, the Heldrich Center has engaged with Will Irving, Professor of Practice, at the Edward J. Bloustein School of Planning and Public Policy. Professor Irving's areas of practice are economic and quantitative methods. The research approach using the R/ECON Input-Output Model is outlined below.

Workforce impacts are estimated for each priority measure (where possible and appropriate) using the R/ECON input-output (I-O) model. The R/ECON I-O model reflects the production "recipe" for over 400 industries and embodies the inter-relationships between these industries. As such, it can be used to show how expenditures in one or more industries "ripple" through the economy, impacting other industries and households. Expenditures made on labor, materials, consulting and other services, and other inputs for a priority measure, have both direct economic effects as those expenditures become incomes and revenues for workers and businesses, and subsequent indirect effects as those workers and businesses, in turn, spend those dollars on other goods and services. These expenditures on consumer goods, business investment expenditures, and other items in turn become income for other workers and businesses. This income gets further spent, and so on.

Based on an identified economic disturbance (direct effect), the R/ECON I-O model estimates the indirect and induced (so-called "multiplier") effects in additional jobs and income of the subsequent economic activity that follow from the initial expenditures. The model also can estimate the gross domestic product for New Jersey and the tax revenues generated by the combined direct and indirect new economic activity caused by the initial spending. In this brief, researchers report only workforce estimates.

In addition, embodied in the model are estimates of regional purchase coefficients (RPCs)—the share of local (i.e., in-state) demand for labor and material that can be met by in-state supplies. That is, based on historical interindustry relationships, the model can roughly estimate the share of project expenditures that are likely to be supplied by establishments in New Jersey (or any other area in the United States that is composed of counties). Similarly, interindustry relationships capture the portion of indirect expenditures (i.e., spending of the business revenues and personal incomes initially generated by the project expenditures) that remain in the state. Those initial expenditures and indirect impacts that spill out of the state are referred to as "economic leakage." Estimates of "economic leakage" associated with project expenditures, of course, are best refined by specific project information regarding the expected sourcing of labor, materials or other services.

The final list of priority measures and enabling actions chosen by NJDEP, the precise nature of the priority measures, and the funding amounts to be spent were not known at the time of this analysis. Thus, rather than present estimates of total workforce impacts, this report instead presents estimates of workforce impacts per $1 million of expenditure for each priority measure (where possible) based on readily available information. Later, when priority measure funding amounts are determined, estimates of impacts per $1 million of initial spending can be used to calculate estimates of total workforce requirements for each priority measure.

For each priority measure, researchers identified the industries represented in the R/ECON I-O model that best represented the types of expenditures likely associated with the work. Where the expenditures for any given priority measure were likely to be allocated across multiple industries, researchers estimated expenditure distributions across sectors that approximate the likely allocation of priority measure costs.

Taken together, these four analyses offer insight into New Jersey's workforce development landscape as it relates to the priority sectors and priority action measures identified by NJDEP for inclusion in the PCAP.

This workforce planning analysis primarily used a previous iteration of NJDEP's priority sectors and priority measures and/or enabling actions to conduct the workforce planning analysis. The analyses have been updated, where possible, to reflect the updated priority sectors and priority measures and/or enabling actions identified by NJDEP in February 2024. This is noted to reflect any limitations and/or discrepancies in the analyses.

NJDEP Priority Sectors and Measures

The following sectors have been chosen by NJDEP as priority sectors for the CPRG PCAP:

- Transportation
- Buildings
- Electric Generation
- Food Waste
- Halogenated Gases
- Natural and Working Lands

Table 1. NJDEP Priority Measures and Enabling Actions

Transportation	
Priority measure 1: Achieve 30% zero-emission medium- and heavy-duty vehicle sales by 2030 and 100% by 2050	
	Enabling actions:
1	Implement the Advanced Clean Truck rule
2	Implement technical assistance program(s) to help fleet owners transition to electric vehicles and provide workforce training programs
3	Purchase zero emission buses and modify and build depots in the NJ Transit system to achieve Electric Vehicle Law goals
4	Electrify NJ TRANSIT Access Link Paratransit, local service, and rail
5	Incentivize replacement of diesel medium- and heavy-duty vehicles, including school buses, with battery electric vehicles or green hydrogen fuel cell electric vehicles
6	Expand medium- and heavy-duty charging infrastructure
Priority measure 2: Achieve light-duty electrification goals in New Jersey's Electric Vehicle Law (P.L. 2019, c. 362) [1]	
	Enabling actions:
1	Implement Advanced Clean Cars II Rule
2	Electrify State and local government fleets to achieve Electric Vehicle Law goals
3	Ensure low- and moderate-income residents have access to clean transportation by expanding eMobility programs that provide electric ride sharing, ride hailing and similar services
4	Expand publicly available electric vehicle charging infrastructure with specific focus on charging for multi-unit dwellings
Priority measure 3: Reduce emissions in and around ports	
	Enabling actions:
1	Electrify drayage trucks
2	Electrify cargo handling equipment
3	Electrify marine vessels and ferries
Priority measure 4: Reduce miles travelled	
	Enabling actions:
1	Expand active transportation infrastructure and complete streets
2	Increase NJ Transit ridership and expand development of transit villages
3	Expand work-from-home and ridesharing programs

[1] Electrification goals include

- 330,000 registered plug-in electric light-duty vehicles by 2024
- 2 million registered plug-in electric vehicles by 2035
- 85% of all new light-duty vehicles sold or leased in the state are plug-in electric vehicles by 2024
- 25% of state-owned non-emergency light-duty vehicles are plug-in electric vehicles by 2025
- 100% of state-owned non-emergency light-duty vehicles are plug-in electric vehicles by 2035

Buildings	
Priority measure 5: Install zero-carbon emission space heating and cooling and water heating systems in 400,000 residential properties and in 20,000 commercial properties	
	Enabling actions:
1	Launch a digital “one stop shop” summarizing federal and state energy rebate funding
2	Offer training grants for residential energy contractors
3	Work with utilities to launch building decarbonization start-up programs
4	Develop a renewable heating and cooling web calculator tool for New Jersey
5	Develop a ground source heat pump siting tool for New Jersey stakeholders
6	Adopt the 2024 International Energy Conservation Code for residential buildings and ASHRAE 90.1-2022 for commercial buildings
7	Explore the adoption of a stretch code to maximize energy efficiency in new construction
8	Implement the appliance standards law and develop the appliance standards recommendations report
9	Pilot community/campus/neighborhood scale district geothermal system decarbonization demonstration projects
10	Explore the adoption of a clean heat standard
11	Continue energy benchmarking efforts and explore building performance standards
12	Develop building decarbonization resources for local government lead by example efforts
13	Pilot building decarbonization efforts at State facilities and at local government facilities
14	Seek grants and funding to pilot beneficial reuse of wastewater for building electrification at wastewater treatment facilities
15	Seek grants and funding to implement NJBPU’s Higher Education Decarbonization Pilot Program
Priority measure 6: Make at least 10% of all low-to-moderate income properties electrification-ready by the year 2030	
	Enabling actions:
1	Expand NJBPU’s Whole House Pilot Program to enable energy efficiency for low-and moderate-income residential buildings
2	Expand electrification and efficiency programs for low- and moderate-income residential buildings
3	Expand NJBPU’s multifamily pilot program, which offers energy audits and installation of energy efficiency measures at multifamily properties

Electric Generation	
Priority measure 7: Achieve 12.2 GW of solar in-state by 2030	
	Enabling actions:
1	Implement Competitive Solar Incentive, Administratively Determined Incentive, and Dual Use Solar Programs
2	Expand the Community Solar Energy Program
3	Site solar infrastructure at State and local government facilities
4	Release revised Solar Siting Analysis
Priority measure 8: Facilitate the integration of clean distributed energy resources into the grid	
	Enabling actions:

1	Improve the hosting capacity of the New Jersey electric distribution system through grid modernization efforts
2	Support implementation of FERC 2222 to help support distributed energy resources
3	Support development of 2.0 GW of energy storage by 2030 through the creation of an Energy Storage Incentive Program
4	Pilot grid supportive technologies such as vehicle-to-everything "V2X" and microgrids systems
5	Implement storage component of Competitive Solar Incentive program
6	Support Resilient Local Governments
Priority measure 9: Support the development of 11.0 GW of offshore wind by 2040	
	Enabling actions:
1	Launch and award New Jersey's fourth offshore wind solicitation
2	Develop and implement State Agreement Approach 2.0 for the goal of 11 GW of wind energy by 2040
3	Support construction of the New Jersey wind port

Food Waste	
Priority measure 10: Achieve a 50% reduction in food waste by 2030	
	Enabling actions:
1	Develop regulations to implement Food Waste Recycling and Food Waste-to-Energy Law
2	Develop guidance and toolkit to encourage local governments to implement food waste management programs
3	Develop tools to connect food waste generators with potential recipients to support food recovery
4	Raise awareness about food waste reduction
5	Encourage Counties to update district solid waste management plans to include food waste reduction
6	Implement statewide waste composition audits
7	Implement a community-scale reusable food-ware system pilot
8	Support food waste recovery systems, such as anaerobic digesters and co-digestion of food waste at wastewater treatment facilities
9	Encourage wastewater treatment facilities to reduce landfilling of residuals
10	Implement local and regional composting programs
11	Encourage schools to adopt the New Jersey School Food Waste Guidelines and institute a food waste reduction curriculum in K-12 schools
12	Address opportunities for food waste reduction at state-owned buildings
13	Continue to pursue revisions to the Recycling Rules (N.J.A.C. 7:26A)

Halogenated Gases	
Priority measures 11: Reduce halogenated gas emissions from refrigeration equipment	
	Enabling actions:
1	Pilot a low-GWP incentive program for refrigeration systems
2	Replace high-GWP refrigerant equipment

Natural and Working Lands	
Priority measure 12: Maintain, protect, and enhance New Jersey's natural carbon sinks.	
	Enabling actions:
1	Plant 250,000 street trees/shade trees by 2030
2	Identify and restore 800 degraded acres of forested lands by 2030
3	Develop a nursery supply and production initiative
3	Complete 1 tidal reconnection project per year (total of 6) by 2030
4	Install 7,800 linear feet of living shoreline per year by 2030
7	Relaunch conservation cost share program

Utilizing these twelve priority measures where possible, the following is the Heldrich Center's Workforce Planning Analysis for the PCAP.

Examination of the State's Workforce Capacity in Priority Measure Sectors

Task: Mapping out the state's strengths, weaknesses, and opportunities related to the priority measures.

Green Economy Landscape

> *"Climate change is the single greatest long-term threat currently facing humanity, and our state and economy are uniquely vulnerable to its devastating effects."*
>
> - New Jersey Governor Phil Murphy

The landscape present in New Jersey creates the core foundation on which it will be possible for the priority measures identified by NJDEP to be funded, implemented, and prioritized. This landscape is a core strength for New Jersey and its future climate mitigation efforts across all sectors of the economy. As such, this research outlines recent policy efforts and initiatives to highlight the way in which the New Jersey landscape is well-primed to fund and implement the priority action measures in the priority sectors identified by NJDEP.

In recent years, New Jersey has made strong commitments to mitigating the impacts of climate change, transitioning the state away from fossil fuels, and establishing clear climate goals. Because of the state's population density and proximity to the coast, New Jersey is at risk for adverse effects of climate change.[2] The specific call to action for New Jersey is as follows,

> "Minimizing these risks requires immediate, decisive, long-term commitments across all levels of government and sectors of the economy to facilitate the steep reductions of greenhouse gas (GHG) emissions that are necessary to protect New Jersey's economic, social, and environmental vitality" (2020, p.v).[3]

In 2021, New Jersey Governor Phil Murphy established the new Office of Climate Action and the Green Economy and formed the New Jersey Council on the Green Economy through the passage of Executive Order 221.[4] The Executive Order further dictated that, within one year of its formation, the Council must deliver an initial report of its recommendations for a comprehensive and coordinated clean energy strategy.[5] Two critical publications that underpin New Jersey's more recent investments in climate mitigation are from these efforts: the Council's *Green Jobs For A Sustainable Future* report and the *New Jersey's Global Warming Response Act 80x50 Report*. These reports lay the foundation for the path forward for New Jersey's clean energy economy and represent areas of continued and future investment.

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[2] https://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdf
[3] https://dep.nj.gov/wp-content/uploads/climatechange/nj-gwra-80x50-report-2020.pdf
[4] https://d31hzlhk6di2h5.cloudfront.net/20210216/63/d5/45/47/41b160487f5a65688f17ec6a/EO-221.pdf
[5] https://www.choosenj.com/news/governor-murphy-announces-100-million-investment-in-clean-transportation-projects/

A key strength for the state is the prioritization and support for climate mitigation investments at all levels of government. In 2021, the Murphy administration announced the $100 million investment in clean and equitable transportation projects that improve air quality and reduce the effects of climate change while moving New Jersey toward 100% clean energy by 2050.[6] The Murphy administration accelerated the timeline in 2023 and committed to achieving 100% clean energy by 2035, an ambitious goal for electrification of the state's building sector that includes collaborative planning for the future of the state's natural gas utilities.[7] New Jersey is also one of only six states in the country to have an energy storage target.[8] Moreover, the state has supported the roll-out of 330,000 zero emission vehicles (ZEVs) by 2025 through the New Jersey Partnership to Plug-in.[9] With such a clear mandate from the Governor's Office, numerous programs and incentives for clean energy have been funded by or are in partnership with the New Jersey Economic Development Authority (NJEDA), including but not limited to NJ Cool and the New Jersey Innovation Evergreen Fund.[10]

Through the aforementioned efforts, New Jersey has made investments to expand clean energy and its related economic and workforce opportunities, with specific emphasis on the diversification of the workforce among historically underrepresented populations. According to the Council's *Green Jobs For A Sustainable Future* report, New Jersey ranked 18th nationally in renewable energy and fuels jobs, accounting for nearly 15,000 workers.[11] Yet studies show that women and/or individuals of color are underrepresented in green jobs. Specifically, women only account for between 17% and 28% of green jobs in environmental infrastructure, energy efficiency, renewable energy generation and clean fuels, alternative vehicles, and grid infrastructure and storage.[12] Black workers also only represent between 9% to 10% of green jobs in New Jersey.[13] While underrepresentation of women and/or individuals of color is not unique to New Jersey, it does require substantial investment to ensure that these groups have equitable access to opportunities brought upon by the clean energy transition. More specifically, in alignment with the principles of energy justice, there should be a targeted focus on the equitable distribution of employment opportunities to the populations most impacted by climate change.[14] In addition to creating access to dedicated career pathways with clear onramps, targeted outreach to historically underrepresented communities within overburdened communities (OBCs) is needed to diversify the clean energy workforce more proactively.

By assessing opportunities for green jobs and the expansion of clean energy in New Jersey, the Council's *Green Jobs For A Sustainable Future* report found that the state will see an increase of 314,888 net job-years.[15] This demonstrates substantial opportunity for growth and development in the priority sectors within the priority measures identified by NJDEP. An area of continued focus is ensuring that employment opportunities derived from the expansion of clean energy are high-quality jobs that pay

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6 https://www.choosenj.com/news/governor-murphy-announces-100-million-investment-in-clean-transportation-projects/
7 https://www.nj.gov/governor/news/news/562023/20230215b.shtml
8 https://www.energy-storage.news/new-jersey-proposes-energy-storage-incentives-to-reach-2gw-deployment-target/
9 https://www.njeda.gov/clean-energy/#:~:text=We've%20committed%20to%20100,Partnership%20to%20Plug%2Din%E2%80%9D
10 https://www.njeda.gov/clean-energy/#:~:text=We've%20committed%20to%20100,Partnership%20to%20Plug%2Din%E2%80%9D
11 https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf
12 https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf
13 https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf
14 https://www.energy.gov/promoting-energy-justice
15 As defined by the NJ Council on the Green Economy, a job-year represents one year of work for one person. In other words, a new construction job that lasts five years would be considered five job-years. As an example, 86,700 job-years for the solar sector over 10 years translates to 8,670 solar jobs supported for the next 10 years.

family-sustaining wages and are accessible to groups historically underrepresented in the sector. As stated in the Council's *Green Jobs for A Sustainable Future* report,

> "If the state is not intentional about, and focused on, the outcomes of this job creation, many of these jobs will not deliver the career pathways, wage parity, and unionization benefits that are critical for a thriving economy" (2022, p.8).[16]

There remains an additional opportunity to insert job quality standards into the conversation around job creation in clean energy, including the priority sectors and measures identified by NJDEP. Job quality standards can include, but are not limited to, prevailing wage standards, project labor and community workforce agreements, and support for unionization.[17] These job quality standards are crucial for ensuring equitable employment opportunities in clean energy.

The policies and initiatives outlined in this section provide the backdrop for the robust workforce development infrastructure, particularly the various education and training programs in the state, on which continued targeted investment would derive pronounced benefits for all those who engage and are looking to enter and/or continue working in the clean energy. The following section assesses the landscape of education and training programs in New Jersey, highlighting potential opportunities for growth in counties with greater limited English proficiency, low income, and minority populations.

Inventory of Workforce Development Infrastructure

The Heldrich Center further examined New Jersey's workforce strengths, weaknesses, and opportunities as they relate to the priority measures for the PCAP by conducting a thorough inventory and examination of the current education and training landscape in the state. In this way, the Heldrich Center's work highlights areas of strength and areas for improvement, ensuring that gaps in the education and training infrastructure can proactively be addressed to maximize support for the priority measures outlined in the PCAP.

New Jersey's investments in clean energy need to be bolstered by a robust education and training system, properly equipped to support sectors of growth and to teach the in-demand skills for the jobs and technologies of the future. In the absence of the appropriate education and training programs, the expansion of new technologies will be curtailed without the underpinnings of a skilled and trained workforce. For these reasons, the Heldrich Center offers the following analysis of the state's strengths, weaknesses, and opportunities from a workforce development lens, focused on the education and training landscape in New Jersey.

The Heldrich Center developed an inventory of education and training programs to assess the state's workforce capacity in each priority area identified by NJDEP. The inventory provides information on career cluster, occupation, program name, program type, award level, and county for every education and training program by priority area. Education and training providers included in the inventory are universities/colleges, community colleges, vocational-technical schools, high schools, employers, associations, nonprofits, community-based organizations (CBOs), townships, and unions.

[16] https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf
[17] https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf

Researchers identified around **6,217** education and training programs that offer apprenticeship, certificate, degree, grant, internship, training, and/or youth opportunities in New Jersey for occupations associated with the five priority areas. Most education and training programs are concentrated in Buildings and Electric Generation (52%), Natural and Working Lands (19%), and Food Waste (18%) (see *Table 2*).[18] This is unsurprising given that researchers identified more occupations for Buildings and Electric Generation, particularly because of the extent of industries involved, as compared to other priority areas.

[18] Buildings and Electric Generation is grouped as one priority area in the inventory in accordance with a previous iteration of the priority areas and measures. The grouping remains because Buildings and Electric Generation share similar occupations and education and training programs. The inventory will distinguish between Buildings and Electric Generation once grants are awarded.

Table 2. Percentage of Education and Training Programs by Priority Area

Priority Area	Number of Education and Training Programs	Percentage of Education and Training Programs
Buildings and Energy Generation	3,262	52%
Food Waste	1,125	18%
Halogenated Gases	336	5%
Natural and Working Lands	1,133	19%
Transportation	361	6%

N = 6,217

Mapping education and training providers shows that most are concentrated in Mercer County (20), Middlesex County (15), Bergen County (12), and Essex County (11) counties (see *Figure 1*).[19] Rural counties in northern and southern New Jersey have fewer education and training providers, and several tended to have higher percentages of low-income communities and limited English proficiency (see *Table 3*). Salem County, for example, has higher averaged percentages of low income (54.67%) and minority (62.77%) populations but few education and training programs (42) compared to other counties.

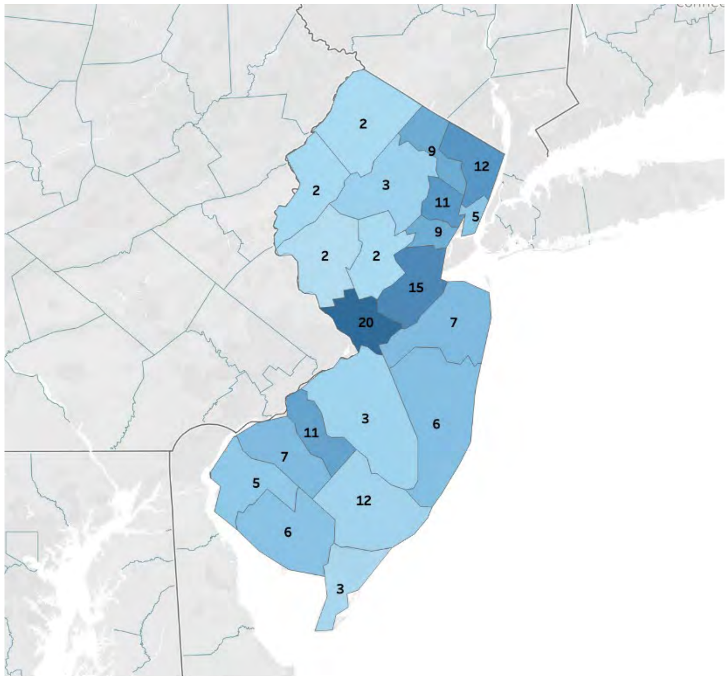
Table 3. Education and Training Program Information with Limited English Proficiency, Low Income, and Minority Populations by Region and County

Region	County	Number of Programs	Number of Providers	Averaged Percentage of Limited English Proficiency	Averaged Percentage Low Income	Averaged Percentage Minority
North	Bergen	497	20	11.51%	20.32%	61.52%
	Essex	923	22	10.79%	36.53%	83.08%
	Hudson	687	9	15.17%	33.53%	75.47%
	Morris	315	7	11.24%	22.03%	58.75%
	Passaic	466	15	19.84%	41.68%	78.68%
	Sussex	45	3	6.84%	35.71%	31.34%
	Union	251	13	15.10%	28.21%	76.86%
	Warren	151	4	4.76%	44.58%	37.09%
Central	Hunterdon	7	2	10.92%	26.10%	54.20%
	Mercer	707	26	10.10%	35.84%	71.58%
	Middlesex	678	20	9.03%	21.08%	67.79%
	Somerset	85	3	7.31%	16.67%	62.98%
South	Atlantic	242	14	9.78%	45.75%	67.56%
	Burlington	130	4	2.48%	25.66%	58.17%
	Camden	188	14	7.91%	40.21%	70.81%
	Cape May	9	3	4.20%	46.26%	31.22%
	Cumberland	86	7	9.56%	45.81%	65.29%
	Gloucester	272	9	2.37%	35.33%	42.93%
	Monmouth	124	9	6.75%	33.09%	53.51%
	Ocean	194	10	2.76%	50.51%	20.72%
	Salem	42	6	5.69%	54.67%	62.77%

[19] Some figures from the inventory and subsequently referenced in this report may not include all education and training programs and/or providers in New Jersey. There may be more education and training providers in Mercer County, for example, but some were excluded from the data visualization due to filtering. Unions are consistently excluded from the maps because local chapters tend to operate in multiple counties and/or regionally.

Note: The number of programs and providers excludes unions and NULL values. Unions are excluded because local chapters tend to operate in multiple counties and/or regionally. Darker shaded cells represent higher numbers respective to that column, whereas lighter shaded cells are lower numbers.

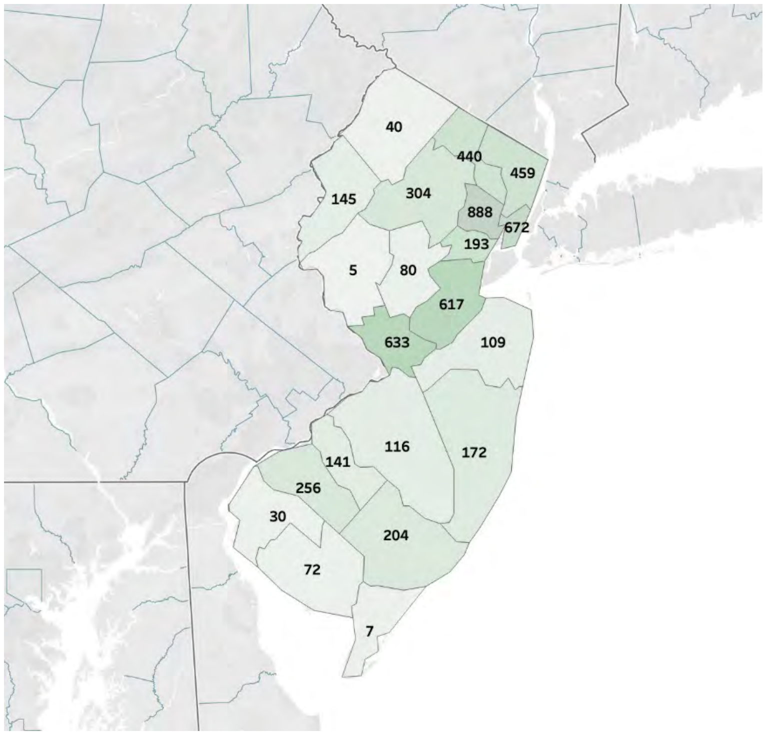
Figure 1. Map of Education and Training Providers Related to Priority Areas in New Jersey



Note: This figure may not reflect *all* education and training providers related to the six priority areas due to filtering (e.g., county, career cluster, and program name). Unions are excluded from this data visualization because local chapters tend to operate out of multiple counties and/or regions. Please refer to the first tab of the inventory for the complete list.

There are more education and training programs in counties with more providers, with the exception of Hudson County. Essex County has 888 education and training programs, for example, that offer different opportunities — apprenticeships, certificates, degrees, and more (see *Figure 2*). Hudson County has 672 education and training programs, followed by Mercer County (633) and Middlesex County (617). Given that there are often fewer providers in rural areas, it is unsurprising that Hunterdon County, Cape May County, and Salem County have the fewest education and training programs.

Figure 2. Map of Education and Training Programs Related to Priority Areas in New Jersey



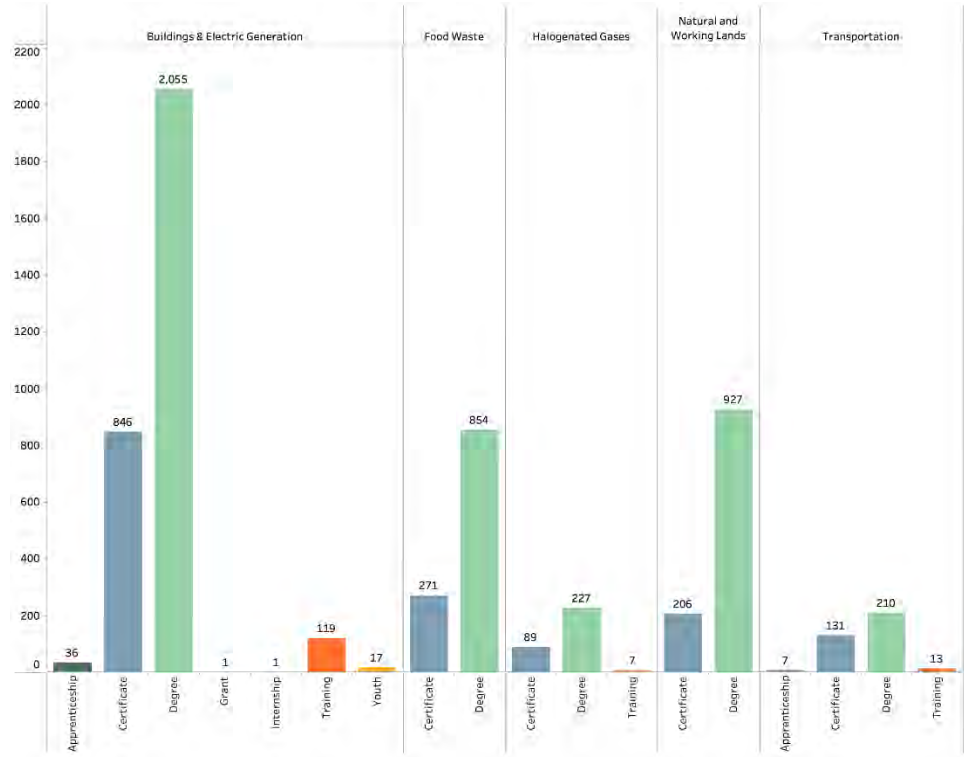
Note: This figure may not reflect *all* education and training providers related to the six priority areas due to filtering (e.g., county, career cluster, and program name). Unions are excluded from this data visualization because local chapters tend to operate out of multiple counties and/or regions. Please refer to the first tab of the inventory for the complete list.

Researchers used Overburdened Community (OBC) data from NJDEP to assess the number of education and training programs in counties with higher frequencies of limited English proficiency, low income, and/or minority populations, which fall under OBCs.[20] Counties with higher frequencies of these populations are Middlesex, Union, Essex, Hudson, and Bergen. At the same time, these counties tend to have more education and training providers and, therefore, programs. These findings are unsurprising, given that these are the most densely populated counties in New Jersey.

Of great concern are rural counties with high limited English, low income, and/or minority populations, as there are fewer opportunities through existing education and training providers. Targeted workforce development is necessary in these communities to ensure equitable access to education and training programs in these priority areas.

[20] OBC data is based on Census tracks. Researchers used aggregate figures for limited English proficiency, low income, and minority populations *by county*. This limits the granularity of analysis and instead provides averages for each county.

Figure 3. Program Type by Priority Area



N = 6,017

Note: This figure does not include all 6,217 education and training programs because there are approximately 200 records with NULL for program type.

Researchers found that higher percentages of education and training programs were degree-based for Natural and Working Lands (82%) and Food Waste (76%) compared to Transportation (58%), Buildings and Electric Generation (63%), and Halogenated Gases (68%). This could suggest that occupations associated with Natural and Working Lands and Food Waste require higher educational attainment than the other priority areas. Relatedly, Buildings and Electric Generation, Halogenated Gases, and Transportation tended to have more programs that offer apprenticeship, certificate, general training, and/or youth opportunities. This finding is unsurprising given the well-established, union-based opportunities in the trades.

Strengths, Weaknesses, and Opportunities

Researchers assessed strengths, weaknesses, and opportunities in the workforce development infrastructure for each priority area based on the education and training landscape outlined above. The following bullet points provide high-level summaries.

Strengths

- **Substantial buy-in exists for workforce development infrastructure related to Buildings, Electric Generation, and Transportation at the state and local level**. Created by Governor Phil Murphy in 2019, the Energy Master Plan (EMP) set aggressive goals toward 100% clean energy by 2050. Five of the seven key strategies outlined in the EMP focus on areas related to Buildings, Electric Generation, and Transportation by reducing energy consumption and emissions from the transportation sector, accelerating deployment of renewable energy and distributed energy resources, maximizing energy efficiency and conservation, reducing energy consumption and emissions from the building sector, and decarbonizing and modernizing New Jersey's energy system. Based on policies set forth by the Murphy administration, there appears to be significant political will to tackle Buildings, Electric Generation, and Transportation, particularly given commitments at the state and local level, promotional efforts to adopt energy efficient technologies through rebates, and encouragement for consumers to convert to EVs through tax incentives.
- **Workforce development infrastructure appears to be stronger for Buildings and Energy Generation than other priority areas.** There have been state and national conversations about electrification – and, to some extent, decarbonization – for decades. This has increased demand for energy efficient technologies in recent years and, therefore, driven demand for workers to manufacture, install, and repair them. These workers are largely concentrated in the trades. Though there are many occupations that require postsecondary education for Buildings and Energy Generation (e.g., Engineering), they are accompanied by hundreds of opportunities through associations, CBOs, and unions. By comparison, occupations for Natural and Working Lands appear to be largely degree-based, as most conservationists need an associate or bachelor's degree or higher.

Weaknesses

- **Workforce development infrastructure appears to be less developed for Food Waste, Halogenated Gases, and Natural and Working Lands.** Though these priority areas are responsible for significant greenhouse gas (GHG) emissions, they do not explicitly reflect industries in the North American Industry Classification System (NAICS) as defined by the Bureau of Labor Statistics.[21] The industries and sectors associated with Food Waste, Halogenated Gases, and Natural and Working Lands are, therefore, less clear than Buildings, Electric Generation, and Transportation, as further evidenced by comments made by participants in the Halogenated

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https://www.bls.gov/IAG/TGS/iag_index_naics.htm#:~:text=Industries%20by%20Supersector%20and%20NAICS%20Code%201%20Natural,Beverage%20and%20Tobacco%20Product%20Manufacturing%20%28NAICS%20312%29%20

Gases stakeholder session. Occupations and potential career pathways in these priority areas, particularly Food Waste, are even less defined. The problem is then two-fold: New Jersey residents do not know about these priority areas, nor do they know how to gain employment or re-skill to enter these priority areas. This poses substantial barriers for individuals in pursuing career pathways in Food Waste, Halogenated Gases, and Natural and Working Lands, with a specific emphasis on the difficulties it presents for OBCs and other nontraditional and underserved communities.

Opportunities

- **Create and/or expand incentive programs for technologies that reduce GHG emissions (e.g., heat pumps, leakage reduction technology, food waste recycling, etc.) to drive demand the need for workers and education and training programs to provide them with the skills and necessary licenses and/or credentials.** Existing incentive programs for Buildings, Electric Generation, and Transportation can be strengthened, whereas the State will need to create new programs for Food Waste, Halogenated Gases, and Natural and Working Lands.

- **Generate greater awareness about the importance of and opportunities within Buildings, Electric Generation, Food Waste, Halogenated Gases, Natural and Working Lands, and Transportation.** This includes increasing awareness about viable career pathways and highlighting existing education and training programs in each priority area. To do this, New Jersey can promote current and anticipated efforts to reach the aggressive goals outlined in the EMP and 80 x 50 report, and highlight stakeholders (e.g., employers) collaborating to implement initiatives that reduce GHG emissions. Targeted outreach must be directed to OBCs to further ensure equitable access to training and education opportunities in New Jersey's green economy.

- **Support and expand targeted investment in rural areas with greater limited English, low income, or minority populations.** Targeted investments should help the development and increase the accessibility of education and training programs in each priority area. These investments can specifically target reducing barriers to participation, namely transportation, childcare, and other supportive services. Targeted investment in support services that serve to increase the accessibility of existing programs as well as encourage the development of new programs will ensure that OBCs participate in the gains and/or prosperity of the emergence of the green economy in New Jersey.

Barrier Identification

Task: Analyzing barriers that underserved communities face in accessing related job opportunities as well as suggesting strategies to overcoming those barriers.

Through the Heldrich Center's research and analyses, the following five barriers were identified for underserved communities and/or OBCs in accessing job opportunities. This is not an exhaustive list of barriers that may be present in historically underserved communities and/or OBCs; however, these are identified as the most critical from a workforce development lens. The Heldrich Center offers a series of strategies that can be deployed to address the identified barriers.

Barrier: **A lack of job quality and diversity standards.**

As noted earlier in the report, it is anticipated that New Jersey's climate change mitigation efforts will result in new jobs and a significant number of job-years. It was also noted that without intervention, the benefits of such job creation will not reach the populations who are historically underserved, who reside in OBCs, and/or who may live in areas most impacted by climate change. In addition to creating clear onramps and career pathways to jobs in clean energy, more can be done to insert job quality and diversity measures into the priority sectors of focus.

Strategy: **Embedding job quality and diversity standards in procurement processes at the State and local level.**

A working paper from the World Resources Institute shows green investment typically yields a higher creation of jobs as compared to unsustainable investments.[22] Though research shows that green investment has the potential to create high-quality jobs, it is often not guaranteed. Their research suggests that, if government investment follows green job creation, it should come with conditions that ensure fair wages and benefits, work security, safe working conditions, opportunities for training and advancement, the right to organize, and accessibility.[23]

Examples of job quality standards for the state to consider are prevailing wage standards, project labor and community workforce agreements, and support for unionization.[24] These mechanisms could be considered on a sector-wide basis. Buy in and backing from relevant sector stakeholders and employers would be needed to ensure that job quality standards are implemented with additional mechanisms for accountability and/or support.

In terms of embedding job quality standards in procurement processes, as stated in the Council's *Green Jobs For A Sustainable Future* report one suggestion is as follows,

[22] Jaeger, J., G. Walls, E. Clarke, J.C. Altamirano, A. Harsono, H. Mountford, S. Burrow, S. Smith, and A. Tate. 2021. "The Green Jobs Advantage: How ClimateFriendly Investments are Better Job Creators." Working Paper. Washington, DC: World Resources Institute. Available online at https://doi.org/10.46830/wriwp.20.00142.
[23] Jaeger, J., G. Walls, E. Clarke, J.C. Altamirano, A. Harsono, H. Mountford, S. Burrow, S. Smith, and A. Tate. 2021. "The Green Jobs Advantage: How ClimateFriendly Investments are Better Job Creators." Working Paper. Washington, DC: World Resources Institute. Available online at https://doi.org/10.46830/wriwp.20.00142.
[24] https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf

> "Where necessary, New Jersey should provide subsidies or phase in approaches that balance green building and the development of energy-efficient affordable housing with stricter job quality standards" (2022, p.31).

Moreover, the Council's *Green Jobs For A Sustainable Future* report goes on to offer the following tactical recommendation to ensure that New Jersey residents engaged in clean energy are able to access high-quality job opportunities that pay a family-sustaining wage,

> "Continue to ensure that high-quality jobs are created by publicly funded projects by phasing in requirements for project labor agreements, prevailing wage, and wage floor requirements for all green contracts that use taxpayer or ratepayer funds; and either leverage existing or provide additional funding, with accountability, to subsidize job quality requirements, especially for small, minority, and women-owned and veteran contractors, and to address any disincentives or economic impacts on development" (2022, p.33).

Embedding diversity standards in sector employment will proactively address the energy justice concerns impacting OBCs throughout the state. Partnering with the New Jersey Environmental Justice Alliance and other related groups could be a first step towards understanding community needs as well as ensuring diversity standards are set, and then ultimately met in the priority Green Economy sectors expected to see the greatest employment gains in the coming years.

***Barrier:* A lack of adequate public transit system to get to better quality, healthier jobs.**

New Jersey's varied urban, suburban, and rural geography present different challenges to accessing reliable public transportation in the state. According to a 2019 study by the Federal Reserve Bank of Kansas City,

> "A lack of transportation is both a pervasive employment barrier and considerably more prevalent in low- and moderate-income (LMI) communities than non-LMI communities" (2019, p.53).[25]

While New Jersey does have a significant public transportation system with rail and bus services, the state still contains transit deserts. A report for The Garden State Initiative identified and mapped New Jersey's rail transit deserts, which showed that the populations in the northern counties on the New York and Pennsylvania border and many southern counties were without access to a rail station within a 5-mile radius.[26] While fixed route services, such as existing bus and rail routes, may not meet the needs of the populations in these transit deserts, innovative practices such micro transit systems and/or county-based transportation are possible options and investments that could be explored in greater depth.

***Strategy:* Conduct a needs assessment focused on transportation in OBCs throughout the state of New Jersey.**

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[25] https://www.kansascityfed.org/Economic%20Review/documents/919/2019-Why%20Aren%E2%80%99t%20More%20People%20Working%20in%20Low-%20and%20Moderate-Income%20Areas%3F.pdf
[26] https://www.bls.gov/cex/research_papers/pdf/peters-gordon-flanagan-equitable-transportation-policy-nj.pdf

Working in conjunction with the New Jersey Department of Labor and Workforce Development, the New Jersey Department of Transportation, and/or NJTRANSIT, NJDEP could commission a transportation-focused needs assessment aimed at the OBCs identified through the PCAP. Additionally, the Alan M. Voorhees Transportation Center at Rutgers University would be a beneficial partner to engage in this work as the Center has conducted numerous studies in examining New Jersey's transportation landscape.

A targeted needs assessment may reveal locations in which public transportation is not a realistic and/or reliable option for individuals to travel to education and training programs and/or employment opportunities that are anticipated for these priority sectors. Using the education and training provider inventory conducted as part of the Heldrich Center's work, future research could triangulate the extent to which OBCs are co-located with education and training providers within transit deserts and what this means for accessibility. This future research would be critical to addressing the barrier of transportation in OBCs in New Jersey.

Once the barriers are more formally understood, relevant stakeholders and partners could look to fund and/or pilot more dynamic and innovative transportation systems, such as micro transit systems, using a targeted approach that responds to the identified needs. Cities like Camden, Jersey City, and New Brunswick have partnered with Via to create micro transit systems that serve the transit deserts identified in their respective cities.

Barrier: **A lack of community input and prioritization of community needs.**

Through the Heldrich Center's participation in the New Jersey Climate Change Resource Center's stakeholder sessions, as well as individual stakeholder interviews, there appears to be a need for greater community voice to be present in conversations about community access and community needs. The impact and power of community voice represented in policy and/or decision-making critically underpins program design, implementation, and the likelihood of successful uptake within communities.

Strategy: **Work with community and faith-based organizations to conduct community round-table awareness sessions on clean energy and opportunities that may be present and/or forthcoming for these populations.**

In the healthcare space, the Robert Wood Johnson Foundation (RWJF) has outlined a strategy to build community power in their quest to advance health equity, with particular successes highlighted in mitigating tobacco use and childhood obesity. Through RWJF's community work, the Foundation has derived the following learning,

> "Low-income people and communities of color have been excluded from decision-making on the policies and practices that impact their health and prosperity, through generations of systemic exclusion and disinvestment."[27]

From this learning, RWJF posits that the people most directly impacted by systemic barriers and inequities are often best situated to identify the solutions and actions necessary to drive change in their

[27] https://www.rwjf.org/en/building-a-culture-of-health/focus-areas/Features/building-community-power-to-advance-health-equity.html

communities.[28] This approach to creating an inclusive culture rooted in community involvement could be replicated and expanded in other sectors targeting historically underrepresented populations and/or OBCs.

With regard to clean energy sectors, a recent publication by Popular Democracy highlights the increasing engagement of historically marginalized communities previously left behind by the environmental movement, specifically naming Black, Indigenous, Latinx/é, low-income communities, and the global south.[29] While this trend may be happening on a national and/or global level, engagement at the community and local level is equally as important to inform and drive impactful change in the areas in most need of support.

Clean energy sector stakeholders, along with NJDEP, could partner with community-based organizations (CBOs), such as Ironbound Community Corporation, New Jersey Work Environment Council, GreenFaith, and other CBOs, to open a dialogue about the needs of communities, with particular emphasis on OBCs, to assess the priorities for these populations in relation to investments for climate mitigation and energy efficiency policies and programs. Creating dedicated space for such engagement will be critical to ensuring that OBCs are engaged in the green economy and reap the benefits from the climate transitions taking place throughout the state of New Jersey.

Barrier: **The existence of barriers that keep people from education and employment, specifically job availability and pay; qualifications, education, and training; transportation; childcare and family issues; crime and substance abuse; housing instability; disabilities and mental and physical health; and public assistance programs.**

There are a host of factors that can contribute to an individual's likelihood of finding and maintaining employment in any sector of the economy. A 2019 study by the Federal Reserve Bank of Kansas City identified prominent barriers to work in low- and moderate-income areas using a survey and text analysis, which revealed that the most prominent barriers were availability of jobs, qualifications and/or inadequate skills for a job, and education and training.[30] These prominent barriers were then followed by transportation, childcare/family, and crime/drugs.[31] Navigating such influences can be a challenge; however, with supportive services and programs in place, individuals can be empowered to minimize such barriers and move forward in their path to education and/or employment. Creating a continuum of supportive services is one way in which to invest in OBCs that may be struggling with a multitude of barriers to education and employment opportunities.

Strategy: **Dedicated funding for supportive services to reduce the barriers experienced by historically underserved populations in OBCs.**

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[28] https://www.rwjf.org/en/building-a-culture-of-health/focus-areas/Features/building-community-power-to-advance-health-equity.html

[29] https://www.populardemocracy.org/sites/default/files/FINAL%2020230223%20The%20Power%20to%20Win.pdf

[30] https://www.kansascityfed.org/Economic%20Review/documents/919/2019-Why%20Aren%E2%80%99t%20More%20People%20Working%20in%20Low-%20and%20Moderate-Income%20Areas%3F.pdf

[31] https://www.kansascityfed.org/Economic%20Review/documents/919/2019-Why%20Aren%E2%80%99t%20More%20People%20Working%20in%20Low-%20and%20Moderate-Income%20Areas%3F.pdf

Throughout the state of New Jersey, there are many organizations and systems in place to support individuals in their journey to education and employment. These entities range from CBOs, faith-based organizations, nonprofits, public libraries, One-Stop Career Centers, and more. However, it is often the case that these organizations work with limited resources and staff, serving as many people as they can with the supportive services they have to offer. Dedicated funding and investment targeted to organizations serving OBCs would be impactful in potentially mitigating the barriers keeping people out of the labor market.

In 2023, the Murphy administration announced their investment in a Lifelong Learning Accounts Pilot Program, designed to give participants autonomy over their education and training pathway with access to flexible funding. This program design promotes equitable opportunities and upward mobility, equipping people with the funding to mitigate the barriers in their lives that may kept them from engaging in an education or training program that would ultimately lead to a higher quality job.[32] Specifically speaking of the Lifelong Learning Accounts Pilot Program,

> "The barriers to family-sustaining employment are well known, but here in New Jersey — with this grant and other forward-thinking initiatives — we are creating life-changing opportunities for underserved residents."[33]

This innovative program design is an example of an investment in people, targeting individuals who need access to education and training but have barriers like those listed above. While this program is not targeted to OBCs, a similar design and/or investment could be made to create a more robust continuum of supportive services. Expanding on current services and/or the creation of new service provision could be considered once there is greater understanding of where the precise needs are within the OBCs of interest.

***Barrier:* OBCs tend to have poorer education systems, lower career awareness about jobs and job training, and inadequate investment in high quality career and vocational-technical education.**

Education, training, and work experience are critical advantages in the labor market.[34] However, it is documented that OBCs struggle with historic disinvestment that leads to lower quality education systems, less career awareness about jobs and job training, and diminished opportunities for career and vocational-technical education. A 2019 study by the Federal Reserve Bank of Kansas City found that residents in low- and moderate-income tracts typically have less experience than residents in non-low- and moderate-income tracts.[35] The research went on further to state,

[32] https://followsouthjersey.com/2023/02/10/lifelong-learning-accounts-pilot-program-gets-10m-for-job-training-employment-support/
[33] https://followsouthjersey.com/2023/02/10/lifelong-learning-accounts-pilot-program-gets-10m-for-job-training-employment-support/
[34] https://www.kansascityfed.org/Economic%20Review/documents/919/2019-Why%20Aren%E2%80%99t%20More%20People%20Working%20in%20Low-%20and%20Moderate-Income%20Areas%3F.pdf
[35] https://www.kansascityfed.org/Economic%20Review/documents/919/2019-Why%20Aren%E2%80%99t%20More%20People%20Working%20in%20Low-%20and%20Moderate-Income%20Areas%3F.pdf

> "A lack of qualifications appears to be a widespread problem, compounded by large gaps in education and experience between low- and moderate-income and non- low- and moderate-income tracts," (2019, p. 53).[36]

With this research in mind, substantial investment needs to be directed to the education, training, and workforce development systems available to residents in OBCs.

Strategy: **Significant investment of funds will be needed to address the employment barriers that are a result of a historic lack of investment in workforce development infrastructure in OBCs.**

This level of investment would need backing at all levels of government. Greater access to opportunities and awareness of those opportunities through marketing campaigns will be needed to make progress towards a more equitable education, training, and employment landscape for nontraditional and underserved communities and OBCs.

According to the NJ Council on the Green Economy Future of Green Jobs In New Jersey 2022 One Year Plan report, state agencies are executing a series of programs and pilots to advance key climate goals for the state of New Jersey. One such pilot program is as follows,

> "Launch a $5 million workforce development pilot to support access to training and wrap-around services for residents in Environmental Justice Communities," (2022, p.2).[37]

Pilot programs such as this are a significant first step towards targeted investments that will increase access to quality education and training programs that will result in the necessary preparations for the jobs of the future. The emphasis on both access to education and training as well as supportive services is critical in ensuring that equitable access is given to OBCs to reduce barriers to participation, thereby increasing the likelihood that the opportunities and benefits of New Jersey's green economy investment are distributed to all.

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[36] https://www.kansascityfed.org/Economic%20Review/documents/919/2019-Why%20Aren%E2%80%99t%20More%20People%20Working%20in%20Low-%20and%20Moderate-Income%20Areas%3F.pdf

[37] https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap%20One%20Year%20Plan.pdf

Workforce Strategies

Task: Identifying opportunities for sector-specific workforce strategies such as upskilling the current labor pool, aligning industry and training programs, employer engagement and sector partnership, career awareness and engagement strategies.

The Heldrich Center for Workforce Development has identified the following cross-cutting sector workforce strategies that could be deployed in any of the priority sectors identified by NJDEP to bring greater awareness to sector employment and stronger alignment with the workforce, employers, and sector investments. Moreover, the Heldrich Center offers supportive evidence and/or examples of each sector strategy to demonstrate the feasibility and impacts of each potential sector strategy. The cross-cutting workforce development strategies are followed by sector-specific workforce development strategies for the priority sectors identified by NJDEP. Taken together, the Heldrich Center offers these cross-cutting and sector-specific workforce development strategies as a path forward for investment in building the resilience of the existing and future green workforce in the state of New Jersey.

The Heldrich Center has evaluated the following workforce strategies with OBCs in mind for the recommendation actions associated with each workforce development strategy. For this work, the Heldrich Center conducted a limited number of interviews with community-based institutions to incorporate the OBC perspective into the workforce planning analysis. Additionally, the Heldrich Center team relied on learnings from recent projects focused on workforce equity. Lastly, the recommendations included in this analysis also pull from the Heldrich Center's institutional knowledge and expertise in the workforce development space. A core tenet of the Heldrich Center's research approach is to ensure that equity and inclusion are at the forefront of the research processes and that the resulting products represent the voices from the communities that the work aims to serve.

Summary Table of Workforce Development Strategies

Table 4. Cross-Cutting Workforce Development Strategies

	Strategy	Recommended Action
	Development of the Talent Pipeline	• Create career pathways with secondary and postsecondary institutions in New Jersey. • Investment in vocational training opportunities, awareness and infrastructure at the local level.
	Upskilling the Existing Workforce	• Customized training priorities for the sector's existing workforce to upskill and/or reskill individuals to meet the sector's workforce demand. • Identify cross-skilling and cross-training opportunities for the sector's existing workforce. • Connect the existing sector workforce with existing training programs, and the necessary wraparound services, to upskill and/or reskill.

Cross-Cutting Workforce Development Strategies	Career Awareness Campaigns	• Invest in counselor and teacher professional development to expand and strengthen STEM-related curriculum. • Create career exploration activities for secondary and post-secondary students. • Create career awareness marketing campaigns for public schools. • Develop career readiness and youth apprenticeship programs. • Invest in career mapping.
	Employer Engagement	• Convene sector panels led by sector employers and/or professional associations and organizations to discuss skills and hiring needs. • Foster greater union engagement and community labor agreements. • Explore New Jersey's Workforce Development Partnership Fund for Customized Training grants and Individual Training Grants.
	Connecting Employers to Education	• Create specialized industry partnerships at the state-level to bring together all relevant voices in the field to discuss workforce challenges/needs and identify potential collaborative solutions. • Encourage industry and employer-driven course curriculum development. • Connect industry to the secondary schools to offer professional development for teachers and school counselors. • Encourage employers to offer experiential learning opportunities and externships.
	Locally Driven Career Awareness and Engagement Strategies	• Foster local and regional hiring initiatives and/or requirements for project development and implementation. • Develop local workforce development sector-specific planning groups. • Highlight resources at the local level (One-Stop Career Centers, public libraries, vocational-technical schools, community-based organizations, faith-based organizations, etc.) that should be cultivated to support the workforce development infrastructure needed to support sector employment at the local level. • Establish One-Stop Career Center connection sites to broaden community-based touch points for

		individuals thinking about engaging in training and/or entering the sector and target career awareness campaigns to One-Stop Career Center job coaches, and job coaches at community-based organizations that provide job search assistance to OBCs to equip them with the labor market information they need to provide coaching to potential training participants and job seekers. • Consider professional development opportunities for staff at the secondary and postsecondary levels to educate on cutting edge skills and careers in related priority measure occupations and skills.
	Engagement with State and Local Workforce Development Systems	• Develop on-the-job (OJT) training opportunities. • Develop federally registered apprenticeships. • Engage with the Eligible Training Providers List (ETPL) for training opportunities in specific sectors. • Connect with local job seeker communities. • Incentivize training opportunities and prioritize outreach for training in OBCs.
	High-Touch Supportive/ Wraparound Services	• Engage with community-based organizations as trusted entities within the traditionally untapped communities of potential workers, i.e., OBCs. • Conduct a community barriers analysis with a focus on childcare, transportation, mental health supports, and drug rehabilitation services.

Cross-cutting Workforce Development Strategies

Below are a series of cross-cutting workforce development strategies that are applicable to the sectors included in NJDEP's priority climate action measures. Each workforce development strategy is associated with a series of recommended actions. These actions provide a path forward for greater investment and alignment in workforce, employer, and sector needs.

Development of the Talent Pipeline

- **Create career pathways with secondary and postsecondary institutions in New Jersey.**
  - Example: New Jersey's secondary and postsecondary institutions, working with sector employers and relevant stakeholders, should invest in creating clear career pathway programs for clean energy jobs so that individuals can learn about the possible opportunities available to them at an early age. FutureReadyNYC is an example of integrating career-focused education and work experience in secondary institutions. Collaboratively, New Jersey's secondary and postsecondary institutions, employers, and relevant sector stakeholders should partner and invest in mapping out careers in clean

energy so that the aforementioned learning institutions can continue to point learners to those pathways. An example of career mapping in clean energy was done by the Office of Energy Efficiency and Renewable Energy. The career mapping should be widely disseminated to relevant stakeholders including secondary and post-secondary teachers and counselors, employers and human resource professionals, and job coaches and career counselors.

- **Investment in vocational training opportunities, awareness, and infrastructure at the local level.**
    - Example: Vocational programs are regarded as playing a critical role in the workforce development pipeline for several key industries in New Jersey. Aligning this component of the workforce development and education ecosystem will be critical to ensure that individuals are properly trained for the jobs of the future. A recent publication from the Organization for Economic Co-operation and Development (OECD), Building Future-Ready Vocational Education and Training Systems, highlights the critical role vocational education and training play in developing the skillsets needed for the labor market, but also points to a need to modernize and re-engineer vocational education and training opportunities to maximize their impact and ensure they are responsible to the changing labor market. This is a key area of partnership for sector stakeholders to consider.

Upskilling the Existing Workforce

- **Customize training priorities for the sector's existing workforce to upskill and/or reskill individuals to meet the sector's workforce demand.**
    - Example: Working with education institutions such as the county colleges, vocational-technical schools, and others, sector stakeholders can collaborate to create customized training opportunities to upskill and reskill the existing workforce to meet the demand for new jobs requiring new skills. Such partnership would foster greater alignment to ensure that the training pipeline is primed to meet the needs of industry. In New Jersey, sector stakeholders should explore the Workforce Development Partnership Program for customized training grants and individual training grants. Moreover, as another example, Iowa's fifteen community colleges have worked in partnership with employers to upskill workers through customized technical and professional training opportunities. One county college in Iowa, Southwestern Community College, worked with seven local businesses to train 216 employees in customized training courses that included welding, CPR and first aid, electrical, leadership, and English and Spanish language skills. This model of education and partnership should be investigated further and replicated in any sector requiring upskilling of the existing workforce.
- **Identify cross-skilling and cross-training opportunities for the sector's existing workforce.**
    - Example: To build a more resilient workforce, sector stakeholders can work to identify cross-skilling and cross-training opportunities for the existing sector workforce to ensure that none are left out in the transition to newer technologies. Methodologies to employ cross-skilling and/or cross-training opportunities include, but are not limited to, on-the-job training, train your trainers model, cohort-based learning exercises, and so on. As is the mandate in the Council's Green Jobs For A Sustainable Future, New Jersey must

maximize the green future and the associated opportunities for organized labor, while specifically leaving no potential worker behind.

- **Connect the existing sector workforce with existing training programs, and the necessary wraparound services, to upskill and/or reskill.**
  - Example: Sector employers and stakeholders, working in partnership with state agencies, specifically the New Jersey Department of Labor and Workforce Development (NJDOL), should consider the ways funds and incentives should be directed to support the upskilling and reskilling of the existing workforce in these priority green sectors. Stipends, paid training opportunities, and/or supportive wraparound supports, i.e., childcare, transportation, and counseling supports amongst others, can be constructed in these priority sectors to ensure that the existing workforce can continue in the labor force. The Green Jobs For A Sustainable Future report noted that stakeholders called for, "Public policies to support workforce development include federal- or state-level workforce plans and policies, transition policies and reports, and tax incentives or subsidies for businesses to create internships and apprenticeships for green jobs," (2022, p.38).[38]

Career Awareness Campaigns

- **Invest in counselor and teacher professional development to expand and strengthen Science, Technology, Engineering and Math-related (STEM) curriculum.**
  - Example: In collaboration, Columbia University and Cornell University offer the Columbia-Cornell STEM Teacher Workshop which is available in the spring and fall and has hosted more than seventy New York City teachers. The workshop is a professional development opportunity for K-12 teachers to learn more about STEM fields to inform the development of curricula in their respective classrooms. Offerings such as this should be created and/or expanded in New Jersey's education institutions.
- **Create career exploration activities for secondary and post-secondary students.**
  - Example: In partnership with the New Jersey Department of Labor and Workforce Development and/or the New Jersey Department of Education, sector stakeholders and other relevant parties should work to create more robust career exploration activities for students in the state seeking information and learnings about potential career pathways. The Ohio Department of Education and Workforce maintains a series of webpages for Grades K-5, Grades 6-8, and Grades 9-12 with a range of activities and content for students seeking information about in-demand jobs in Ohio.
- **Create career awareness marketing campaigns for public schools.**
  - Example: The New Jersey Department of Education (NJDOE) provides the New Jersey Career Assistance Navigator (NJCAN) website free to all middle and high schools in New Jersey that allows them to explore careers and education. NJDOE should prioritize updating NJCAN to include career profiles, videos, interviews with current workers, and education programs related to New Jersey's climate-related occupations. NJDOE should use NJCAN as a tool to raise career awareness about climate-related workforce opportunities among New Jersey's students and deploy a targeted career exploration

[38] https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf

curriculum directly related to the climate workforce and ensure that middle school students across New Jersey have the opportunity to access all or portions of it.

- **Develop career readiness and youth apprenticeship programs.**
    - Example: New York's Career Readiness and Modern Youth Apprenticeship (CRMYA) is a new multi-year initiative for the 2022-2023 school year that gives students the opportunity to receive advanced training and paid work experiences as part of their public-school education. More specifically, schools participating in CRMYA offer career readiness courses, early college credit courses and apprenticeship opportunities to their students.
- **Invest in career mapping.**
    - Example: The City University of New York Graduate Center created a career map for the Medical Assistant position. This map includes potential career pathways and related occupations. A career map such as this example is a great illustrative tool for career pathway education. This career mapping can be led by education institutions, employers, or both working in partnership to provide greater clarity to potential career pathways for sector employment, thereby promoting career awareness overall.

Employer Engagement

- **Convene sector panels led by sector employers and/or professional associations and organizations to discuss skills and hiring needs.**
    - Example: Coordinate panel discussions with sector employers focused on the skill and hiring needs they face in expanding their workforce. Public-private partnerships that bring together employers, education, and other sector stakeholders are critical in moving a sector forward to be able to meet the changing needs of sector employers. Applying the Business Industry Leadership Team (BILT) approach is one evidence-based model the State should explore. In this approach, a team of public private partnerships provide a platform for employers to apply a systematic approach with training providers and other key stakeholders to identify and prioritize the knowledge, skills and abilities workers in climate-related occupations need and develop cutting-edge training curricula that employers will recognize to hire for high-priority jobs.
- **Foster greater union engagement and community labor agreements.**
    - Example: Greater engagement and partnership with unions for workforce training will ensure that a highly skilled workforce is in place for green jobs in the state of New Jersey. According to the Green Jobs for a Sustainable Future report,

        > "Union jobs are high-quality jobs. Building and Construction trades, along with many unions, offer members specialized, fully funded training pathways that lead to stable careers with family-sustaining wages and worker protections. These training programs can be especially transformative for the green economy if they also provide greater access to unions for non-union workers" (2022, p 12)[39].

[39] https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf

Facilitated by unions, established training programs, registered apprenticeships, and career pathways will be a critical avenue for workforce development in the green economy.

- **Explore New Jersey's Workforce Development Partnership Fund for Customized Training grants and Individual Training Grants.**
    - Example: Provided by NJDOL, the Workforce Development Partnership Fund provides funding that supports job training efforts in the state. More specifically, according to NJDOL documentation "The Workforce Development Partnership (WDP) program, which is funded through a dedicated assessment on workers and their employers, is a key component in the State's effort to train workers and job seekers and to help individuals move from welfare to work. In addition, the customized training segment of the WDP program provides matching grants to employers to upgrade the skills of their workforce and provides funding to prepare New Jersey's workforce for emerging industries such as those in the "Green Economy" (NJDOL, p. D—215)[40]. Customized training opportunities and individual training grants available through the Workforce Development Partnership Fund is avenue that sector stakeholders should pursue to align the current workforce with emerging job opportunities and their associated in-demand skills.

Connecting Employers to Education

- **Create specialized industry partnerships at the state-level to bring together all relevant voices in the field to discuss workforce challenges/needs and identify potential collaborative solutions.**
    - Example: In 2018, NJDOL established the Talent Networks, a systematic series of targeted industry partnerships in key sectors in New Jersey: Advanced Manufacturing, Health Care, Construction/Utilities, Life Sciences, Financial Services, Retail, Hospitality and Tourism, Food Industry, and Transportation, Logistics and Distribution. This industry-focused approach to align workforce needs, investments, and talent development was an effective model for engaging all relevant stakeholders necessary to identify sector challenges and discuss innovative solutions. This model of industry-focused engagement should be reinvigorated to reflect New Jersey's priorities for clean energy.
- **Encourage industry and employer-driven course curriculum development.**
    - Example: To address issues with the talent pipeline and/or training and skills mismatches in the workforce, employers and industry representatives must be involved in the conversation to create greater alignment in the talent development infrastructure. An example of this alignment can be found in field of automotive manufacturing. Established in the mid-2000s and funded by the National Science Foundation, the Automotive Manufacturing Technical Education Collaborative is an industry collaboration compromised of 55 collegiate partners and 30 industry partners in 15 states. The Collaborative maintains 12 competency-based, modularized, online curricula with labs that are vetted by industry partners.

[40] https://www.nj.gov/treasury/omb/publications/12budget/pdf/62.pdf

- **Connect industry to the secondary schools to offer professional development for teachers and school counselors.**
    - Example: Sector stakeholders should engage with secondary school educators to bridge the perceived gaps in the pipeline for the jobs of the future. Providing professional development opportunities for teachers and school counselors will equip educators to better prepare their students for the careers of the future. This investment in secondary schools and educators would be in accordance with the U.S. Department of Education initiative, Raise the Bar: Unlocking Career Success. This initiative calls for industry and education institutions at all levels to work to align their interests in order to "increase and expand access to high-quality training programs to help young Americans pursue jobs in today's in-demand fields, and be prepared for careers of the future[41].
- **Encourage employers to offer experiential learning opportunities and externships.**
    - Example: Employers should engage with colleges and universities to create experiential learning opportunities and externships to extend and expand the learnings available to individuals looking to enter sector employment. Practical learning opportunities such as these have the distinct benefit of deepening the education of students, but also of adding value to employers who may be interested in hiring individuals upon completion of their education. The National Library of Medicine detailed the value of externships in the healthcare space in an article *The Unique Value of Externships to Nursing Education and Health Care Organizations.* The value and impact of such practical educational opportunities for students and employers alike should be extended to other sectors, particularly in clean energy.

Locally Driven Career Awareness and Engagement Strategies

- **Foster local and regional hiring initiatives and/or requirements for project development and implementation.**
    - Example: The Newark Alliance's Newark 2020 Hire Newark program is a local hiring initiative that prioritized employment opportunities for the citizens of Newark to ensure that economic development in Newark benefitted its residents. Hire Newark maintains a Hire Newark 2020 Talent Pool where the citizens of Newark can submit their credentials for employment to be considered by the initiative's employer partners committed to hiring local residents. This model of service should be replicated for OBCs and the emerging opportunities stemming from New Jersey's green economy investments.
- **Develop local workforce development sector-specific planning groups.**
    - Example: Middlesex County has partnered with RWJBarnabas Health to create the RWJBarnabas Health Workforce Partnership. This partnership brings together 1) local workforce development, 2) student and education representatives, and 3) industry experts, to create educational pathways and curricula designed to effectively train the County's workforce pipeline to meet the growing demand for health care workers in Middlesex County. The partnership also serves to create preferential access for RWJBarnabas to recruit talent from related training programs at Middlesex College.

[41] https://www.commerce.gov/news/press-releases/2022/11/icymi-us-department-education-launches-new-initiative-support-career

- **Highlight resources at the local level (One-Stop Career Centers, public libraries, vocational-technical schools, community-based organizations, faith-based organizations, etc.) that should be cultivated to support the workforce development infrastructure needed to support sector employment at the local level.**
    - Example: To create an accessible asset map for resources available to individuals would facilitate greater understanding of the extent of localized supports geared towards workforce development, and or any other subject of interest. An example of an asset map is NYC OpenData Map Community Resources tool. This tool maps the presence and/or absence of resources across 59 NYC community districts. A tool such as this should be developed to map out workforce development supports across specific communities, such as low income and disadvantaged communities, in order to understand the degree of support and services currently available, and where these supports should be expanded in the future.
- **Establish One-Stop Career Center connection sites to broaden community-based touch points for individuals thinking about engaging in training and/or entering the sector and target career awareness campaigns to One-Stop Career Center job coaches, and job coaches at community-based organizations that provide job search assistance to OBCs to equip them with the labor market information they need to provide coaching to potential training participants and job seekers.**
    - Example: Expanding the presence and reach of One-Stop Career Centers in communities, specifically OBCs, would broaden the potential population that should be supported by the workforce development services made available by this institution. Expansion to libraries and/or community-centers as satellite connection sites is one way to operationalize this engagement strategy. At present, libraries across New Jersey advertise One-Stop Career Center services on their websites, but greater integration should be considered in the future. The Mercer County Library System website is just one example. Local community partnership would be critical in expanding the reach of existing workforce development services.
- **Consider professional development opportunities for staff at the secondary and postsecondary levels to educate on cutting edge skills and careers in related priority measure occupations and skills.**
    - Example: The New York City Department of Environmental Protection offers Climate Change Education Module resources designed for teachers to incorporate in their classrooms. These resources include Climate Change Information and Resources, Climate Science Lessons and Worksheets, and Climate Change Systems Lessons and Worksheets. Moreover, for the 2023-2024 school year, New York City Public Schools instituted Climate Action Days, which are four days to celebrate climate action in every school. The themes for the four days are as follows – Energy, Waste, Health, Wellness, and Green Space, and Water. In this way, the New York public school system has incorporated professional development opportunities and learnings for both educators and students directly around clean energy.

Engagement with State and Local Workforce Development Systems

- **Develop on-the-job (OJT) training opportunities.**

- Example: Sector stakeholders should engage with NJDOL at the state and local level to leverage Workforce Innovation and Opportunity Act (WIOA) funding for On-the-Job (OJT) training opportunities where possible. New Jersey's WIOA Formula-Funded On-the-Job Training Policy provides an overview of the program and insights on participant and employer eligibility. OJT creates experiential learning opportunities for individuals to gain practical experience and the necessary skills to be successful in an employment opportunity. OJT opportunities can serve as on-ramps for historically underserved populations to enter the workforce through a guided learning approach.

- **Develop federally registered apprenticeships.**
  - Example: Sector stakeholders should work with the New Jersey Apprenticeship Network (NJAN) to facilitate the creation and/or continuation of federally registered apprenticeship programs that can be made available to individuals seeking education and training in the priority sectors of New Jersey's green economy. Some of these apprenticeship opportunities already exist or are currently in development for employment in clean energy, but greater attention and resources should be placed in ensuring that these opportunities are available, accessible, and result in meaningful employment.
- **Engage with the Eligible Training Providers List (ETPL) for training opportunities in specific sectors.**
  - Example: Sector stakeholders should ensure that their relevant training opportunities are listed on New Jersey's Eligible Training Providers List (ETPL), so that historically underserved communities may be able to access those opportunities with paid training dollars via their One-Stop Career Center. Connecting with and posting on the ETPL will also make it easier for individuals to search for education and training opportunities with the NJDOL's Training Explorer Tool.
- **Connect with local job seeker communities.**
  - Example: There are untapped pools of talent that sector stakeholders should consider engaging with to ensure that the pipeline of workers for anticipated sector workforce demands are readily met. Sector stakeholders should connect with the One-Stop Career Center in their communities to access the population of individuals engaging in workforce development services. More specifically, sector stakeholders should work with local One-Stop Career Centers to engage with the returning citizen population. An opportunity explicitly stated in Green Jobs For A Sustainable Future report is "focus on wraparound and comprehensive services and support for underserved communities, returning citizens, and transitioning workers to broaden the reach of the green economy," (2022, p. 10)[42]. Relatedly, local community-based organizations, such as New Communities in Newark or ISLES in Trenton and local libraries, are organizations that have direct access to the underemployed and unemployed populations in their respective communities.
- **Incentivize training opportunities and prioritize outreach for training in OBCs.**
  - Example: As part of Governor Phil Murphy's Future of Work Initiative, New Jersey recently created the Lifelong Learning Accounts (LiLA) Pilot Program that offers flexible

[42] https://www.nj.gov/governor/climateaction/documents/CGE%20Roadmap.pdf

dollars to individuals who qualify for the program. Program dollars are intended to assist unemployed or underemployed individuals receive the training, credentials, and supportive services they need to develop their careers. Incentivized and supported training programs, such as the LiLA Pilot Program, are opportunities for individuals in need of support to get the education and training they need to become and/or stay an active member of the labor force in New Jersey. The application of programs like LiLA are critical to sectors in need of talent, lifting up historically underserved populations, to enter or reenter the workforce with the skills needed to fulfill the demands of the sector workforce.

High Touch Supportive/Wraparound Services

- **Engage with community-based organizations as trusted entities within the traditionally untapped communities of potential workers, i.e., OBCs.**
    - Example: To make greater inroads in untapped communities of interest throughout the state, partnership with community-based organizations, such as GreenFaith, will result in more effective collaboration, connection, and results. Organizations like GreenFaith can reach individuals where they are within their own communities to foster productive conversations of opportunities for career development and advancement in the industries and sectors of interest.
- **Conduct a community barriers analysis with a focus on childcare, transportation, mental health supports, and drug rehabilitation services.**
    - Example: Individuals can face barriers when pursuing education and training programs. Common barriers include, but are not limited to, childcare, transportation, and counseling. The U.S. Department of Energy Better Buildings Initiative created the Low-income Energy Affordability Data (LEAD) Tool to better understand low-income household energy characteristics and associated barriers. Conducting a barriers analysis and needs assessment identifies gaps in service provision, particularly related to providing wraparound services, that are factors in individuals' ability to access education, training, and employment.

The above sector strategies are areas for investment that cut across all industries in the energy efficiency sector more broadly. These sector strategies have proven to be effective in bringing greater alignment and synergy to sectors that may be struggling to find the workforce needed to fill employer needs. These outlined strategies cover the full range of workforce interventions, from developing a stronger talent pool and pipeline, creating greater alignment amongst interested parties in the sector, and building a stronger community-based network to meet the rising demand for talented skilled workers in these key growing industries. These workforce development strategies are presented at the state level; however, depending on sector application and stakeholder buy-in, these interventions should be deployed on a county or regional scale.

Targeting workforce development initiatives, such as those outlined above, towards OBCs and/or historically underserved populations would ensure that all populations can participate in the prosperity derived from the emergence of the green economy and reap the benefits of the high-quality family-sustaining jobs this emerging sector will create in New Jersey. These workforce initiatives bring more equitable access to opportunities for the entire workforce pipeline, from career awareness for students enrolled in secondary learning institutions through upskilling the existing workforce to ensure that no one is left behind in the transition to green technologies. There is an opportunity to ensure that the benefits of clean energy going towards OBCs are multi-faceted. With an emphasis on workforce opportunities, these benefits can take the form of education and training for in-demand jobs, paid learning opportunities, high-quality jobs, well-paying jobs, continued opportunities for professional development, and more. Investment in creating a more equitable highly skilled workforce is a first step in ensuring that these historically underserved populations are an integral part of the workforce pipeline for the green jobs of the future in New Jersey.

Sector-Specific Workforce Development Strategies

As previously mentioned, NJDEP has identified the following six sectors as priority sectors – Transportation, Buildings, Electric Generation, Food Waste, Halogenated Gases, and Natural and Working Lands. NJDEP has also identified associated priority measures within each sector. The Heldrich Center's sector-specific workforce development strategies are not exhaustive, but rather offer broad workforce priorities and initiatives for each of the priority sectors identified by NJDEP. These sector-specific strategies have been informed by the learnings from the previous tasks outlined in this research. These strategies can be further refined as more is known about the level of investment in each priority sector and priority action measure by NJDEP.

Transportation

Create and/or expand specialized workforce training programs for electric vehicles (EVs).

To support the expansion of electrical vehicle charging stations in the state of New Jersey, a specialized workforce training program can be created to ensure that interested individuals have the opportunity to receive the training needed to be an electrician, with specialization in electrical vehicle charging station infrastructure support and maintenance. The workforce training program can be created in partnership with the New Jersey Department of Labor and Workforce Development system to ensure that the training is available on the state's Eligible Training Provider List (ETPL), thereby expanding its availability to the populations engaged with public workforce development services, with specific regard to OBCs. Ensuring that trainings are included in the ETPL increases equitable access to these opportunities if the state is able to pay for trainings for individuals who meet certain program criteria, such as those enrolled in Workforce Investment and Opportunity Act (WIOA) services.

Opportunity and awareness go hand-in-hand when examining how to generate a more robust talent pipeline for key sectors in clean energy. Education and training opportunities must be present for individuals to engage in such learning opportunities; however, it is also critical that core communities are aware that there are pathways to education and careers available to them. As Transportation is a major investment area for the green economy and the goals laid out in New Jersey's Global Response Act 80x50 Report, greater awareness for education, training, and occupations in this critical sector is an underpinning of a successful workforce development strategy that cannot be overlooked.

Buildings

Support and strengthen workforce development infrastructure for electrifying residential and commercial buildings.

Research shows that there are specific challenges, particularly around skills gaps and licensing, that hinder the education-to-career pipeline and set back large-scale efforts towards electrification and decarbonization. For example, HVAC technicians may not receive sufficient training on the latest heat pump technologies that reduce carbon emissions in homes. There are also significant licensing barriers, as counties and municipalities in New Jersey have different building and construction requirements. The same research suggests that these skills, especially technological expertise, and licensing are required to keep pace with the demand for a highly skilled workforce to reduce carbon emissions from residential and commercial buildings through electrification.[43]

For these reasons, continued and expanded investment in state-funded federally registered apprenticeships for occupations such as HVAC technicians is an area of key consideration. In recent years, the New Jersey Department of Labor and Workforce Development has incentivized the creation of federally registered apprenticeships in non-traditional industries/sectors associated with Buildings and Grid.[44] Once such programs are funded and operational, it is critical that these state-funded federally registered apprenticeships target recruitment and participation among OBCs in New Jersey. A federally registered apprenticeship opportunity is an onramp to a high-quality job with a family-sustaining wage; therefore, equitable access to a career pathway such as this is paramount.

Electric Generation

Invest in the creation of solar design and installation training programs that provide a clear training-to-career pipeline in New Jersey.

According to the Solar Energy Industries Association, New Jersey is a leader in solar and ranks in the top 10 for solar states.[45] The solar market continues to grow in the state, with 2023 data showing 462 solar companies in New Jersey and 7.55% of the state's electricity being derived from solar.[46] If New Jersey is going to continue to invest in solar with actions, such as expanding the Community Solar Energy Program and installing solar infrastructure at state and local government facilities, the demand for a skilled workforce to support such technologies will be critical. According to the Office of Energy Efficiency & Renewable Energy, depending on the career in question, training for solar jobs can include, but is not limited to, high school career technical education program, an undergraduate or graduate degree program, a work-based learning program, or a continuing education course for working professionals.[47] The Office of Energy Efficiency & Renewable Energy further offers data from the 2020 Solar Jobs Census, which shows that 67% of solar industry jobs are in installation and project

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[43] https://www.nrel.gov/docs/fy22osti/80480.pdf
[44] https://www.nj.gov/labor/forms_pdfs/apprenticeship/apprenticeshipfaqs.pdf
[45] https://www.seia.org/state-solar-policy/new-jersey-solar
[46] https://www.seia.org/state-solar-policy/new-jersey-solar
[47] https://www.energy.gov/eere/solar/solar-design-and-installation-training

development, and an additional 7% of jobs are in system operations and maintenance.[48] Moreover, Solar Career Map highlights 40 jobs across four solar industry sectors and identifies over 60 routes to advancement.[49] Taken together, these data show the need for a robust training pipeline, at all levels of education, to support further investment in solar career pathways that lead to employment. With New Jersey's current and future investment in solar, developing a robust training infrastructure in the state to support the future workforce will be a critical step in New Jersey's solar energy goals.

Food Waste

An awareness and education campaign to highlight the development of food waste processing facilities, better food waste practices, and energy recovery efforts from wastewater treatment facilities.

As outlined in the New Jersey's Global Response Act 80x50 Report, there are multiple avenues that NJDEP and other relevant stakeholders will pursue to reduce emissions in the agriculture and waste sectors. With the adoption of new practices and technologies, there will be a need for a trained workforce to support these efforts, such as staffing food waste facilities, installing and maintaining new refrigerant technologies, and maximizing energy recovery from existing facilities. The existing workforce can be reskilled to support the changing technology landscape with targeted investments from sector employers and education and training institutions. Industry and education should work in partnership to ensure that the existing workforce, as well as the future workforce, has the right opportunities to find meaningful employment in the sectors undergoing changes to both reduce and prevent future emissions.

Halogenated Gases

Incentivize low-global warming potential (GWP) refrigerant products to drive demand and transition workforce training programs to support new technologies.

Creating and incentivizing a low-GWP refrigerant program would drive the demand for the adoption of new technologies. Relatedly, existing workforce training programs should be adjusted and/or new programs stood up to support the maintenance of new technologies. This would ensure that the new and/or current workforce keeps pace with changing technologies in the relevant sector.

According to Occupational Information Network (O*Net), critical skills in Heating, Ventilation, and Air Conditioning (HVAC)-related occupations include, but are not limited to, Operations Monitoring, Troubleshooting, and Installation. Technology Skills for HVAC-related occupations include, but are not limited to, facilities management software (Computerized maintenance management system (CMMS), facility energy management software, Johnson Controls Metasys, ManagerPlus) and industrial control software (Alerton Ascent Compass; Building automation software, Honeywell WEBs-N4, Siemens APOGEE Building Automation Software.)[50]

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[48] https://www.energy.gov/eere/solar/solar-design-and-installation-training
[49] https://www.irecsolarcareermap.org/
[50] https://www.onetonline.org/link/summary/49-9021.00?redir=49-9021.01

These are core skills and competencies are just a few to ensure are readily available in the training and education infrastructure present in New Jersey. Moreover, with the adaptation of new technologies, the trainings in these core competencies should be monitored and/or updated where necessary. Trainings associated with new technologies, specifically the manufacturing and installation of low-GWP HVAC technologies, and the abilities to repair leakages in existing systems, will address the foreseeable workforce needs in the area of Halogenated Gases.

Natural and Working Lands

Develop a federally registered apprenticeship program.

Through the Climate Action Resource Center's stakeholder sessions, stakeholders suggested that there need to be additional onramps and career pathways to working in the Natural and Working Lands sector. The development of a federally registered apprenticeship program is an accessible entrance point with vast potential reach due to the lower barriers to entry. NJDEP, working in partnership with the NJDOL, should engage with the New Jersey Future Farmers of America to collaboratively create a federally registered apprenticeship program. Partnership with New Jersey Future Farmers of America and other organizations with closer ties to the communities in which they serve would ensure that the creation of an apprenticeship program addresses the needs of the local residents who would engage in such a program, with particular regard to OBCs. Moreover, NJDOL and/or NJDEP should allocate funding for employers and firms in the Natural and Working Lands sector to hire interns or apprentices. Financial investment, along with an awareness campaign, would likely drum up interest and support for engagement with the program for the benefit of the sector at large.

This is not a comprehensive assessment of workforce development initiatives that could take place in each of these priority sectors, but rather an assessment of possible avenues NJDEP and relevant stakeholders can take once more in known about future investments of resources. Further information is needed to associate workforce initiatives with each priority measure selected by NJDEP and the development of any effective strategies must be closely aligned with skill demands of sector employers and supply demands of job seeker advocacy and service organizations. This task could be completed in the Comprehensive Climate Action Plan (CCAP).

Modeled Labor Changes

Task: Modeling the anticipated labor changes necessary to realize those measures

As previously mentioned in this research, NJDEP has identified 12 priority clean energy measures for potential funding under the federal Climate Pollution Reduction Grant (CPRG) program. The following modeled labor changes were originally drafted based upon a previous iteration of priority action measures in which 17 priorities were listed. Researchers have included updated measures and enabling actions, where possible, as there is overlap in the previous iteration of measures and those finalized by NJDEP, but this analysis can be further refined for the Comprehensive Climate Action Plan. This analysis provides a baseline understanding of anticipated labor changes in the priority sectors identified by NJDEP.

This research is intended to inform the effort to estimate the workforce impacts of the expenditures to be made on those priority measures. CPRG funding applications have not yet been completed, and it is anticipated that the list of priority measures will be further narrowed. In addition, the amount of funding to be sought has not yet been determined. As such, rather than providing estimates of total workforce impact, this research provides estimated workforce impacts per $1 million of spending on each type of CPRG-funded priority measure, with the expectation that these estimates can be used in the next stage of the work as a tool to estimate total workforce impacts once the priority measure expenditure amounts have been determined.

Priority measures with the same distribution of expenditures across industries are grouped together. Workforce impact estimates for each priority measure are provided in terms of ***job-years*** supported per $1 million in expenditures. A job-year is equivalent to one job lasting one year. It expresses the employment impacts of investments (i.e., one-time project expenditures); a job-year is, thus, distinct from a permanent job that is supported by recurring operating expenditures. For each priority measure, we provide the estimated number of direct and indirect and induced job-years likely to be supported by the initial expenditures. We also provide breakdowns of the supported job-years by industry and occupation.

Net Impacts of Certain Programs

For some priority measures, it is highly likely that the job impacts generated by any program expenditures would not represent a net increase in employment, but rather a replacement of employment on one type of project or technology with employment associated with another type of technology. In most cases, this is the result of substituting different (greener) equipment/technology (e.g., electric vehicle charging stations for gasoline stations). The assumption in such substitution is that the installation of the new equipment takes place with the same schedule as the installation of traditional equipment – i.e., when existing equipment is due to be replaced. If a program accelerates the replacement schedule, net employment gains will arise more quickly.

Priority Areas with Workforce Impact Estimates

Priority Measure and/or Enabling Action: High-Powered Charging Hubs for MDV/HDV

Notes

This program would fund installation of charging infrastructure for NJ's medium- and heavy-duty electric vehicles. *Note that to the extent that such charging facilities would be built instead of traditional gas stations, the estimated impacts would not represent a net increase in workforce needs. However, the rapid expansion of the EV fleet will likely accelerate the need for new charging facilities resulting in a net increase in workforce demand.* Impacts per million dollars are based on the cost estimates shown below for a 350 kW direct current fast charger (DCFC) as cited in an Idaho National Laboratory study of 2022[51]. **Note that 68% of the cost of an installation go toward the purchase of the charging unit. We assume they are manufactured outside New Jersey. As a result, only a small portion of costs result in labor impacts with the state.** The Idaho National Laboratory study indicates that installation labor includes both electrical and other related construction labor, and that material includes wiring, electrical components and other construction material apart from the charger itself. The costs do not appear to include construction of a full "gas station" type complex but are specific to the installation of a charging unit and necessary surroundings. We allocate 85% of labor and 90% of material to electrical contractors and equipment, with the remainder allocated to construction labor and materials (asphalt, concrete). Expenditures in material sectors are subject to regional purchase coefficients.

Item	Cost* (Idaho Natl. Lab report)	Per-Million Basis
DCFC Charger	$140,000	$681,133
Labor	$27,840	$135,448
Materials	$37,700	$183,419
Total	**$205,540**	**$1,000,000**

* Excludes nominal permit and tax estimates cited in the Idaho National Laboratory Report.

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Excluded from Model (DFC Charger)	$681,133
Electrical contractors	$115,131
Transportation structures and highway and street construction	$20,317
Communication and energy wire and cable mfg.	$55,026
Wiring device mfg.	$55,026
All other miscellaneous electrical equipment and component mfg.	$55,026
Asphalt paving mixture and block mfg.	$9,171
Ready-mix concrete mfg.	$9,171
Total	**$1,000,000**

[51] Schey, S. et al., *Breakdown of Electric Vehicle Supply Equipment Installation Costs*, Idaho National Laboratory, August 2022. https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_63124.pdf

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
0.92	0.95	1.87

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	0.00	0.00	0.00
Mining	0.00	0.00	0.00
Utilities	0.00	0.00	0.00
Construction	0.70	0.03	0.73
Manufacturing	0.22	0.07	0.29
Wholesale Trade	0.00	0.06	0.06
Retail Trade	0.00	0.13	0.13
Transportation and Warehousing	0.00	0.07	0.07
Information	0.00	0.01	0.01
Finance and Insurance	0.00	0.05	0.05
Real Estate and Rental and Leasing	0.00	0.06	0.06
Professional and Technical Services	0.00	0.09	0.09
Administrative and Waste Services	0.00	0.07	0.07
Educational Services	0.00	0.02	0.02
Healthcare and Social Assistance	0.00	0.13	0.13
Arts, Entertainment and Recreation	0.00	0.02	0.02
Accommodation and Food Service	0.00	0.06	0.06
Other Services	0.00	0.06	0.06
Government	0.00	0.03	0.03
Total	**0.92**	**0.95**	**1.87**

* Totals may not sum due to rounding.

Priority Measure and/or Enabling Action**: eMobility Programs**

Notes

eMobility programs would "fund electric ride-sharing and ride-hailing based on analysis of multi-unit dwellings, overburdened communities, local needs and regulations, etc." ***Note that if these funded transportation services using electric vehicles replace existing activity using traditional gas-powered vehicles, there would likely be no net workforce impacts.*** If the electric ride-sharing and ride-hailing services were in addition to existing services, there would be a net increase in workforce requirements (drivers, support, etc.). ***The estimates presented below assume that the services are in addition to already existing capacity. The high level of direct employment effects results from the relatively lower wage levels and part-time work arrangements prevalent in the sector.***

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Transit and ground passenger transportation	$1,000,000

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
29.40	3.70	33.10

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	0.00	0.01	0.01
Mining	0.00	0.00	0.00
Utilities	0.00	0.01	0.01
Construction	0.00	0.06	0.06
Manufacturing	0.00	0.08	0.08
Wholesale Trade	0.00	0.09	0.09
Retail Trade	0.00	0.39	0.39
Transportation and Warehousing	29.40	0.20	29.60
Information	0.00	0.05	0.05
Finance and Insurance	0.00	0.57	0.57
Real Estate and Rental and Leasing	0.00	0.29	0.29
Professional and Technical Services	0.00	0.29	0.29
Administrative and Waste Services	0.00	0.46	0.46
Educational Services	0.00	0.07	0.07
Healthcare and Social Assistance	0.00	0.46	0.46
Arts, Entertainment and Recreation	0.00	0.07	0.07
Accommodation and Food Service	0.00	0.23	0.23
Other Services	0.00	0.25	0.25
Government	0.00	0.11	0.11
Total	**29.40**	**3.70**	**33.10**

* Totals may not sum due to rounding.

Priority Measure and/or Enabling Action: **Grid-Supportive Technology Program**
Priority Measure and/or Enabling Action: **Technical Assistance Program**

Notes

Expenditures in these priority areas are primarily intended for technology evaluation pilot projects and assistance in citing EV charging stations. These types of activities fall broadly under the rubric of technical consulting. As is generally the case with service sectors, a large portion of industry expenditures is allocated to compensation (i.e., the sector is labor-intensive, rather than capital-intensive), resulting in relatively high employment impacts per $1 million of expenditure. We assume that such services are provided on-site, thus direct expenditures support employment within the state as opposed being generated in, say, New York City or Philadelphia.

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Environmental and Other Technical Consulting Services	$1,000,000

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
7.25	5.65	12.91

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	0.00	0.02	0.02
Mining	0.00	0.00	0.00
Utilities	0.00	0.01	0.01
Construction	0.00	0.05	0.05
Manufacturing	0.00	0.13	0.13
Wholesale Trade	0.00	0.13	0.13
Retail Trade	0.00	0.55	0.55
Transportation and Warehousing	0.00	0.30	0.30
Information	0.00	0.07	0.07
Finance and Insurance	0.00	0.33	0.33
Real Estate and Rental and Leasing	0.00	0.38	0.38
Professional and Technical Services	7.25	0.83	8.08
Administrative and Waste Services	0.00	0.82	0.82
Educational Services	0.00	0.12	0.12
Healthcare and Social Assistance	0.00	0.77	0.77
Arts, Entertainment and Recreation	0.00	0.14	0.14
Accommodation and Food Service	0.00	0.44	0.44
Other Services	0.00	0.40	0.40
Government	0.00	0.15	0.15
Total	**7.25**	**5.65**	**12.91**

* Totals may not sum due to rounding.

Priority Measure and/or Enabling Action**: Workforce Training Program**

Notes

Expenditures in this priority area are described as "funding to develop curricula, support pre-apprenticeship programs, and promote electrician pathways to become certified to install EV charging stations." These types of activities fall broadly under the rubric of technical/vocational training and are most consistent with the higher education sector that includes professional schools. As is generally the case with service sectors, a large portion of industry expenditures is allocated to compensation (i.e., the sector is labor-intensive, rather than capital-intensive), resulting in relatively high employment impacts per $1 million of expenditure. We assume that such services are provided on-site, thus direct expenditures support employment within the state as opposed being generated in, say, New York City or Philadelphia.

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Junior colleges, colleges, universities, and professional schools	$1,000,000

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
7.26	3.85	11.11

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	0.00	0.02	0.02
Mining	0.00	0.00	0.00
Utilities	0.00	0.02	0.02
Construction	0.00	0.06	0.06
Manufacturing	0.00	0.09	0.09
Wholesale Trade	0.00	0.10	0.10
Retail Trade	0.00	0.44	0.44
Transportation and Warehousing	0.00	0.18	0.18
Information	0.00	0.04	0.04
Finance and Insurance	0.00	0.23	0.23
Real Estate and Rental and Leasing	0.00	0.59	0.59
Professional and Technical Services	0.00	0.26	0.26
Administrative and Waste Services	0.00	0.24	0.24
Educational Services	7.26	0.13	7.39
Healthcare and Social Assistance	0.00	0.64	0.64
Arts, Entertainment and Recreation	0.00	0.10	0.10
Accommodation and Food Service	0.00	0.32	0.32
Other Services	0.00	0.25	0.25
Government	0.00	0.14	0.14
Total	**7.26**	**3.85**	**11.11**

* Totals may not sum due to rounding.

Priority Measure and/or Enabling Action: Planting Street/Shade Trees
Priority Measure and/or Enabling Action: Restoring Degraded Forested Lands
Priority Measure and/or Enabling Action: Completing Tidal Reconnection Projects
Priority Measure and/or Enabling Action: Installing Living Shoreline Projects

Notes

Expenditures in these priority areas would be primarily devoted to the production, acquisition and planting of trees in urban, natural and agricultural environments. Because there are currently no details available about the operations of these programs, we allocate 50% to the Services to Buildings and Dwellings sector that includes landscaping services, and 50% to the Greenhouse sector that produces and distributes saplings. As is generally the case with service sectors, a large portion of industry expenditures is allocated to compensation (i.e., the sector is labor-intensive, rather than capital-intensive), resulting in relatively high employment impacts per $1 million of expenditure. We assume that such services are provided on-site, thus direct expenditures support employment within the state as opposed being generated in, say, New York City or Philadelphia.

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Services to Buildings and Dwellings (includes landscaping services)	$500,000
Greenhouse, Nursery and Floriculture Production	$500,000

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
14.51	5.05	19.56

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	9.22	0.82	10.04
Mining	0.00	0.00	0.00
Utilities	0.00	0.02	0.02
Construction	0.00	0.06	0.06
Manufacturing	0.00	0.13	0.13
Wholesale Trade	0.00	0.25	0.25
Retail Trade	0.00	0.65	0.65
Transportation and Warehousing	0.00	0.28	0.28
Information	0.00	0.05	0.05
Finance and Insurance	0.00	0.24	0.24
Real Estate and Rental and Leasing	0.00	0.44	0.44
Professional and Technical Services	0.00	0.38	0.38
Administrative and Waste Services	5.28	0.46	5.74
Educational Services	0.00	0.09	0.09
Healthcare and Social Assistance	0.00	0.50	0.50

Arts, Entertainment and Recreation	0.00	0.09	0.09
Accommodation and Food Service	0.00	0.26	0.26
Other Services	0.00	0.25	0.25
Government	0.00	0.10	0.10
Total	**14.51**	**5.05**	**19.56**

* Totals may not sum due to rounding.

Priority Measure and/or Enabling Action: **Support Development of Distributed Energy Resources**

Notes

Forbes Home provides an overview of costs for a Generac PWRCell backup storage unit for residential use.[52] They estimate average total costs with installation of $18,000 and cite installation costs ranging from $12,000 to $20,000. Other estimates put the typical cost of a battery at $10,000 to $20,000 before installation.[53] These estimates do not include solar panels if the unit is to be integrated with solar charging. For purposes of this analysis, we assume the midpoints of the cited ranges for the battery itself ($15,000) and the installation cost ($16,000), and scale these to shares of the $1 million in expenditures. Battery costs are allocated to the storage battery manufacturing sector (subject to the regional purchase coefficient for the sector) and installation costs are allocated to the electrical contracting sector.

Distribution of $1 million in Expenditures by Model Sector

Item	Cost/Expenditure (Forbes Home/CNET)	Per-Million Basis
Storage Battery	$15,000	$483,871
Installation	$16,000	$516,129
Total	**$31,000**	**$1,000,000**

* Excludes nominal permit and tax estimates cited in the Idaho National Laboratory Report.

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Storage Battery Manufacturing	$483,871
Electrical contractors	$516,129
Total	**$1,000,000**

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
2.65	2.49	5.14

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	0.00	0.01	0.01
Mining	0.00	0.00	0.00

[5252] https://www.forbes.com/home-improvement/solar/generac-pwrcell-battery-cost/
[53] https://www.cnet.com/home/energy-and-utilities/backup-battery-vs-generator-which-emergency-power-option-is-better/

Utilities	0.00	0.01	0.01
Construction	2.61	0.12	2.73
Manufacturing	0.03	0.12	0.16
Wholesale Trade	0.00	0.13	0.13
Retail Trade	0.00	0.42	0.42
Transportation and Warehousing	0.00	0.15	0.15
Information	0.00	0.03	0.03
Finance and Insurance	0.00	0.12	0.12
Real Estate and Rental and Leasing	0.00	0.17	0.17
Professional and Technical Services	0.00	0.23	0.23
Administrative and Waste Services	0.00	0.17	0.17
Educational Services	0.00	0.05	0.05
Healthcare and Social Assistance	0.00	0.35	0.35
Arts, Entertainment and Recreation	0.00	0.06	0.06
Accommodation and Food Service	0.00	0.15	0.15
Other Services	0.00	0.15	0.15
Government	0.00	0.06	0.06
Total	**2.65**	**2.49**	**5.14**

* Totals may not sum due to rounding.

Priority Measure and/or Enabling Action: Grid Modernization and Infrastructure Investments

Notes

Activity in this priority area is described as “Work with utilities to identify distribution circuits of high priority for upgrading to support increased DER Load, covering 50% or more of investments.” Assuming that the program is limited to identifying circuits for upgrade, rather than performing the actual upgrades, this activity would be classified as consulting in the engineering services sector. As is generally the case with service sectors, a large portion of industry expenditures is allocated to compensation (i.e., the sector is labor-intensive, rather than capital-intensive), resulting in relatively high employment impacts per $1 million of expenditure. We assume that such services are provided on-site, thus direct expenditures support employment within the state as opposed being generated in, say, New York City or Philadelphia.

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Architectural, engineering and related services	$1,000,000

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
6.07	5.60	11.68

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	0.00	0.02	0.02
Mining	0.00	0.00	0.00
Utilities	0.00	0.01	0.01
Construction	0.00	0.05	0.05
Manufacturing	0.00	0.14	0.14
Wholesale Trade	0.00	0.14	0.14
Retail Trade	0.00	0.49	0.49
Transportation and Warehousing	0.00	0.29	0.29
Information	0.00	0.07	0.07
Finance and Insurance	0.00	0.29	0.29
Real Estate and Rental and Leasing	0.00	0.43	0.43
Professional and Technical Services	6.07	0.93	7.01
Administrative and Waste Services	0.00	0.91	0.91
Educational Services	0.00	0.11	0.11
Healthcare and Social Assistance	0.00	0.70	0.70
Arts, Entertainment and Recreation	0.00	0.12	0.12
Accommodation and Food Service	0.00	0.45	0.45
Other Services	0.00	0.30	0.30
Government	0.00	0.14	0.14
Total	**6.07**	**5.60**	**11.68**

* Totals may not sum due to rounding.

Priority Measure and/or Enabling Action: Wastewater Treatment Project

Notes

This program would fund installation of anaerobic digesters and energy recovery systems at wastewater treatment facilities for possible sale of power back to the grid. A 2014 study by Tighe & Bond for the city of Eastham, Massachusetts, provides an aggregate cost breakdown for an anaerobic digester with a cogeneration unit.[54] Details on costs of digester components beyond the digester (tank) itself were not available. The full cost of the "Digester System" reported by Tighe & Bond (p. 8-4) is included in the Metal Tank (Heavy Gauge) Manufacturing sector (NAICS 332420), which explicitly includes industrial-type digesters. The wastewater treatment plant modifications noted in the cost breakdown ("WWTF Modifications") are defined as "piping improvements" to connect the digester and treatment plant. We allocate 50% of these costs to labor and 50% to PVC pipe. Digester system and cogeneration unit (generator) are allocated to appropriate industries, with proportions of in-state spending determined by the model's regional purchase coefficients. Selective Catalytic Reduction system is allocated to the auto mfg. sector that includes catalytic converters. 25% of site work and installation labor was allocated to electrical contracting associated with the cogeneration unit, with the remainder allocated to other nonresidential construction.

Item	Cost (Tighe & Bond report)	Per-Million Basis*
Digester System	$2,630,500	$486,351
600 kW Cogen Unit	$1,000,000	$184,889
Selective Catalytic Reduction System	$130,000	$24,036
WWTF Modifications	$400,000	$73,956
Estimated Site Work & Installation	$624,075	$115,385
Estimated Design, Engineering & Permitting	$624,075	$115,385
Total	**$5,408,650**	**$1,000,000**

* May not sum due to rounding

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Metal tank (heavy gauge) manufacturing	$486,351
Motor and generator manufacturing	$184,889
Other motor vehicle parts manufacturing	$24,036
Plastics pipe, pipe fitting, and unlaminated profile shape manufacturing	$36,978
Other nonresidential structures (construction)	$123,517
Electrical contractors	$28,846
Architectural, engineering and related services	$115,385
Total	**$1,000,000**

* May not sum due to rounding.

[54] *City of Eastham: Anaerobic Digestion Feasibility Study*, Tighe & Bond for City of Eastham, MA. May 2014. https://easthamptonma.gov/DocumentCenter/View/320/Organics-to-Energy---Anaerobic-Digestion-Feasibility-Study-2014-PDF

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
2.28	2.22	4.50

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	0.00	0.01	0.01
Mining	0.00	0.00	0.00
Utilities	0.00	0.01	0.01
Construction	0.88	0.03	0.91
Manufacturing	0.69	0.19	0.88
Wholesale Trade	0.00	0.13	0.13
Retail Trade	0.00	0.22	0.22
Transportation and Warehousing	0.00	0.15	0.15
Information	0.00	0.02	0.02
Finance and Insurance	0.00	0.13	0.13
Real Estate and Rental and Leasing	0.00	0.15	0.15
Professional and Technical Services	0.70	0.26	0.96
Administrative and Waste Services	0.00	0.26	0.26
Educational Services	0.00	0.04	0.04
Healthcare and Social Assistance	0.00	0.27	0.27
Arts, Entertainment and Recreation	0.00	0.05	0.05
Accommodation and Food Service	0.00	0.14	0.14
Other Services	0.00	0.12	0.12
Government	0.00	0.05	0.05
Total	**2.28**	**2.22**	**4.50**

* Totals may not sum due to rounding.

Priority Measure and/or Enabling Action: Achieve 12.2 GW of solar in-state by 2030

Notes

This program would implement a range of incentives and initiatives to expand solar deployment at various scales. As a pro forma example of a cost distribution for solar projects, we use the National Renewal Energy Laboratory's (NREL) distribution of the estimated $1.84 per watt modeled market price (MMP) for a 200 kW rooftop installation.[55] NREL's cost estimates and cost distributions vary across installation types, with costs per watt costs ranging from as high as $2.95 for residential installations to as low as $0.87 for utility-sized installations. We scale the cost distribution for 200kW commercial rooftop installations to provide an example of per-million-dollar workforce requirements. These impacts would vary across installation types based on the differences in cost distributions as well as total costs for different types of installations. EPC overhead (engineering, procurement, construction overhead) is included with the power structure construction and electrical contractor allocations. Equipment is included with installation labor in the power and communication structures construction and electrical contracting sectors. We exclude soft costs, including developer overhead (administrative costs) from the model. We also exclude solar modules and inverters from the model, assuming they are acquired from manufacturers outside the state.

Item	Cost per Watt (NREL)	Per-Million Basis*
Soft Costs: EPC/Developer Profit, Contingency, Developer Overhead, Sales Tax, Permitting/Inspection/Interconnection	0.67	$362,162
Solar Module and Inverter	0.51	$275,676
Engineering/Procurement/Construction Overhead	.18	$97,297
Installation Labor and Equipment	.15	$81,081
Electrical Balance of System (conductors, switches, conduit, etc.)	.21	$113,514
Structural Balance of System (racking)	.13	$70,270
Total	**$1.84**	**$1,000,000**

* May not sum due to rounding

Distribution of $1 million in Expenditures by Model Sector

Sector	Expenditure
Soft Costs – Excluded from Model	$362,162
Solar Module and Inverter – Excluded from Model	$275,676
Power and communication structures	$89,189
Electrical Contractors	$89,189
Wiring device manufacturing	$113,514
Iron and steel mills (racking)	$70,270
Total	**$1,000,000**

* May not sum due to rounding

[55] Ramasamy, V. et al., *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks, With Minimum Sustainable Price Analysis: Q1 2022,* Technical Report NREL/TP-7A40-83586 National Renewable Energy Laboratory, September 2022. www.nrel.gov/publications.

Employment Impact per $1 Million Expenditure

Direct Job-Years	Indirect/Induced Job-years	Total Job-Years
1.21	1.04	2.25

Employment Impact per $1 Million Expenditure by 2-Digit NAICS Sector

Sector	Direct Job-Years	Indirect Job-Years	Total Job-Years
Agriculture, Forestry, Fishing and Hunting	0.00	0.00	0.00
Mining	0.00	0.00	0.00
Utilities	0.00	0.00	0.00
Construction	0.98	0.03	1.01
Manufacturing	0.23	0.08	0.30
Wholesale Trade	0.00	0.07	0.07
Retail Trade	0.00	0.14	0.14
Transportation and Warehousing	0.00	0.07	0.07
Information	0.00	0.01	0.01
Finance and Insurance	0.00	0.06	0.06
Real Estate and Rental and Leasing	0.00	0.07	0.07
Professional and Technical Services	0.00	0.10	0.10
Administrative and Waste Services	0.00	0.08	0.08
Educational Services	0.00	0.02	0.02
Healthcare and Social Assistance	0.00	0.14	0.14
Arts, Entertainment and Recreation	0.00	0.02	0.02
Accommodation and Food Service	0.00	0.06	0.06
Other Services	0.00	0.06	0.06
Government	0.00	0.03	0.03
Total	**1.21**	**1.04**	**2.25**

* Totals may not sum due to rounding.

Conclusion

Taken together, the Heldrich Center's research highlights the projected impacts as well as the strengths, weaknesses, and opportunities for the state, from a workforce development lens, in advancing the priority measures set by NJDEP. The inventory of education and training programs highlights the state's workforce capacity as well as the workforce development infrastructure in relation to OBCs. This work further explores the barriers that historically underserved populations and OBCs may face when trying to access education, training, and employment.

Proactively addressing any perceived or anticipated gaps in the workforce will ensure that a highly skilled pipeline of workers is primed for the high-quality jobs developed in clean energy. Targeted engagement, recruitment, training, and hiring within OBCs will also ensure that a diverse workforce, comprised of underserved, disadvantaged, or historically overlooked populations, will be able to participate in the prosperity generated from a thriving green economy in the state of New Jersey.

Throughout all the identified workforce strategies, stakeholder buy-in and partnership will be critical. Stakeholders include, but are not limited to, employers, education and training providers, county and/or regional leadership, state leadership, community leaders, CBOs, faith-based institutions, and other nonprofits. These workforce interventions must be prioritized by stakeholders, in terms of both staff support and financial backing, to be made effective and have the anticipated workforce benefits.

More research can be done to expand upon the workforce interventions most appropriate for each priority sector and priority measure identified by NJDEP for the PCAP and CCAP to ensure that the benefits of clean energy extend to historically underserved communities, including OBCs in the state of New Jersey. The Heldrich Center looks forward to continuing to support NJDEP in the planning and implementation of the CPRG.

APPENDIX 7.6

NEW JERSEY GREENHOUSE GAS INVENTORY REPORT 1990-2021

2024

NJ Greenhouse Gas Emissions Inventory Report Years 1990-2021

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

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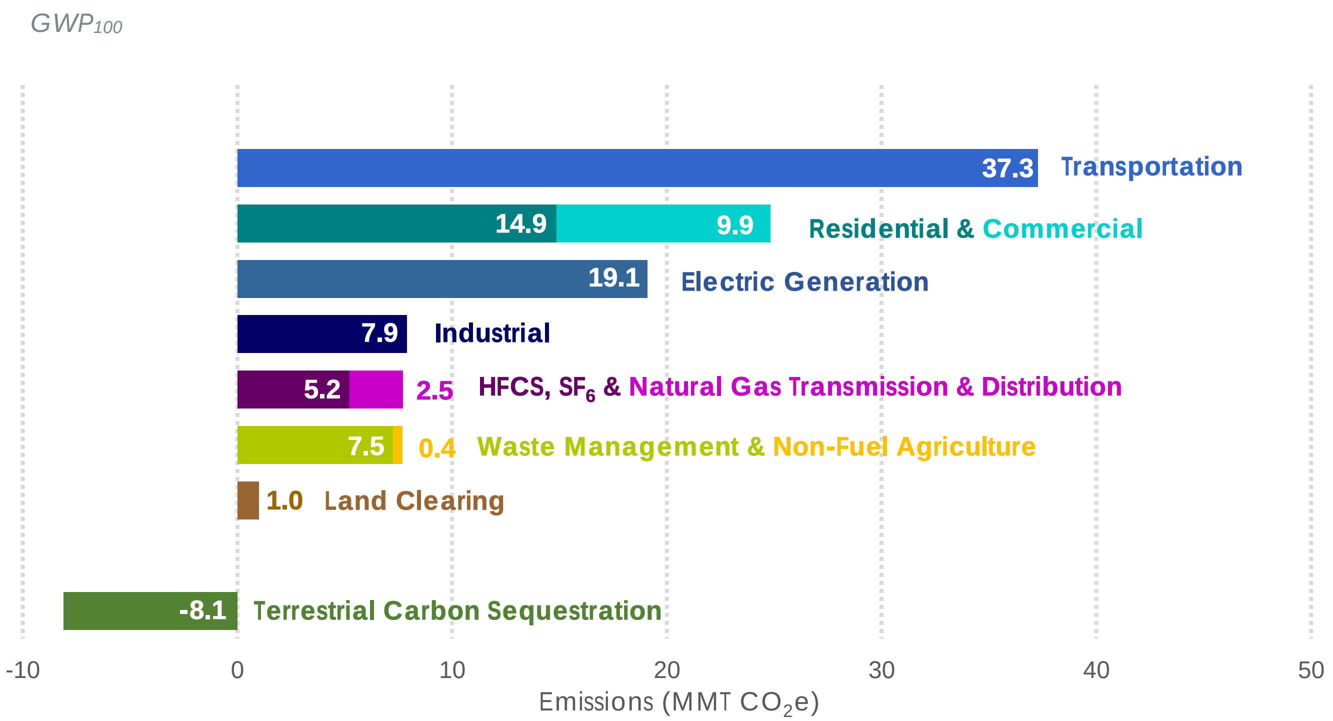
EXECUTIVE SUMMARY

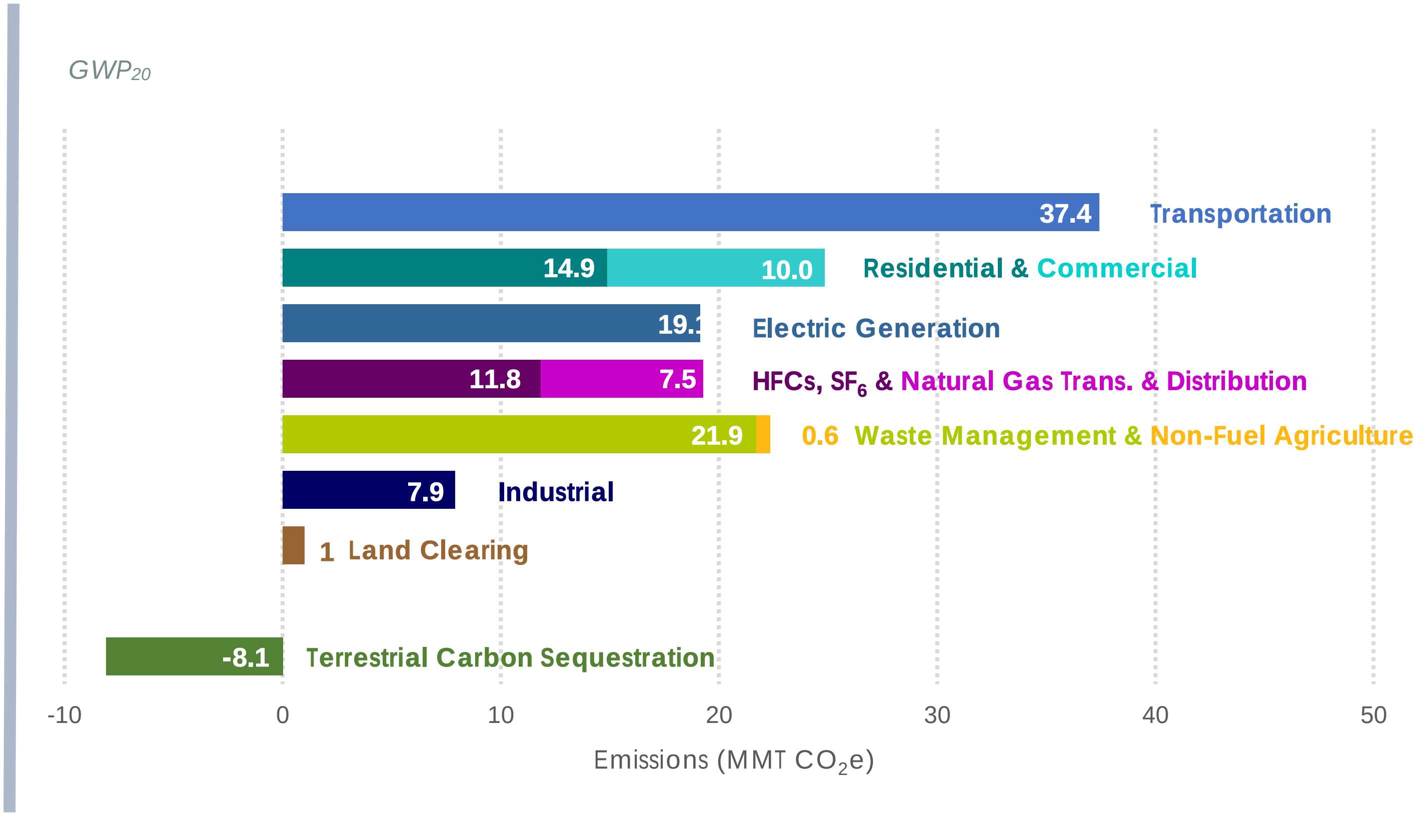
The New Jersey Greenhouse Gas Inventory Report serves as the foundation of the State's strategy to mitigate climate change. It is designed to identify the sources of greenhouse gas emissions in the State, measure progress in reducing those emissions and disseminate this information to decision makers to inform climate policy. This report provides the most up-to-date estimation of annual emissions from 1990, and 2005-2021. New Jersey uses an inventory scope and framework consistent with international and national greenhouse gas inventory practices.

CURRENT STATEWIDE GREENHOUSE GAS EMISSIONS

In 2021, statewide gross emissions were 105.7 million metrics tons of carbon dioxide equivalent (MMT CO_2e) when calculated using GWP_{100} (Figure ES-1). Energy consuming sectors were the largest sources of emissions (84%), resulting from fossil fuel combustion from transportation, electric generation, residential and commercial, and fuel-consuming industrial activities. Non-energy emissions accounted for the remaining 16% of emissions and are associated with a variety of processes such as the release of greenhouse gases from sectors using or producing halogenated gases, sulfur hexafluoride, natural gas transmission and distribution, waste management and other industrial processes. Approximately 8% of 2021 emissions were removed via carbon sequestration from New Jersey's natural and working lands, such as forests and wetlands, resulting in a net emission total of 97.6 MMT CO_2e.

Figure ES-1. 2021 Emissions by Sector (GWP_{100} and GWP_{20})



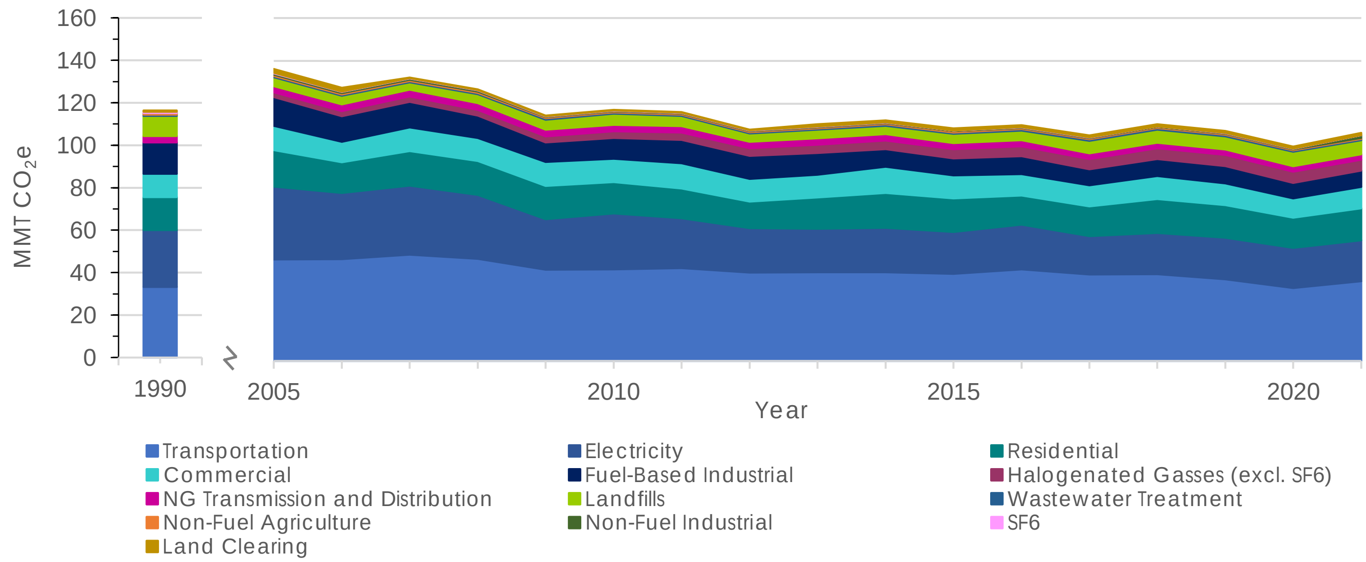


TRENDS IN GREENHOUSE GAS EMISSIONS, 1990-2021

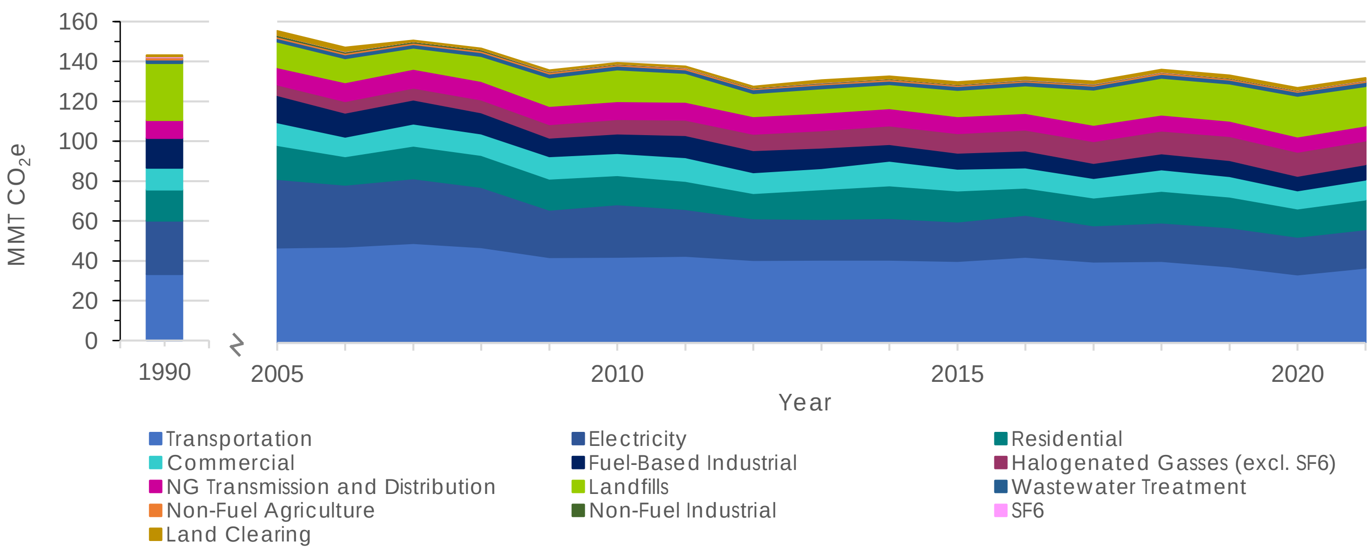
Since 1990, New Jersey's annual net emissions have dropped from 112.6 MMT CO2e to 97.6 MMT CO2e in 2021 (Figure ES-2). This represents a 13% reduction over the 31-year period. However, year-to-year fluctuations are superimposed on this trend due to weather and world events, the most recent example being the State's drop and rebound following the pandemic. From a low of 92.2 MMT CO2e in 2020, the lowest since the state began keeping records of GHG emissions, New Jersey's emissions rebounded 5.4 MMT CO2e by the end of 2021. But looking across the 31-year period, enduring reductions can be traced to adoption of new technologies that bring with them inherent environmental benefits. For example, aging coal-fired power plants have been entirely phased out in the State, replaced by less-polluting and more efficient combined-cycle natural gas electric systems and burgeoning renewable energy. Similarly, improvements in the fuel efficiency of passenger vehicles has further contributed to emission reductions. Even so, many of these improvements have been offset by increased consumer demand for larger trucks and sport utility vehicles. But if there is one key observation from recent experience, it is that it is possible for social behaviors to change quickly , as witnessed by the drastic reductions in worldwide climate emissions when travel patterns, shopping habits, and personal behaviors adapted to the pandemic threat. (Figure ES-2)

Figure ES-2. Greenhouse Gas Emissions for 1990 and 2005-2021 (GWP_{100} and GWP_{20})..[1]

GWP_{100}



GWP_{20}



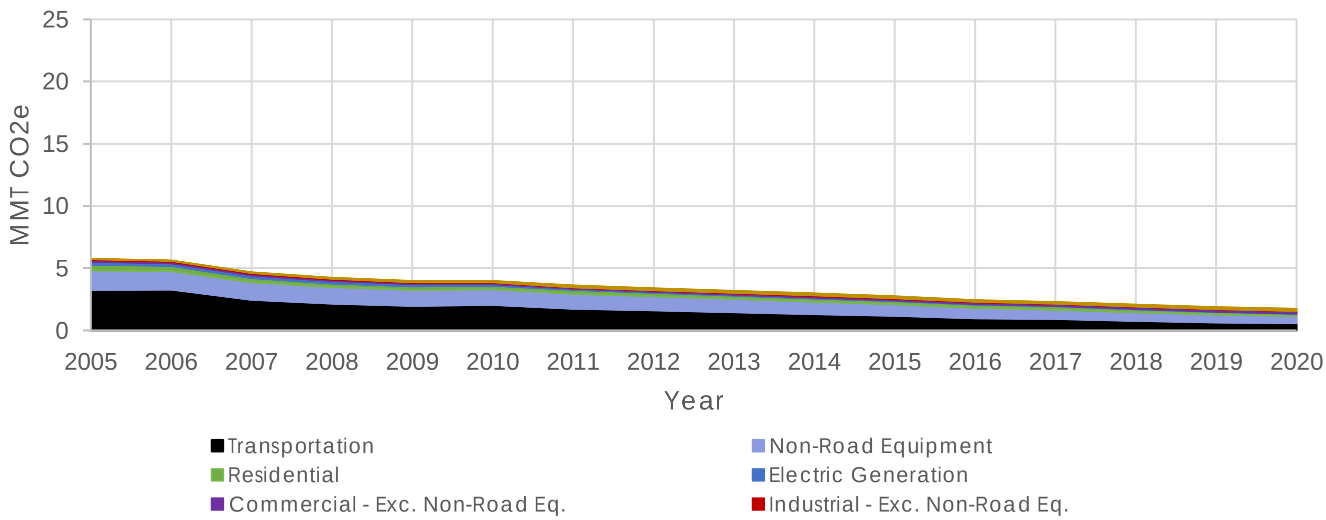
BLACK CARBON INVENTORY

Black carbon, or soot, is a subset of fine particulate matter ($PM_{2.5}$). It is an airborne particle left behind by incomplete combustion of fuels and is closely associated with adverse respiratory impacts when respired. As such, it has been a long-standing focus of DEP regulatory efforts. Black carbon, with its dark color and low albedo, absorbs light and thereby contributes to atmospheric warming. It also settles on the earth, where it can accelerate the melting of snow, and when airborne can alter cloud formation. In 2020, the most recent year for which full data is available, total black carbon emissions in the State were 1.7 MMT CO_2e based on GWP_{100}.

[1] Gross emissions, not adjusted for terrestrial carbon sequestration.

Diesel engine exhaust, frequently occurring in and around ports and other economic hubs, is the single largest source of black carbon emissions in the State, as depicted in estimated emissions for the transportation sector and from non-road equipment (Figure ES-3). However, federal regulations mandating cleaner engines, coupled with other transitions in the State, have resulted in consistent downward trends such that black carbon emissions today are less than half those seen in 2005. With anticipated increased adoption rates of electric vehicles and the expansion of renewable energy generation, black carbon emissions are expected to drop further in the coming years. Black carbon from in-state electric generation comprises less than 2% of all New Jersey black carbon emissions.

Figure ES-3. Black Carbon Emissions 2005-2020 (GWP_{100}).[2]



GLOBAL WARMING POTENTIALS

In accordance with legislative requirements (P.L. 2019 c.319), the New Jersey Greenhouse Gas Inventory Report includes calculations based on both 100-year and 20-year Global Warming Potentials (GWP_{100} and GWP_{20}, respectively). GWP allows various gases to be compared in terms equivalent to carbon dioxide, denoted as CO_2e. Estimates utilizing GWP_{20} prioritize the impact of short-lived climate pollutants such as methane, nitrous oxide, and hydrofluorocarbons. Utilizing GWP_{20} reorders the sources of GHG emissions, identifying methane from waste management and halogenated gases as larger contributors to climate change compared to commercial and industrial emissions. While the use of GWP_{20} highlights the value of reducing short-lived climate pollutant (SLCP) emissions in the near term by making their impact appear larger, the Intergovernmental Panel on Climate Change (IPCC) recognizes that this approach overestimates the potential benefits of SLCP reductions. The United Nations Framework Convention on Climate Change (UNFCCC) and IPCC have not established any suitable timeframes for SLCP reporting other than 100 years. With these limitations in mind, estimated emissions based on GWP_{20} are presented in this report alongside GWP_{100} emissions to assist policymakers and the public in recognizing the disparate impacts of SLCPs compared to CO_2 and long-lived greenhouse gases.

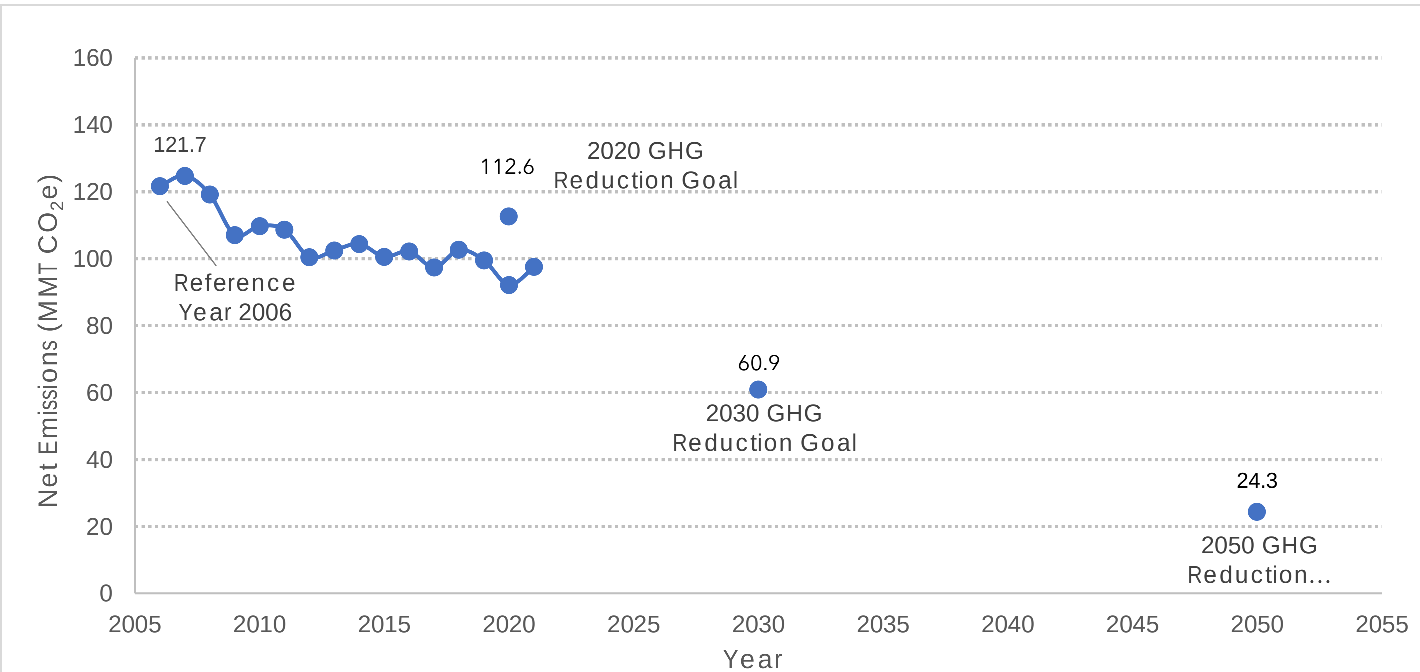
[2] GWP_{20} values (not shown) are 3.5 times greater.

1.0 INTRODUCTION

The New Jersey Global Warming Response Act (GWRA) (P.L. 2007, c.112, as amended 2019) requires that a comprehensive greenhouse gas inventory report be prepared by the Department of Environmental Protection every other year, and that updated estimates be provided during each of the intervening years. This is the eleventh assessment in the series, the first being released in 2008. The most recent release, a mid-cycle update with emissions data through 2020, was published in December of 2022.[3] The current inventory report extends those estimates to 2021 and uses updated data and methods. Further, it includes a detailed discussion of emissions by sector, a review of greenhouse gas emissions trends, and an overview of steps taken by the State to reduce emissions.

Periodic inventory updates provide vital information for assessing the State's progress towards meeting its greenhouse gas emission objectives. Specifically, the GWRA calls for the State, no later than January 1, 2020, to reduce greenhouse gas emissions to, or below, the level of emissions in 1990. Based on the assessment presented here, the State achieved that goal in 2009, eleven years ahead of schedule (Figure 1). The GWRA also requires the State to reduce its statewide greenhouse gas emissions to at least 80% below 2006 levels by January 1, 2050. More recently, Governor Phil Murphy's Executive Order 274 established an interim target of reducing total greenhouse gas emissions to 50% of 2006 levels by 2030. An accurate assessment of greenhouse gas emissions is essential to recognizing the specific levels of emissions to be reached and evaluating the effectiveness of the policies applied.

Figure 1. New Jersey Emissions and Greenhouse Gas Reduction Goals



[3] An archive of the previous inventory reports is available on can be found at https://dep.nj.gov/ghg/nj-ghg-inventory/inventory-archive/.

1.1 INVENTORY STRUCTURE AND PROCESS

New Jersey uses an inventory scope and framework consistent with international and national greenhouse gas inventory practices, and using the methods described in Appendix B. This inventory provides estimates of anthropogenic greenhouse gas emissions within New Jersey, and those associated with imported electricity and exported waste. Biogenic (natural) sources are not included in the inventory. The inventory includes estimates for:

- Carbon Dioxide (CO_2);
- Methane (CH_4);
- Nitrous Oxide (N_2O);
- Fluorinated gases with high global warming potentials (High-GWP) which includes hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF_6);
- Estimates of Carbon Sequestration from natural and working lands; and
- Separate, detailed inventory for Black Carbon.

These emissions are organized into four overarching sections, with further sector breakdowns within each, listed below in Table 1. Emission estimates are recalculated for all years to maintain a consistent time-series following IPCC recommendations for developing greenhouse gas inventories. Thus, emissions levels in this report differ from those in previous inventory editions. Emissions are calculated using both United Nations standard 100-year Global Warming Potentials (GWP_{100}) and short-term 20-year GWPs (GWP_{20}) as required pursuant to P.L. 2019 c.319.[4] Estimates utilizing a GWP_{20} prioritize the impact of short-lived climate pollutants such as methane, nitrous oxide, and hydrofluorocarbons. However, since CO_2 is the reference gas, GWP_{20} estimates are nearly identical to those based on GWP_{100} for emissions from combustion processes since they emit few if any short-lived pollutants. Therefore, in this report when the two estimates are nearly identical only the 100-year estimate is provided. Full tabular results based on both GWP_{20} and GWP_{100} are included in Appendix A. An overview of GWP is included in Appendix C. A comparison of this report's results with USEPA estimates for 2021 is provided in Appendix D, showing agreement to within 2% for net total in-state emissions. The following discussion breaks down the State's emissions trends and provides context for each of the source categories.

Table 1. Section Descriptions

SECTION	SECTORS/ACTIVITIES INCLUDED
Energy Emissions	Emissions of all greenhouse gases resulting from fossil fuel combustion from transportation, electric generation, residential and commercial buildings, and fuel-consuming industrial activities.
Non-Energy Emissions	Emissions associated with sectors using or producing halogenated gases, the electric transmission and distribution system (using sulfur hexafluoride as an insulator); the natural gas transmission and distribution system; agriculture (enteric fermentation, manure and soil management), waste management, industrial processes other than fuel consumption, and natural land clearing.
Carbon Sequestration	Estimates of removal of carbon dioxide from the atmosphere through sequestration on forests, wetlands, and agricultural lands.
Black Carbon	Emissions associated with combustion of fossil and biogenic materials.

[4] Global warming potentials used in this report for methane, nitrous oxide and sulfur hexafluoride were taken from the IPCC Fifth Assessment Report Working Group I, Table 8-A, Lifetimes, Radiative Efficiencies and Metric Values. (www.ipcc.ch/report/ar5/wg1/) . GWPs for HFCs were from IPCC AR4 as applied in the California Air Resources Board F-Gas model. GWP values for black carbon were from Section 12.1 of T. C. Bond, et al., Bounding the role of black carbon in the climate system: a scientific assessment. *J. Geophysical Research*, Vol 118, pp. 5380-5552, 2013. Use of GWP_{100} values from AR5 Table 8-A for methane, nitrous oxide and sulfur hexafluoride is consistent with IPCC conventions and allows comparison of New Jersey emissions estimates with those developed by other national and international agencies. Previous releases of the NJ Greenhouse Gas Inventory Report used GWPs from the IPCC Fourth Assessment Report, consistent with IPCC guidance in effect at that time. Methane estimates based on AR5 are 12% to 17% greater than under AR4, and nitrous oxide estimates are 9% to 11% lower.

2.0 TRENDS IN GHG EMISSIONS

2.1 STATEWIDE TRENDS

Total estimated net greenhouse gas emissions for 2021 were 97.6 MMT CO_2e when calculated using GWP_{100} (Figure 2; tabular data is in Appendix A, Table A-1), and 124.1 MMT CO_2e when calculated using GWP_{20} (Figure 3; Table A-3). A recalculation of 1990 data found estimated emissions of 112.6 MMT CO_2e based on GWP_{100}, and 139.4 MMT CO_2e based on GWP_{20}. Because emissions decreased to below 1990 levels before January 1, 2020, (based on GWP_{100} or GWP_{20}), it can be concluded that the State has achieved the first reduction goal of the GWRA. The significance of reaching this milestone is made clear by comparing the State's current conditions with what was projected under business-as-usual conditions in the 2008 Greenhouse Gas Inventory Report. In that scenario, the absence of State action would have resulted in emissions of 160 MMT CO_2e by today (using GWP_{100}).[5] The State has therefore managed to keep emissions far below that projected amount.

As with previous inventory years, the four leading sectors of GHG emissions in 2021 were transportation, residential, and commercial fossil fuel use, and electric generation, based on GWP_{100} (Figure 4). Specifically, transportation remained the largest source of GHG emissions at 37.3 MMT CO_2e, or 38% of the net statewide emissions. Both the residential and commercial sectors combined totaled 24.8 MMT CO_2e, or 25% of net statewide emissions; and electric generation accounted for 19.1 MMT CO_2e, or 20% of net statewide emissions. Carbon captured by the State's natural sinks was estimated to be 8.1 MMT CO_2e in 2021, "offsetting" 8% of the gross statewide GHG emissions.[6] Using GWP_{20}, the second greatest contributor was highly warming gases,[7] which accounted for 16% of net emissions (Figure 5). Transportation, electricity generation, residential fuel use and commercial fuel use accounted for 30%, 15%, 12% and 8% of net emissions, respectively, using GWP_{20}.

While keeping emissions growth in check has been successful, the challenge is now to drive emissions rapidly downward. The GWRA sets a goal of reducing emissions by 80% from our 2006 baseline by 2050 which equals a goal of 24.0 MMT CO_2e (GWP_{100}). If New Jersey were to continue the rate of decrease observed from 2006 through 2021, it wouldn't reach the 80% goal until 2060, thus emphasizing the need for aggressive action. The State has published detailed emissions reduction pathways in both the 2019 Energy Master Plan[8] and 2020 GWRA 80x50 report, and has initiated multiple policy actions based on these outlines.[9] However, many of the strategies will take substantial time to reach full effectiveness and are now only in their earliest stages. Future releases of this inventory report will document the degree to which those plans are successful in lowering emissions.

[5] The corresponding figure using GWP_{20} would be approximately 221 MMT CO_2e.

[6] The carbon sequestration value relies on statewide land use and land cover data. Values remain constant at 2015-year levels awaiting publication of new data.

[7] The category shown as highly warming gases in Figures 3 and 4 includes halogenated gases, sulfur hexafluoride, emissions from non-fuel agricultural activities, and emissions from natural gas transmission and distribution. Emissions from waste disposal also consist largely of methane, a highly warming gas, and are accounted for in a separate category. Combined, highly warming gases and waste management represent 16% of emissions using GWP_{100} and 34% using GWP_{20}.

[8] NJBPU, 2019 New Jersey Energy Master Plan, Pathway to 2050. https://www.state.nj.us/emp/index.shtml

[9] NJDEP, New Jersey's Global Warming Response Act 80x50 Report, 2020. https://www.nj.gov/dep/climatechange/mitigation.html

Figure 2. Greenhouse Gas Emissions for 1990 and 2005-2021 (GWP100).[10]

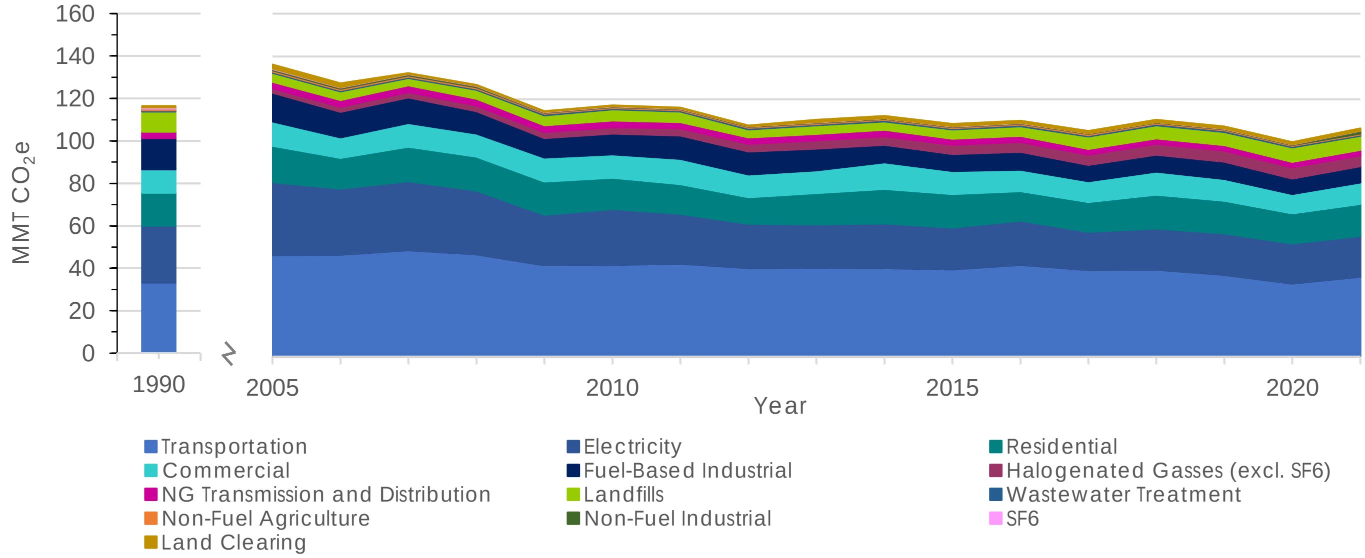
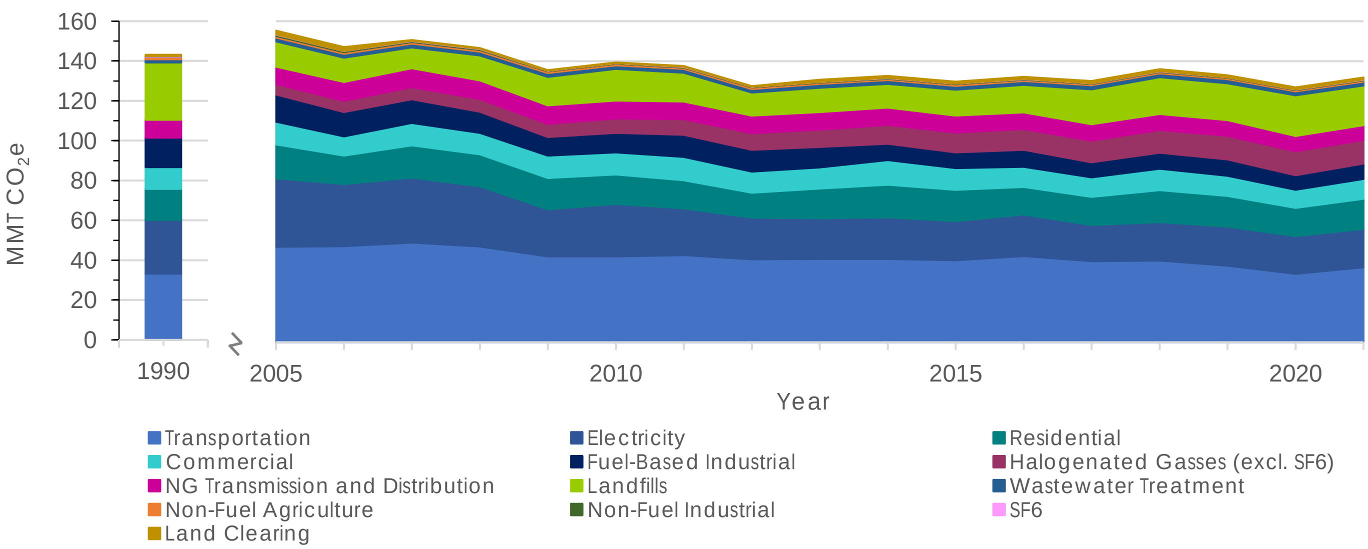


Figure 3. Greenhouse Gas Emissions for 1990 and 2005-2021 (GWP20).[11]



[10] Gross emissions, not adjusted for terrestrial carbon sequestration.
[11] Gross emissions, not adjusted for terrestrial carbon sequestration.

Figure 4. 2021 Emissions by Sector (GWP_{100})

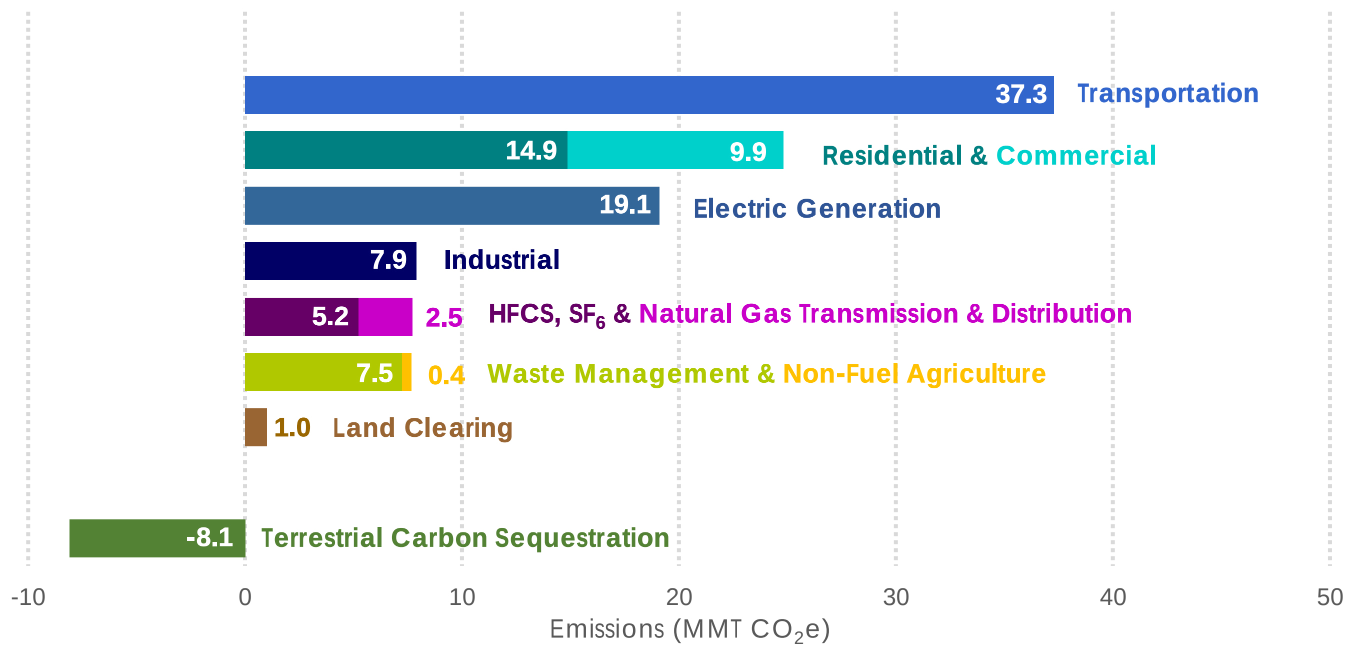
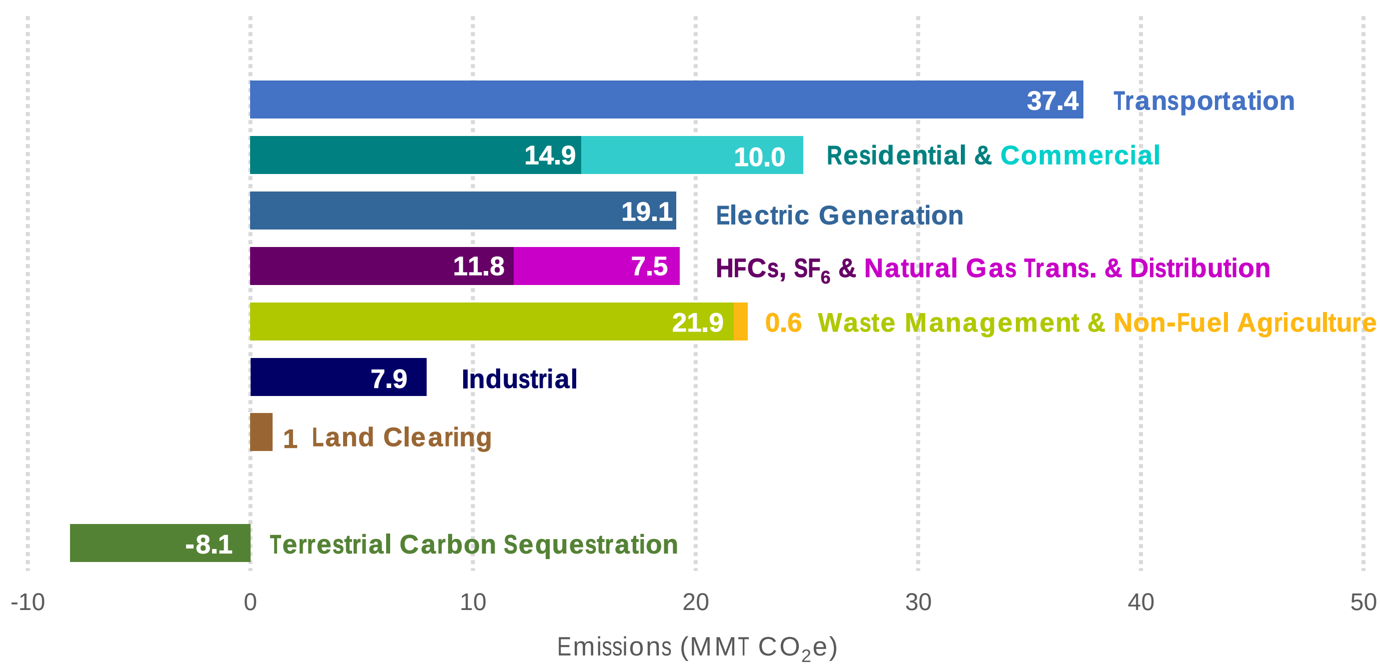


Figure 5. 2021 Emissions by Sector (GWP_{20})



2.2 NATIONAL AND GLOBAL TRENDS

New Jersey's climate mitigation efforts are only one part of the world-wide response to global warming. Placed in context, New Jersey is responsible for 1.7% of national emissions and 0.3% of worldwide emissions (Table 2). On a per capita basis, New Jersey in-state emissions averaged 12.0 metric tons CO_2e per resident between 2016 and 2021.[12] This was slightly more than half the national average of 20.0 metric tons per resident, and about double the international average of 5.0 metric tons per resident. However, it should be noted that New Jersey residents benefit from emissions-generating activities outside the State, and some of the observed discrepancies between state and national rates are due to goods and services imported from outside state boundaries. The figures cited above do not account for these consumption-based transfers, with the exception of New Jersey's inclusion of emissions from out-of-state solid waste disposal and imported electricity.[13]

Table 2. Comparison of New Jersey with the United States and the World.[14]

	Gross Emissions (MMT CO_2e, GWP_{100})			NJ as Percent of		Emissions per Capita (MT CO_2e/person)		
Year		U.S.	World	U.S.	World	NJ	US	World
2016	110.3	6,578	35,524	1.7%	0.3%	12.1	20.4	4.8
2017	105.5	6,562	36,097	1.6%	0.3%	11.6	20.2	4.8
2018	110.7	6,755	36,827	1.6%	0.3%	12.1	20.7	4.8
2019	107.6	6,618	37,083	1.6%	0.3%	11.7	20.2	4.8
2020	100.3	6,026	35,264	1.7%	0.3%	10.8	18.2	4.5
2021	105.7	6,340	37,124	1.7%	0.3%	11.4	19.1	4.7

[12] Based on GWP_{100}.

[13] National totals also include some wide-scale emissions such as those from passenger aircraft at cruising altitude that are not included in the New Jersey estimates.

[14] US emissions from Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2021. USEPA EPA430-R-23-002, 2023, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021. Global emissions from P. Friedlingstein, et al., Global Carbon Budget 2022. Global Carbon Project, https://www.globalcarbonproject.org/carbonbudget/22/data.htm.

US and global populations from US Census Bureau, https://www.census.gov/data-tools/demo/idb/#/country. New Jersey population for 2010 and 2020-21 from US Census Bureau, with intervening years estimated by interpolation and subsequent years as estimated by the Census Bureau. https://www.census.gov/data/tables/time-series/dec/popchange-data-text.html; https://www2.census.gov/programs-surveys/popest/tables/2020-2022/state/totals/NST-EST2022-POP.xlsx

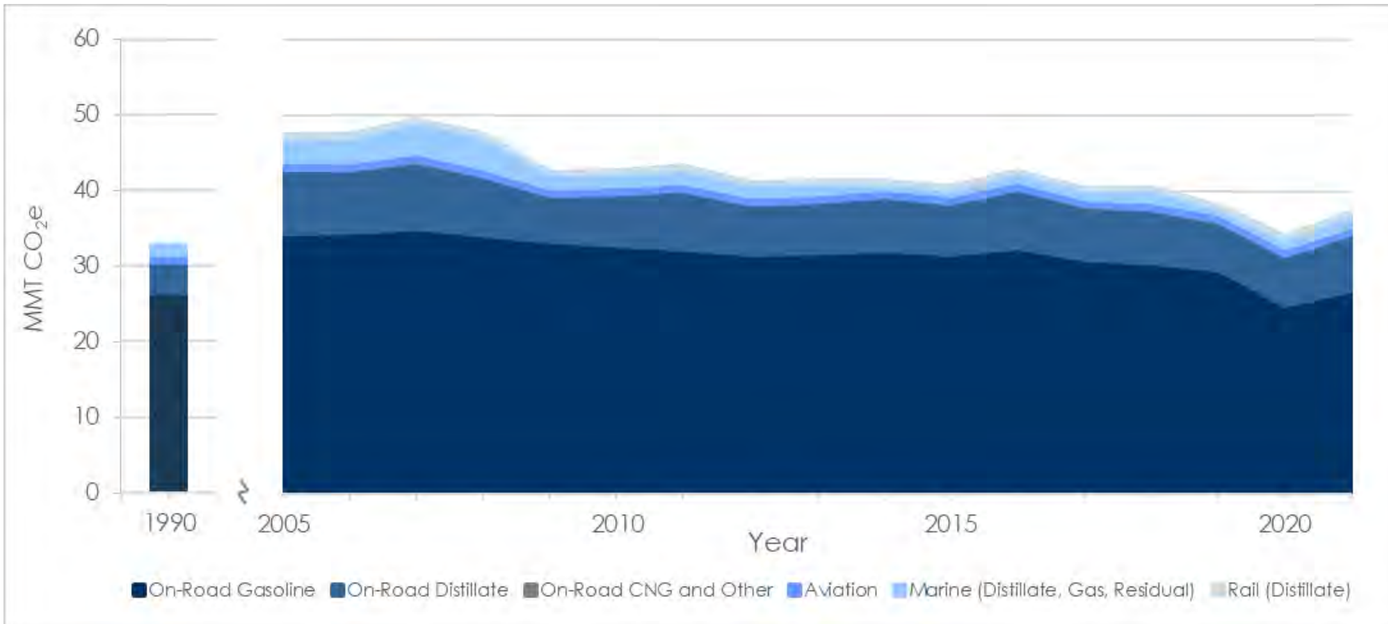
3.0 ENERGY EMISSIONS

3.1 TRANSPORTATION

The transportation sector consists of activities that move people and goods from one location to another.[15] Familiar examples of emissions sources in this sector include light-duty passenger vehicles, trucks, and other on-road vehicles; non-road modes of transport include trains, subways, cargo ships and passenger ferries. Other sources of mobile emissions such as construction equipment and forklifts are included in estimates for the sectors in which they are used. For example, construction equipment emissions are accounted for in the industrial sector while forklift truck emissions are listed in either the commercial or industrial sector, depending on the type of business.

Total emissions from the transportation sector in 2021 were 37.3 MMT CO_2e (GWP_{100})/37.4 MMT CO_2e (GWP_{20}). This represents a decrease of 10.3 MMT CO_2e from 2006 levels, but an increase of 4.1 MMT CO_2e over 1990 levels, using GWP_{100}. These shifts were dominated by on-road emissions and can be attributed to the transition of the passenger vehicle fleet to larger, less efficient models, offset by application of federal performance standards (Figure 6; Tables A-1 and A-3).

Figure 6. Transportation Sector Emissions by Mode of Transport (GWP_{100})



On-Road Transportation

Total on-road emissions rose from 30.3 MMT CO_2e in 1990 to a high of 44.0 MMT CO_2e in 2007 (GWP_{100}).[16] Emissions then slowly dropped at an average rate of 0.66 MMT CO_2e per year, reaching 36.1 MMT CO_2e in 2019. During the pandemic, on-road emissions dropped 13% to 31.5 MMT CO_2e, but rebounded 9% in 2021 to 34.4 MMT CO_2e (Figure 7). Throughout this period, the proportion of emissions attributed to gasoline averaged 82% (range 78% to 84%). In 2021, on-road gasoline contributed 27.0 MMT CO_2e, or 78% of the on-road total. The balance of on-road emissions were nearly all from diesel fuel (21%). Compressed Natural Gas (CNG) and other fuels contributed 0.1 MMT CO_2e in 2021 (0.3%). Emissions from the electric generation used to supply power to electric vehicles are not included in this total but are considered part of the electric generating sector.

By far, the vehicle types contributing the greatest share of emissions in 2021 were gasoline-powered passenger vehicles, including sedans, pickup trucks, and SUVs, at 24.5 MMT CO_2e (Figure 8; Tables A-5 and A-6). Diesel-powered medium- and heavy-duty vehicles followed at 5.8 MMT, not including diesel buses which emitted 0.6 MMT CO_2e. Gas-powered medium-

[15] USEIA, https://www.eia.gov/tools/glossary/index.php?id=T

[16] Emissions estimates are based on GWP_{100}. Estimates based on GWP_{20} are within 0.1 MMT CO_2e of the GWP_{100} values. Totals listed in the text may not agree exactly with sums of the numbers shown in the tables in Appendix A due to rounding of estimates in the tables.

and heavy-duty vehicles contributed 2.4 MMT CO_2e, followed by gasoline-powered buses which emitted less than 0.1 MMT CO_2e.

Figure 7. On-road transportation greenhouse gas emissions by fuel type (GWP100)

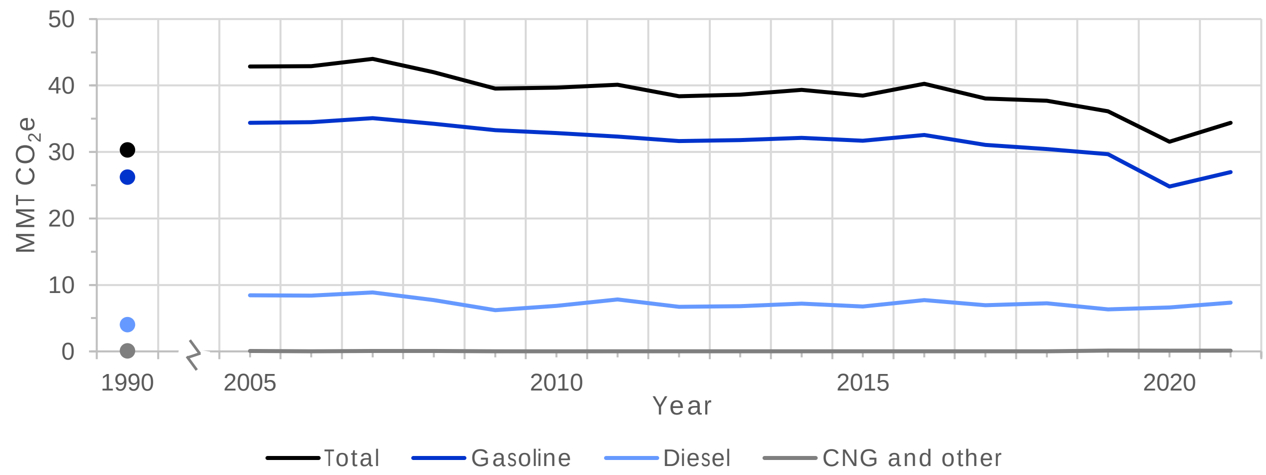
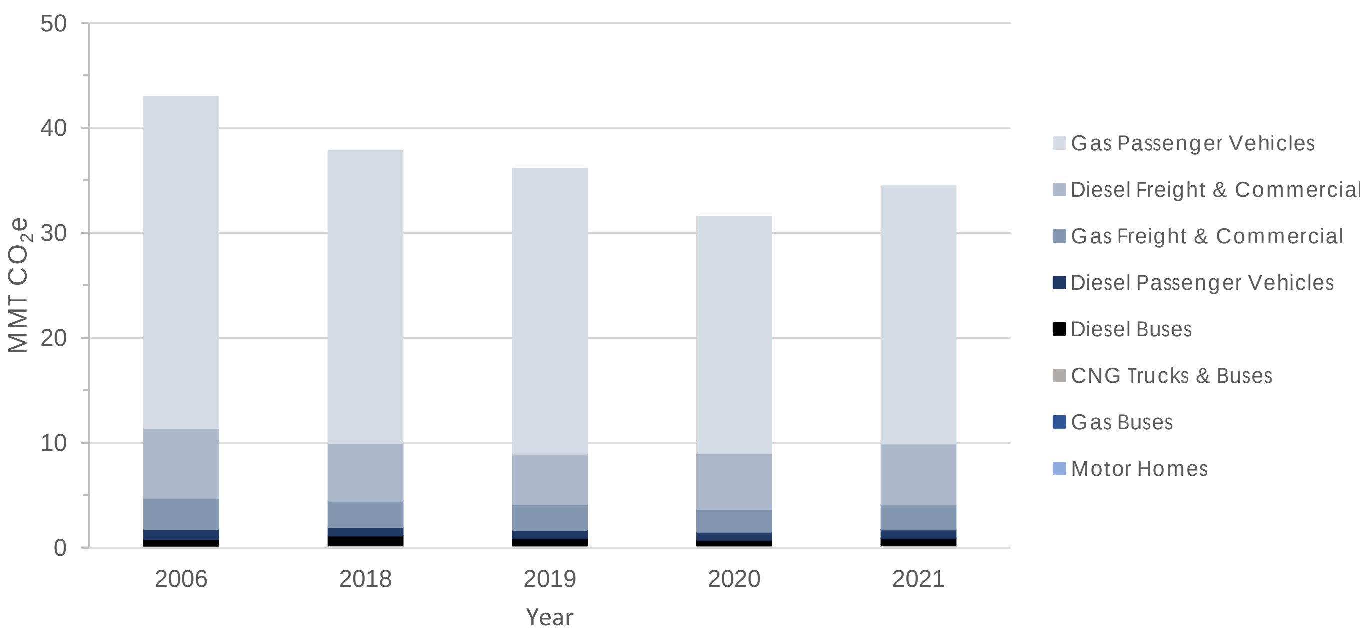


Figure 8. On-road emissions by vehicle category (GWP100)



Aviation

New Jersey is home to forty public airports, the largest being Newark Liberty International Airport in Essex County which served more than 43 million passengers in 2022, ranking 13th nationally and 23rd worldwide.[17] New Jersey also hosts Joint Base McGuire Dix Lakehurst, a major air transportation hub for the US military stretching across 42,000 contiguous acres in Burlington and Ocean Counties. New Jersey's in-state aviation emissions were estimated to be approximately 1.0 MMT CO_2e based on the assessment in the 2008 NJ Greenhouse Gas Inventory Report[18] The state's estimate is in close agreement with the 2017 USEPA National Emissions Inventory (NEI), which found that in-state aviation emissions totaled 0.8 MMT CO_2 for that year. [19, 20] More detailed information was released in the 2020 NEI, which estimated that total flight emissions during the pandemic year were 0.6 MMT CO_2 (Table 3).

Table 3. Aviation Emissions for 2020 (Metric Tons CO_2)[21]

County	General Aviation		Air Taxi	Commercial	Military	Total
	Piston	Turbine	Turbine			
Atlantic	1,008	3,649	841	5,104	13,175	23,776
Bergen	1,224	4,262	13,450	41	82	19,060
Burlington	3,020	11,132	0	12,220	8,632	35,005
Camden	148	535	0	0	0	683
Cape May	1,926	6,974	0	0	147	9,047
Cumberland	1,938	7,018	1	0	66	9,023+
Essex	1,859	6,655	17,063	329,217	1,255	356,050
Gloucester	1,019	3,691	0	0	0	4,711
Hudson	0	0	0	0	0	0
Hunterdon	1,763	6,383	0	0	0	8,146
Mercer	3,020	10,935	921	2,871	284	18,032
Middlesex	417	1,508	0	0	0	1,925
Monmouth	1,482	5,362	3,155	1	0	10,000
Morris	2,746	9,940	2,325	15	90	15,115
Ocean	1,512	5,305	132	5	50,236	57,191
Passaic	433	1,569	0	0	0	2,002
Salem	291	1,054	0	0	0	1,345
Somerset	2,778	10,061	1,485	0	0	14,325
Sussex	1,327	4,807	0	0	0	6,134
Union	1,581	5,725	0	0	309	7,615
Warren	1,156	4,185	0	0	0	5,340
Total	30,649	110,752	39,375	349,474	74,276	**604,526**

[17] Port Authority of New York and New Jersey, 2022 Airport Traffic Report, and 2009 Air Traffic Report, https://www.panynj.gov/airports/en/statistics-general-info.html. Accessed August 29, 2023.

[18] The 1.0 MMT CO_2e emissions estimate is based on the analysis described in Appendix C of *New Jersey Greenhouse Gas Inventory and Reference Case Projections 1990-2020*, November 2008. The estimate is limited to landing-and-takeoff activity within the state's territorial boundary. Because aviation emissions are a result of combustion, carbon dioxide is the dominant climate pollutant and only small amounts of methane and nitrous oxide are produced. Estimates based on GWP_{100} or GWP_{20} are therefore nearly identical.

[19] Actual emissions were likely greater than indicated in the 2017 NEI because it did not include CO_2 emissions from all aviation sources. The assessment in the 2020 NEI addressed most if not all of those missing sources.

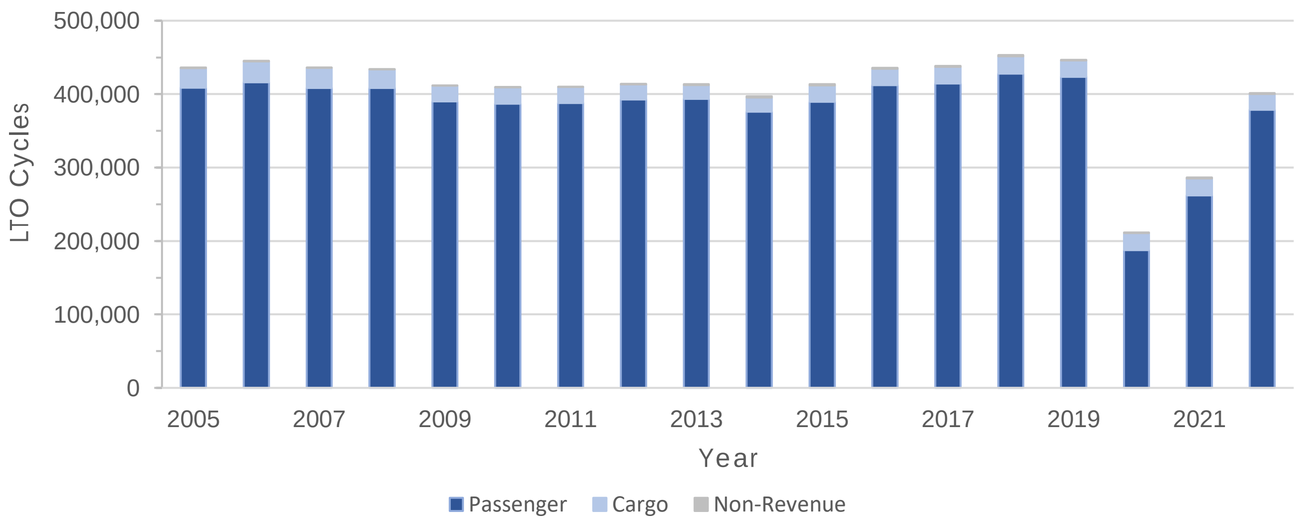
[20] Sum of CO_2 emissions for SCC codes 2275050011, 2275050012, 227506001, 2275060012, 2275020000 and 2275001000. https://gaftp.epa.gov/air/nei/2017/data_summaries/2017v1/2017neiJan_facility_process_byregions.zip

The NEI reported CO_2 emissions without CH_4 or N_2O, but because fuel is combusted, very little CH_4 and N_2O are released and the estimated CO_2e is nearly identical to CO_2.

[21] USEPA, 2020 National Emissions Inventory. https://www.epa.gov/air-emissions-inventories/2020-nei-supporting-data-and-summaries

The impact of the COVID-19 pandemic is reflected in air traffic activity at Newark Liberty International Airport. Flights dropped by more than half between 2019 and 2020, primarily due to fewer passenger flights, but by 2022 the number of landing-and-takeoff cycles had nearly recovered to pre-pandemic levels. (Figure 9). Aviation emissions across the State likely followed a similar trend as reflected in the NEI data.

Figure 9. Landing-and-Takeoff Cycles at Newark Liberty International Airport[22]



Marine Transportation

Marine transport includes large ocean-going vessels, recreational watercraft, and regional transportation such as passenger ferries. Three types of fuel commonly used in this sector are residual oil, distillate (diesel), and gasoline. For ocean-going vessels, the largest part of their emissions take place outside the territorial waters of the United States. Therefore, these international emissions are excluded in the State's emissions estimates in accordance with IPCC guidelines. Services provided at ports such as cargo handling are included in the Commercial sector since they use equipment that is not specifically a means of transportation.

Since 1990, estimates of marine emissions have varied significantly (Figure 10; Table A-7), starting at 1.7 MMT CO_2e in 1990 and reaching a high of 4.3 MMT in 2008. Estimated emissions for 2021 were 1.5 MMT, of which 1.0 MMT was from residual fuel oil; 0.2 MMT was from diesel fuel; and 0.3 MMT was from gasoline.[23] Much of the variability may be attributed to the limitations of leveraging fuel sales data as a proxy for actual emissions activity. Residual fuel in particular may be purchased elsewhere and brought to the State or sold here and used later when a ship is away from the state. Comparing 2020 estimates with the 2020 NEI, both New Jersey and the NEI found emissions from gasoline to be 0.3 MMT. Diesel emissions estimated by NJ were 0.2 MMT while the NEI estimated 0.5 MMT. The NEI did not include estimates of emissions from residual fuel oil.

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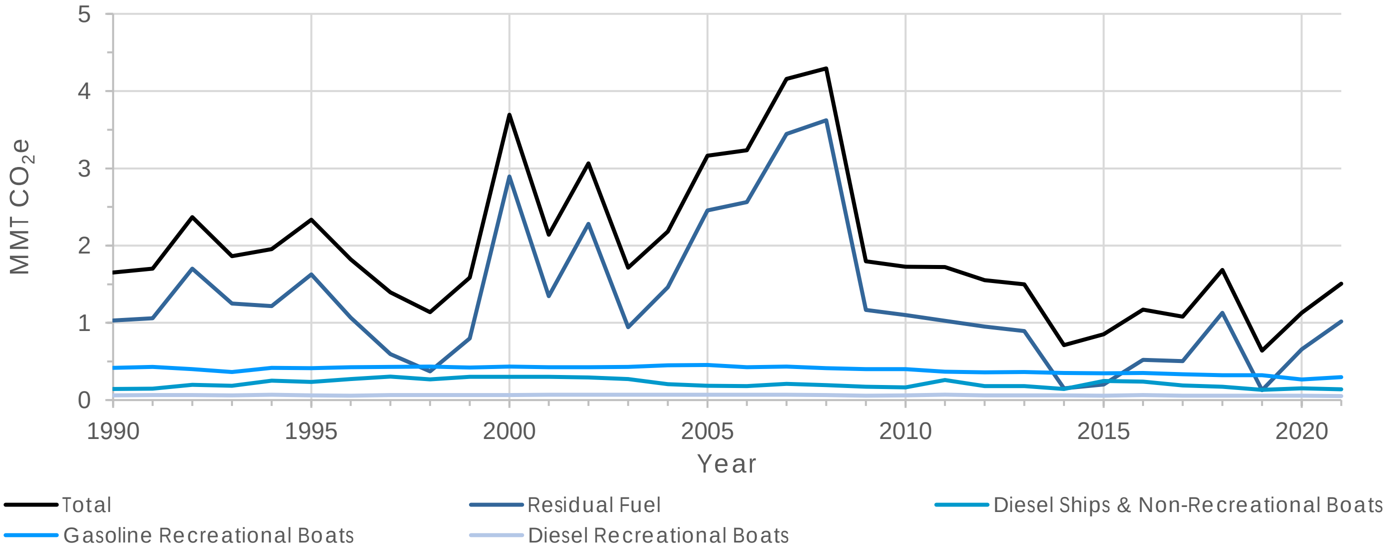
[22] Port Authority of New York and New Jersey, 2022 Airport Traffic Report, and 2009 Air Traffic Report, https://www.panynj.gov/airports/en/statistics-general-info.html. Accessed August 29, 2023.

[23] Emissions estimates are based on GWP_{100}. Estimates based on GWP_{20} are within 0.1 MMT CO_2e of the GWP_{100} values.

Figure 10. Marine Emissions (GWP_{100})



Rail Transportation

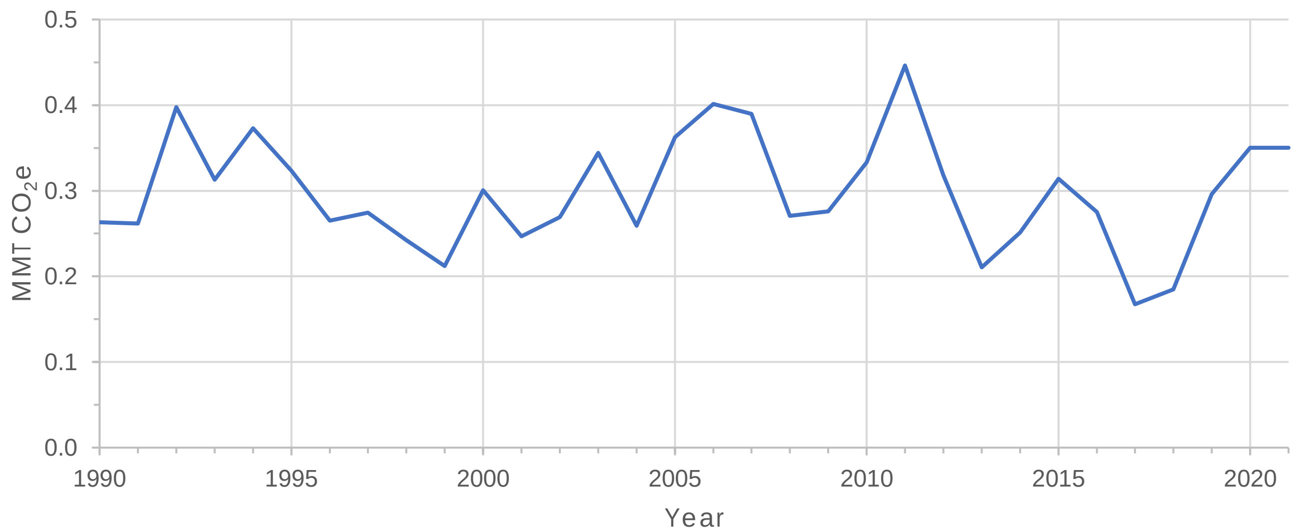
Rail transportation plays a major role in facilitating economic activity within the State. NJ Transit operates the State's public transportation system and has more than 500 miles of track, 166 rail stations, and provides almost 90 million passenger trips a year.[24] With respect to emissions, electrified rail service is well-established in the State, but considerable traffic still relies on diesel-powered locomotives, especially for freight service. Diesel-powered rail emissions remained relatively stable from 1990 through 2020, fluctuating between 0.2 and 0.4 MMT CO_2e across all years (Figure 11; Table A-8).[25] Fossil-powered freight and passenger rail accounted for 0.3% of New Jersey's gross emissions in 2020.[26] For comparison, the 2020 NEI reported rail emissions of 0.23 MMT CO_2e based on railroad activity data while NJ estimated 0.35 MMT CO_2e based on fuel consumption.

[24] https://www.njtransit.com/careers/railroad-careers/

[25] Emissions estimates are based on GWP_{100}. Estimates based on GWP_{20} are within 0.1 MMT CO_2e of the GWP_{100} values.

[26] Due to a technical issue, the USEIA has suspended release of the underlying fuel sales data used to estimate rail emissions. As a result, 2021 emissions are assumed to be unchanged at 0.4 MMT CO_2e for 2021. https://www.eia.gov/pressroom/releases/press532.php

Figure 11. Estimated New Jersey Rail GHG emissions from Diesel Fuel (GWP_{100})



3.2 ELECTRIC GENERATION

Electric generation, which includes dedicated in-state generation; in-state resource recovery facilities; and imported electricity, has consistently ranked as the State's second largest source of emissions after transportation. In 2021, emissions for the sector were 19.1 MMT CO_2e,[27] a decrease of 14.9 MMT CO_2e from the 2005 peak emissions of 34.0 MMT CO_2e (Figure 12; Table A-9). With respect to in-state generation (including resource recovery), emissions have dropped from the peak of 20.6 MMT CO_2e in 2005 to 14.3 MMT CO_2e in 2021, while at the same time in-state power output increased from 60,565 GWh to 64,512 GWh.[28] These shifts were largely due to reduced reliance on coal, expanded reliance on high-efficiency combined-cycle natural gas systems, and surging growth in renewable energy. In particular, the greater availability of clean energy in-state resources since 2005 has reduced demand for electricity imports, which tend to come from facilities with higher emissions rates.

In New Jersey's in-state energy mix, the dominant fossil fuel was natural gas which, combined with nuclear energy, provided 89.4% of in-state electric generation in 2021 (Figure 13, with incorporated table). Coal continued to decline, while renewable energy output[29] more than quadrupled since 2006. In 2021, renewables generated 5,202 GWh of electric power, or 8.1% of New Jersey's 64,512 GWh of in-state electric power generation.

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[27] Emissions estimates are based on GWP_{100}. Estimates based on GWP_{20} are within 0.1 MMT CO_2e of the GWP_{100} values.

[28] Including behind-the-meter solar photovoltaic. Totals listed in the text may not agree exactly with sums of the numbers shown in the tables in Appendix A due to rounding of estimates in the tables.

[29] Renewables include NJ Class I and Class II renewable energy sources, including but not limited to grid-connected and behind-the-meter solar photovoltaic, wind, hydroelectric, landfill gas, and solid waste resource recovery (biologically-produced component of fuel only).

Figure 12. Emissions from Electricity Generation (GWP_{100})

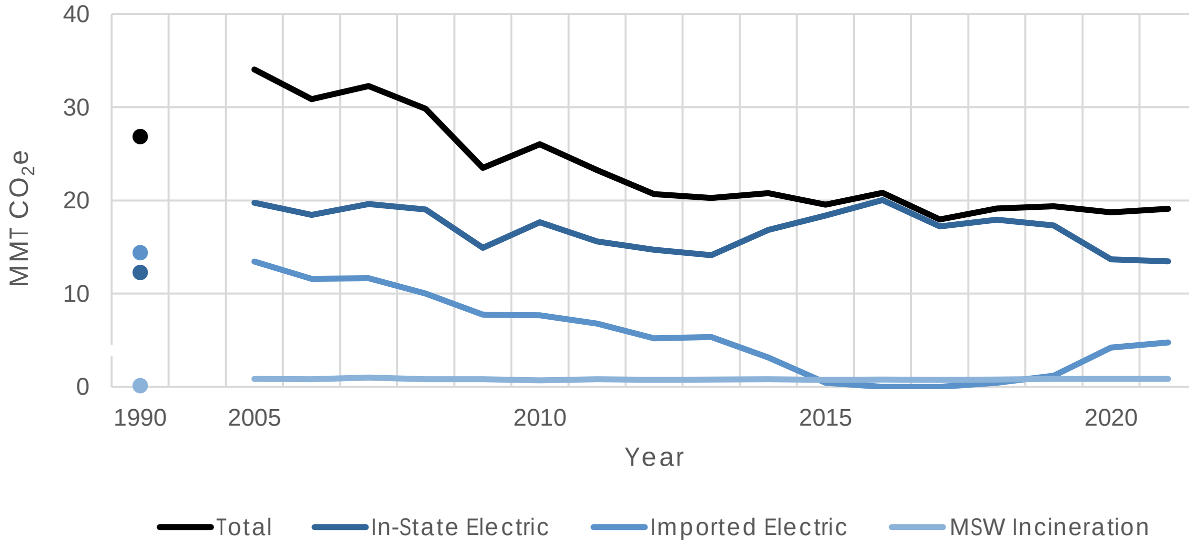
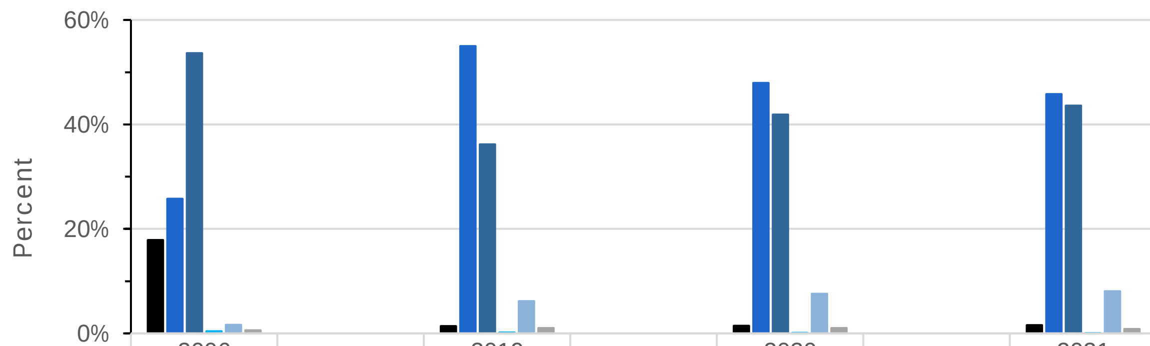


Figure 13. Percent of In-State Electricity Generated by Major Energy Sources

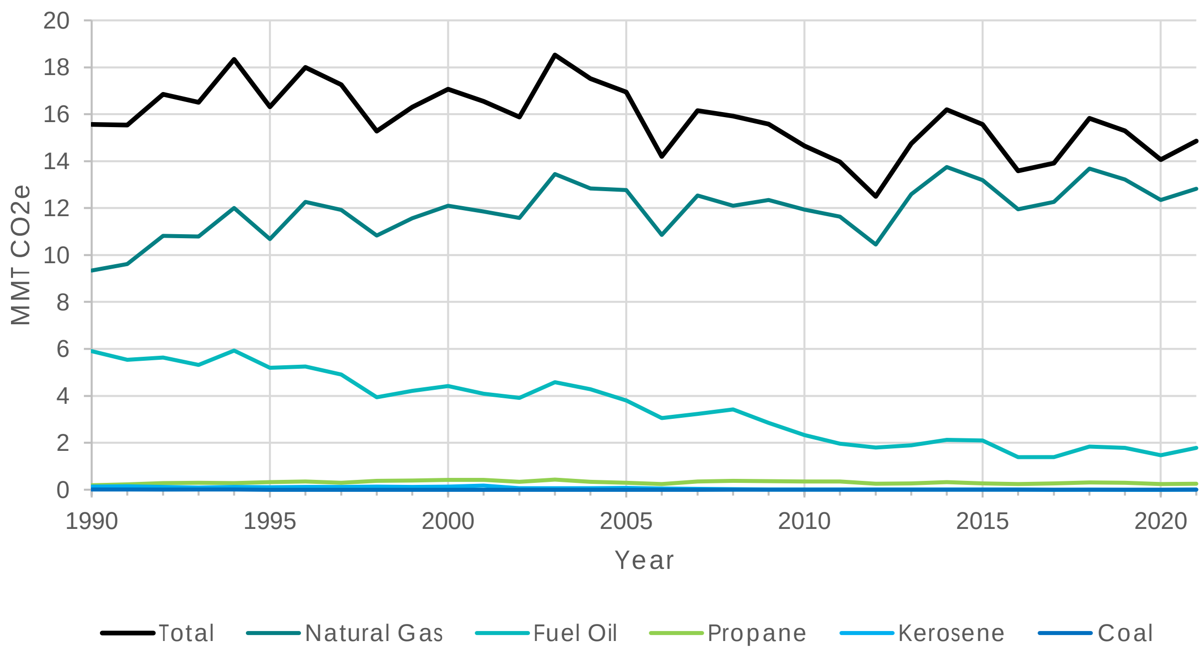


	2006	2019	2020	2021
Coal	17.9%	1.4%	1.4%	1.6%
Natural Gas	25.8%	55.0%	48.0%	45.8%
Nuclear	53.6%	36.2%	41.9%	43.6%
Petroleum	0.4%	0.2%	0.1%	0.1%
Renewables	1.6%	6.2%	7.6%	8.1%
Others	0.6%	1.0%	1.1%	0.9%

RESIDENTIAL SECTOR

Residential single and multi-family housing emissions are associated with space heating, water heating, air conditioning, lighting, refrigeration, cooking, appliances, and other household activities.[30] In 1990, emissions based on GWP_{100} totaled 15.6 MMT CO_2e, rose to 18.5 MMT by 2003, and fell to a low of 12.5 MMT in 2012. Most recently, 2021 emissions were 14.9 MMT (Figure 14; Table A-10).[31] Since the largest greenhouse gas contributor in this sector is carbon dioxide, estimates based on GWP_{20} are nearly identical. Combustion of natural gas accounted for 12.8 MMT in 2021, fuel oil 1.8 MMT, and the balance, propane (0.3 MMT).

Figure 14. Residential sector greenhouse gas emissions by fuel type (GWP_{100})



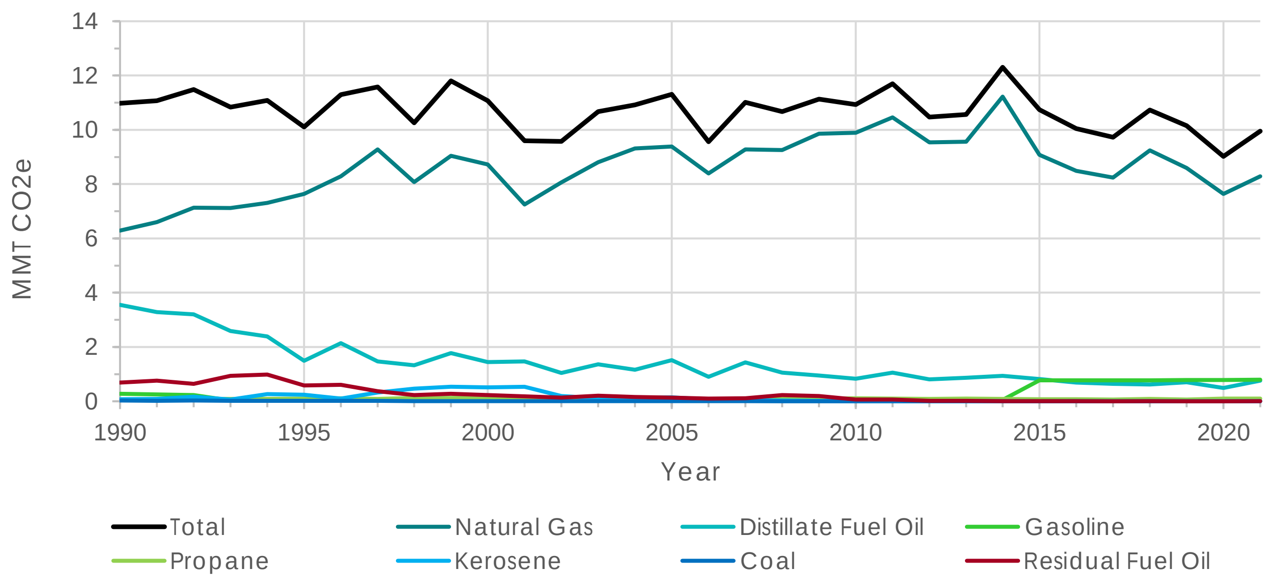
3.4 COMMERCIAL SECTOR

The Commercial sector includes service-providing facilities, business equipment, government activities, institutional living quarters, colleges, and religious institutions. Examples of sources that contribute to greenhouse gas emissions in this sector include heating, ventilation, and air conditioning (HVAC), cooking, and production of behind-the-meter electricity that is not fed into the electric grid. Emissions associated with fuel consumption at water and wastewater treatment plants are also included in this sector, as are those from cargo handling services at ports, warehouses and similar service providers. Methane emitted from biological processes at landfills and wastewater treatment plants is distinct in that it does not arise from combustion of fossil fuels, and therefore are discussed in later sections of this report specific to those activities.

[30] US Energy Information Agency, Glossary, Residential Sector, https://www.eia.gov/tools/glossary/. Accessed December 7, 2021.
[31] Estimates based on GWP_{20} are within 0.1 MMT CO_2e of the GWP_{100} values.

Emissions from the commercial sector have been stable since 1990, beginning the period at 11.0 MMT CO_2e (GWP_{100}).[32] Values reached a low of 9.6 in 2006, and climbed to a high of 12.3 in 2014. By 2021, emissions had fallen to 9.9 MMT CO_2e. (Figure 15, Table A-11). Emissions from fuel oil declined, and were matched by comparable increases from natural gas, the changeover being essentially complete before 2005.

Figure 15. Commercial sector greenhouse gas emissions by fuel type (GWP_{100})



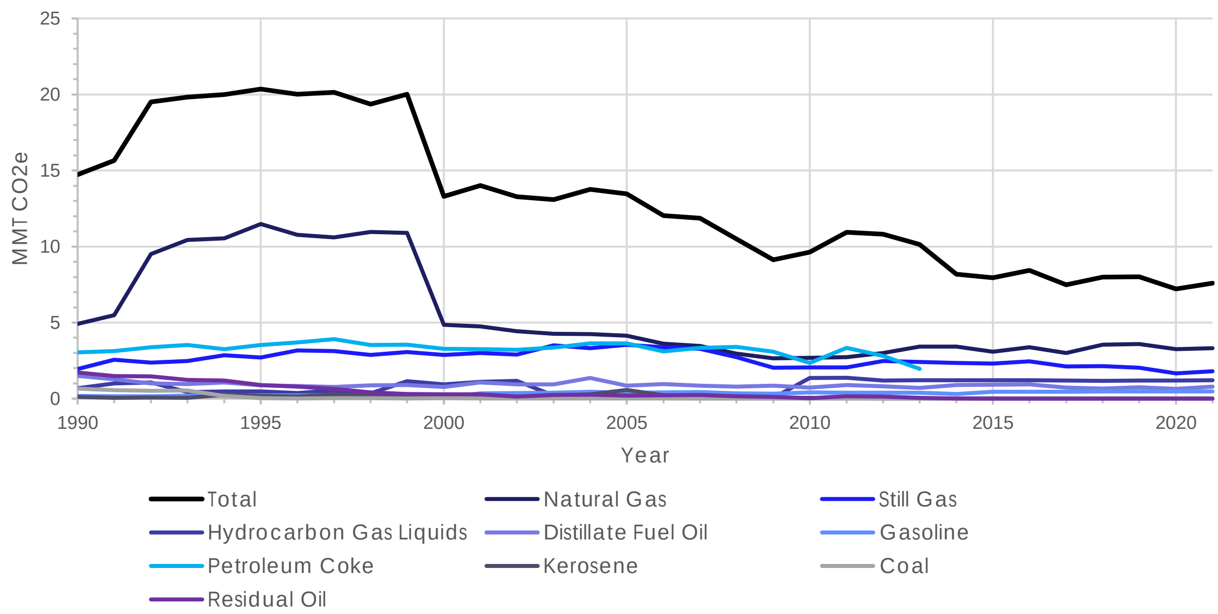
3.5 INDUSTRIAL SECTOR

The industrial sector includes activities that produce, process, or assemble goods, agriculture, and building construction as well as mining, and fossil-fuel production.[33] Emissions arise from energy use, such as from powering manufacturing equipment, tractors, logging equipment, and commercial fishing vessels. Emissions can also originate from fuel used for electric generation where that generation is fully "behind the meter" and does not feed the larger electrical grid. Categories of industrial emissions that are unrelated to fuel consumption, for example emissions from farming practices and industrial process chemistry,[34] are included in the inventory report as separate categories, distinct from fuel consumption.

Emissions from fuel consumption in the industrial sector have fluctuated as activities have shifted over time. Emissions were 14.7 MMT CO_2e in 1990,[35] but dropped to a low of 7.5 MMT CO_2e by 2017.[36] Emissions for 2021 were 7.6 MMT CO_2e (Figure 16, Table A-12). Emissions from combustion of natural gas dropped from 4.9 MMT CO_2e in 1990 to between 2.6 and 3.6 MMT CO_2e in recent years. Emissions from still gas, a product generated within refineries and used onsite as a fuel source, have remained between near 2 MMT CO_2e since 2009. In 2021 they were the second largest source of emissions in the sector at 1.8 MMT CO_2e.

[32] Estimates based on GWP_{20} are within 0.1 MMT CO_2e of the GWP_{100} values.
[33] USEIA Glossary, https://www.eia.gov/tools/glossary/index.php?id=I
[34] Examples of industrial processes that emit greenhouse gas emissions include cement manufacture, lime manufacture, limestone and dolomite use, soda ash manufacture and use, aluminum production, iron and steel production, ammonia production, and urea consumption. Not all of these processes take place in New Jersey.
[35] GWP_{100} basis. Because the fuel-based processes generating these emissions create very few highly-warming gases such as methane, estimates based on GWP_{20} are nearly identical. Additional information is in the appendices.
[36] Emissions estimates are based on GWP_{100}. Estimates based on GWP_{20} are within 0.1 MMT CO_2e of the GWP_{100} values.

Figure 16. Industrial sector fuel greenhouse gas emissions (GWP_{100})



4.0 NON-ENERGY EMISSIONS

4.1 HALOGENATED GASES (EXCLUDING SULFUR HEXAFLUORIDE)

Halogenated gases are compounds containing elements from the halogen group of the periodic table, including fluorine, chlorine, bromine, and iodine. With respect to climate change, hydrofluorocarbons (HFCs) are of the greatest concern because they are widely used and cause substantially more intense global warming than carbon dioxide on a weight per weight basis. On the other hand, HFCs break down relatively quickly in the environment compared to carbon dioxide, and their climate influence therefore decreases rapidly in response to lower emissions. HFCs are most commonly found in refrigeration and air conditioning equipment as well as in products such as foams, spray cans, and fire-fighting systems. Since their introduction in the early 1990s, HFCs have been widely deployed as replacements for ozone-depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs).

Since 2005, HFC emissions have gradually increased from 2.2 MMT CO_2e to a peak of 5.3 MMT CO_2e (GWP_{100}) in 2020, but decreased to 5.2 MMT CO_2e in 2021 due to adoption of policies phasing out use of these materials (Figure 17; Tables A-13). The three largest source types in 2021 were commercial refrigeration (1.8 MMT CO_2e), light-duty motor vehicle air conditioning (0.6 MMT CO_2e) and small commercial air conditioning units (0.7 MMT CO_2e) (Figure 18). Using a 20-year GWP, total HFC emissions rose from 5.2 MMT CO_2e (GWP_{20}) in 2005 to a peak of 12.0 MMT CO_2e (GWP_{20}) in 2020, but dropped to 11.8 MMT CO_2e in 2021. Commercial refrigeration accounted for 4.1 MMT CO_2e (GWP_{20}) in 2021, light-duty motor vehicle air conditioning 1.5 MMT CO_2e (GWP_{20}), and small commercial air conditioning equipment 1.5 MMT CO_2e (Figures 19 and 20; Table A-14).

Figure 17. Hydrofluorocarbon emissions by category (GWP_{100})

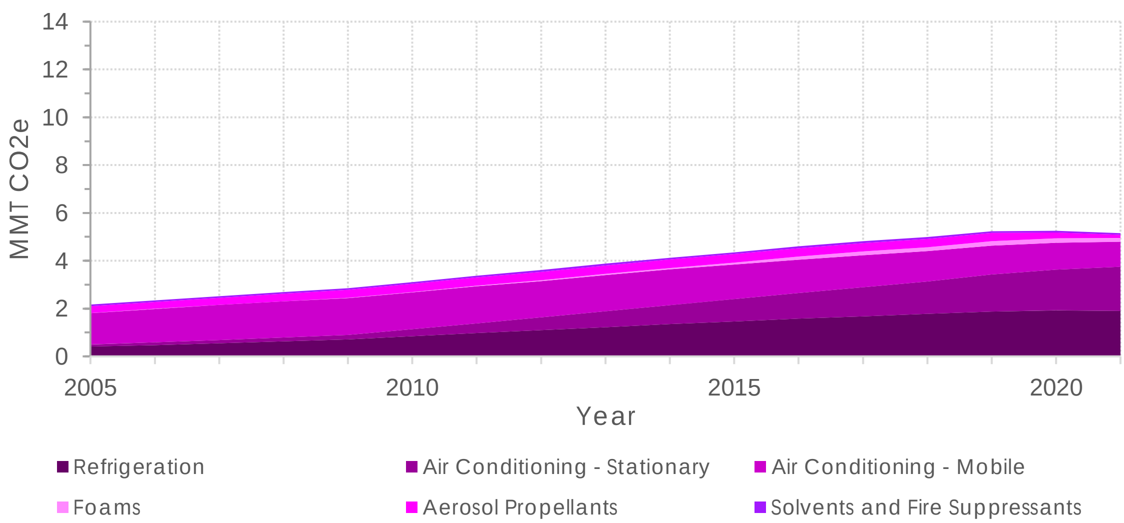


Figure 18. 2021 HFC emissions profile (GWP_{100})

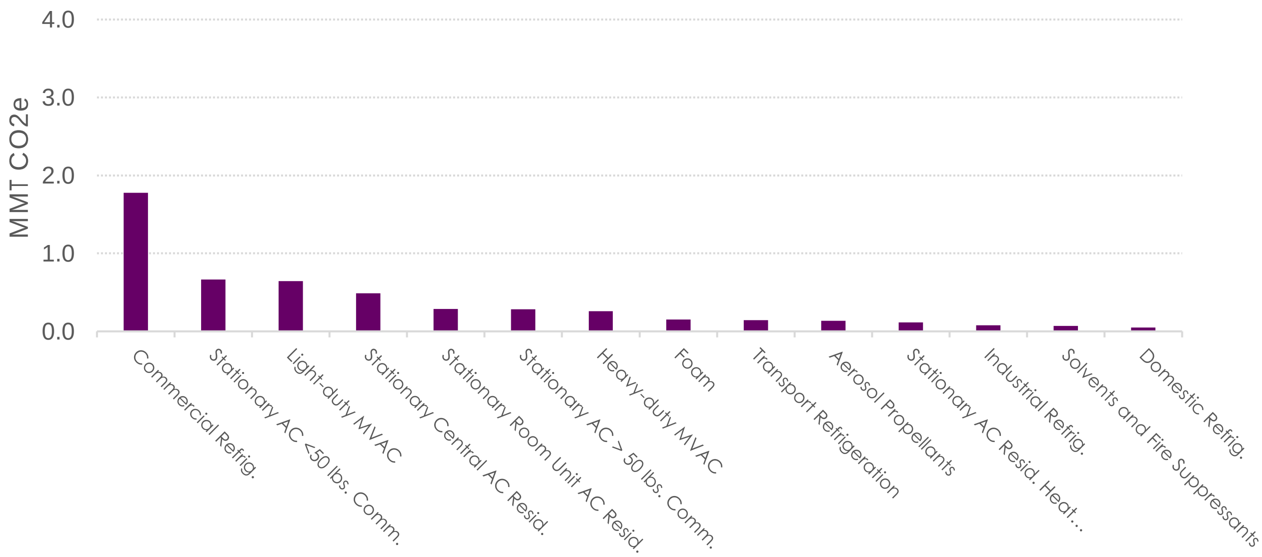


Figure 19. HFC emissions by category (GWP_{20})

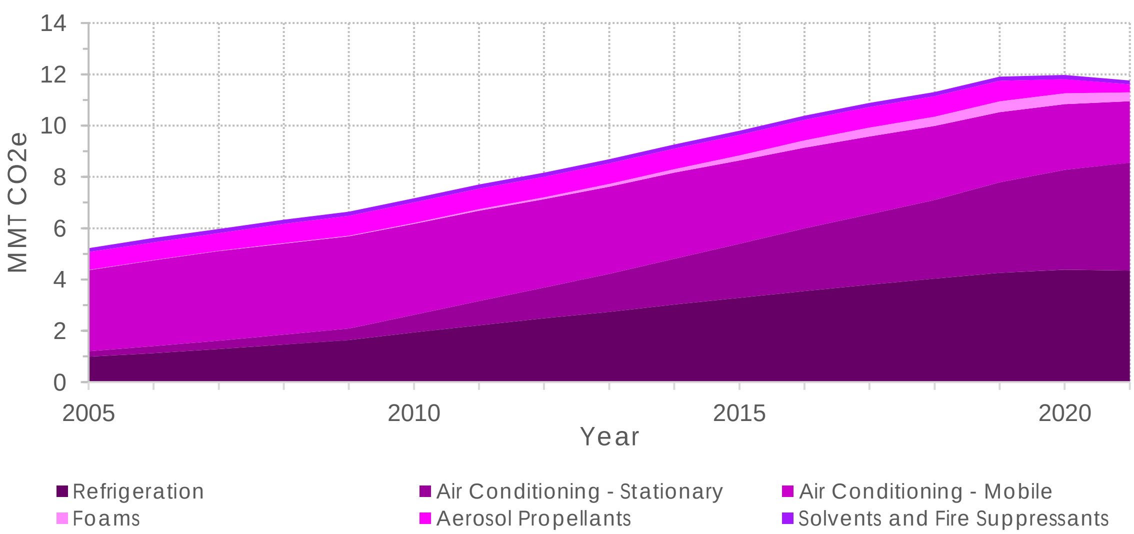
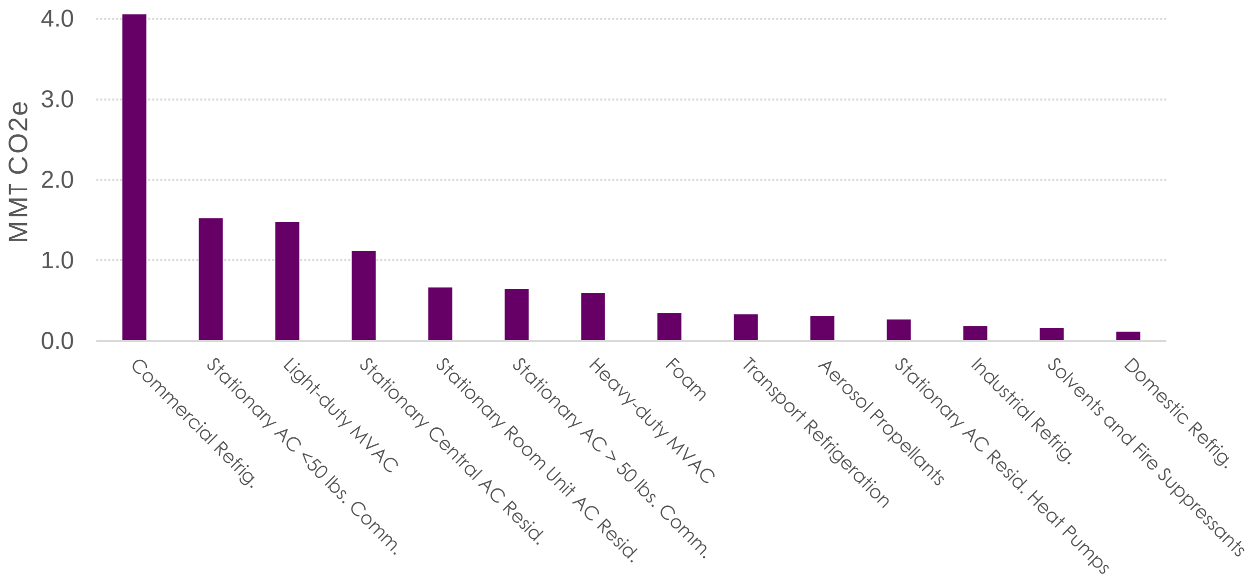


Figure 20. 2021 HFC emissions profile (GWP_{20})



4.2 NATURAL GAS TRANSMISSION AND DISTRIBUTION

Natural gas, which consists primarily of methane, is used throughout New Jersey for space heating, hot water heating, cooking and industrial applications. In 2021, over 1,600 miles of long-distance transmission pipelines crossed the state, and over 35,700 miles of distribution mains delivered gas to users through more than 2.3 million service connections. At each step of the delivery process, methane can potentially be released to the atmosphere. However, because of methane's explosive risk, extensive precautions are used to minimize releases. Equally important, New Jersey does not have any natural gas production wells or pre-transmission processing facilities, eliminating the risk of emissions from these operations.

Between 2006 and 2021, emissions from New Jersey's natural gas transmission and distribution system decreased 19%, from 3.1 MMT CO_2e at the outset to 2.5 MMT CO_2e in 2021 based on GWP_{100}, or from 9.4 to 7.5 MMT CO_2e based on GWP_{20} (Figures 21 and 22, Table A-15). Emissions arise primarily from the distribution system, and specifically from older service connections. Efforts to replace older service lines with lower-emitting infrastructure are the primary cause of the observed decrease. An apparent increase in 2006 was the result of a reclassification of a large number of service connections in the PSEG utility distribution network from a lower-emitting category to a higher-emitting category. There was no significant change in the distribution system itself. As a result, emissions estimates for the years preceding 2006 are likely underestimated by a small amount (approximately 0.2 MMT CO_2e (GWP_{100})/ 0.6 MMT CO_2e (GWP_{20}). However, DEP has used the published data for the years in question and has not attempted to adjust the emissions estimates for those years.

Figure 21. Natural gas transmission and distribution (GWP_{100})

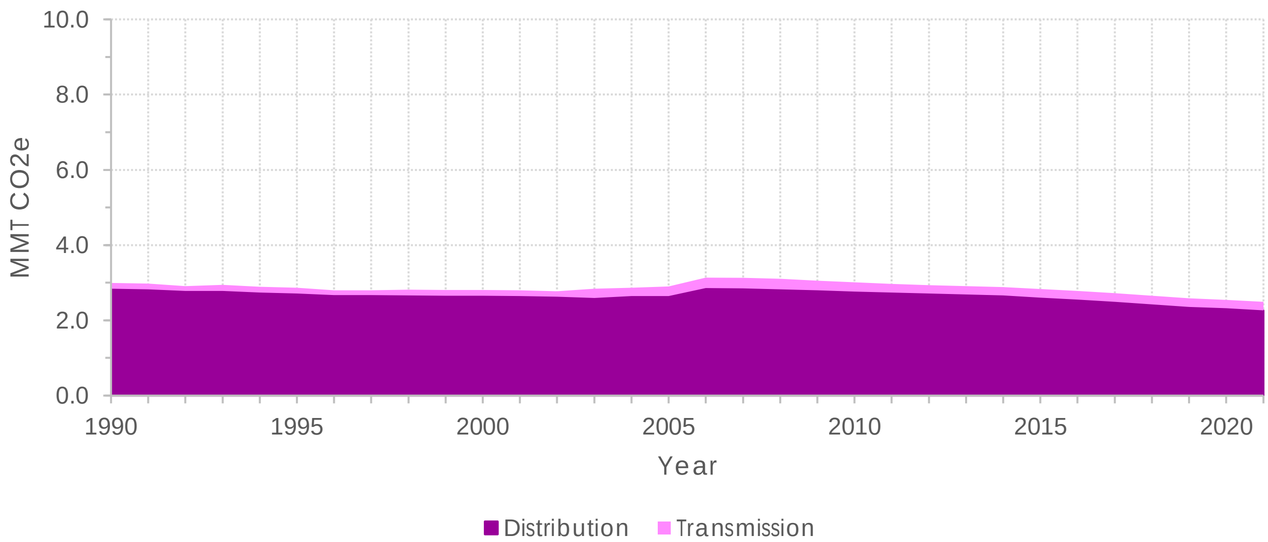
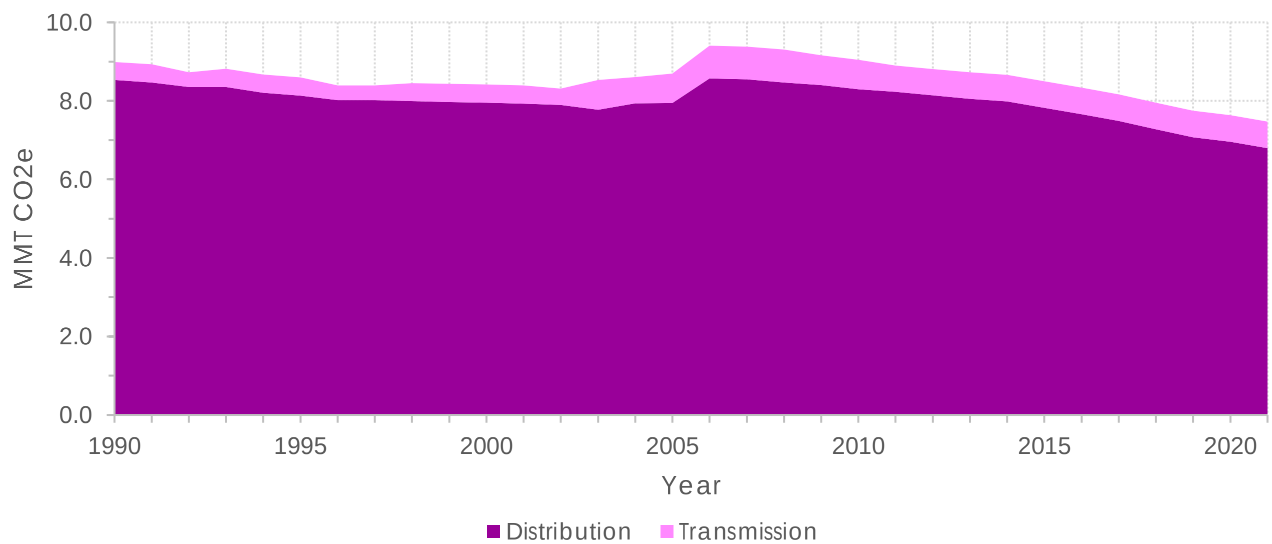


Figure 22. Natural gas transmission and distribution (GWP_{20})



4.3 LANDFILLS

Disposal of solid waste by landfill results in anaerobic decomposition that in turn produces landfill gas, a mixture of approximately equal parts methane and carbon dioxide by weight. Because carbon dioxide in landfills arises almost entirely from the decomposition of plant matter (which in turn grew using atmospheric carbon dioxide), its return to the atmosphere does not represent a net addition and is therefore not included in the State's greenhouse gas emissions. This approach is consistent with international convention as well as USEPA policy.[37] On the other hand, the methane produced in landfills is many times more potent as a greenhouse gas than the atmospheric carbon dioxide absorbed by plants when the organic matter was created, and it is therefore included in the state's greenhouse gas inventory.

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[37] The impacts of land use change associated with forestry and other agricultural practices are addressed separately under the land clearing and carbon sequestration categories in this report.

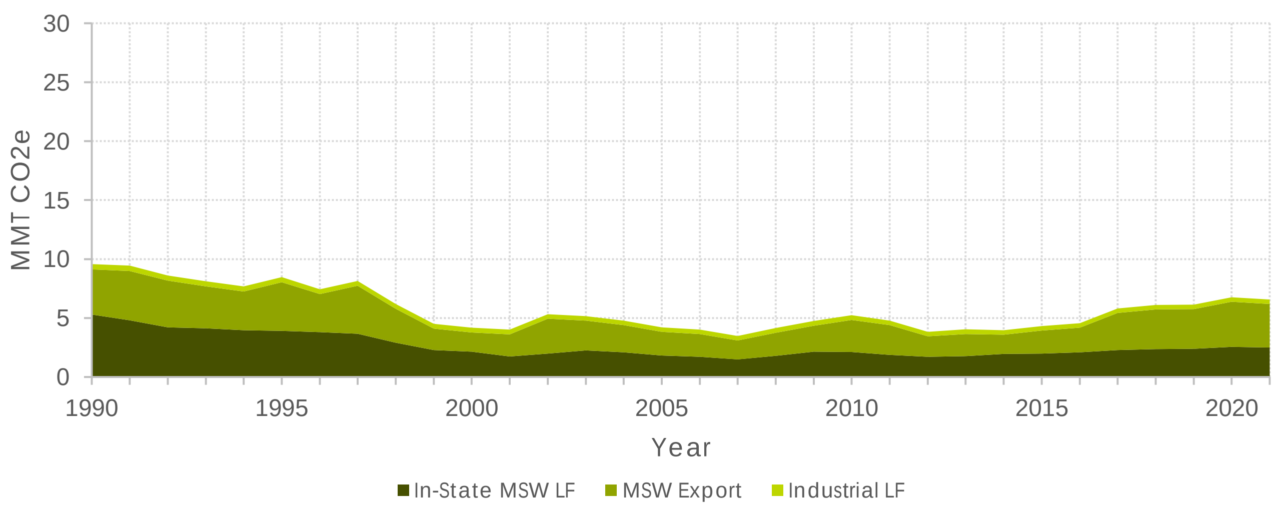
Modern landfills include systems to collect landfill gas and either directly vent it to the atmosphere, burn the gases by flaring, or, when sufficient quantities are available, combust the gases onsite for electricity generation. Methane emissions reported here are those directly vented to the atmosphere. If the methane is burned in a flare or electric generating system, the resulting carbon dioxide is not considered to represent a net increase to the atmosphere, just as for carbon dioxide released directly from the landfill. Emissions from waste disposed of out-of-state are also estimated based on the assumption that methane is released at the same rate per ton as waste disposed of at in-state landfills.

Methane emissions from landfill disposal decreased from 9.6 MMT CO_2e (GWP_{100})/ 28.7 MMT CO_2e (GWP_{20}) in 1990 to 3.5 MMT CO_2e (GWP_{100})/ 10.5 MMT CO_2e (GWP_{20}) in 2007.[38] By 2021, emissions increased to 6.6 MMT CO_2e (GWP_{100})/19.7 MMT CO_2e (GWP_{20}) (Figures 23 and 24, Table A-16). Emissions have been divided fairly evenly between in-state and out-of-state sources. In 2021, out-of-state sources accounted for 56% of emissions, in-state sources 38%, and industrial landfills 6%.

State Action: Waste Management

New Jersey has passed a series of laws to reduce the amount of food waste entering the municipal waste stream in the state. The Food Waste Reduction Act (P.L. 2017, c.136) establishes a specific goal of reducing food waste generated in the state by 50% by 2030.[39] As part of this effort, the Department of Environmental Protection has developed the New Jersey Food Waste Reduction Plan, quantifying food waste production and establishing short-term and long-term strategies to achieve the 50% goal.[40] Following on the heels of the Food Waste Reduction Act, in 2020, the Food Waste Recycling and Waste-to-Energy Production Act (P.L. 2020, c.24) was passed, requiring large food waste generators (those who produce 52 tons or more of food waste per year) located within 25 road miles of an approved recycling facility to source separate and recycle their food waste. The Department of Environmental Protection is actively developing a rule proposal to implement this law.

Figure 23. Emissions from solid waste landfills (GWP_{100})

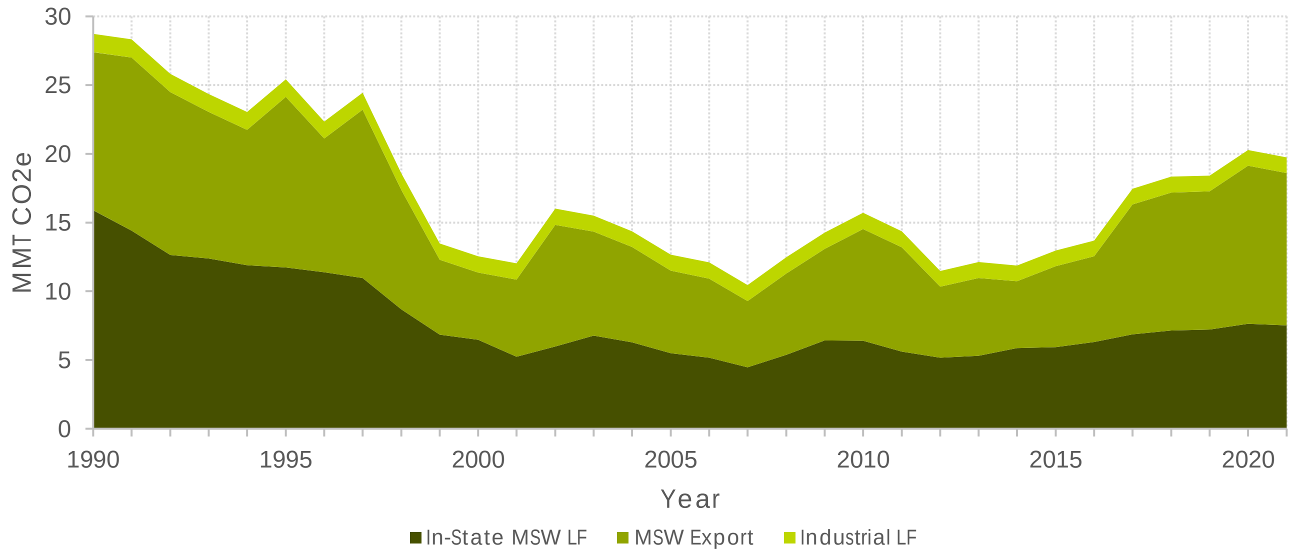


[38] Totals listed in the text may not agree exactly with sums of the numbers shown in the tables in Appendix A due to rounding of estimates in the tables.

[39] https://www.nj.gov/dep/dshw/food-waste/pl_2017_136.pdf, July 21, 2017. The statute calls for a 50% reduction below 2017 levels. Accessed December 14, 2023.

[40] https://www.nj.gov/dep/dshw/food-waste/food_waste_reduction_plan.pdf, October 2023. The plan concluded that New Jersey generated 1.48 million tons of food waste in 2017, comprising about 22% of all municipal solid waste disposal. Accessed December 14, 2023.

Figure 24. Emissions from solid waste landfills (GWP_{20})



4.4 WASTEWATER TREATMENT

Treatment of municipal wastewater can result in production of methane when anaerobic digestion is used as part of the solids management process. Nitrous oxide can also be produced in the treatment process and in residential septic systems. Carbon dioxide is also produced, but, as with landfills, it is excluded from consideration based on that fact that it comes from decomposition of biological materials and therefore does not represent a net increase in atmospheric CO_2.

Wastewater treatment emissions have remained nearly constant throughout the period, rising from 0.7 MMT CO_2e/1.8 MMT CO_2e (GWP20) in 1990 to 0.9 MMT CO_2e (GWP_{100})/2.2 MMT CO_2e (GWP_{20}) in 2021 (Figures 25 and 26; Table A-17). The estimates are based on nationally-determined assumptions regarding organic waste production and state population size, and may therefore not reflect individual state-specific circumstances. The estimates are, however, considered sufficiently accurate to allow wastewater treatment emissions to be compared with other emissions sources for policy development.

Figure 25. Wastewater treatment emissions (GWP_{100})

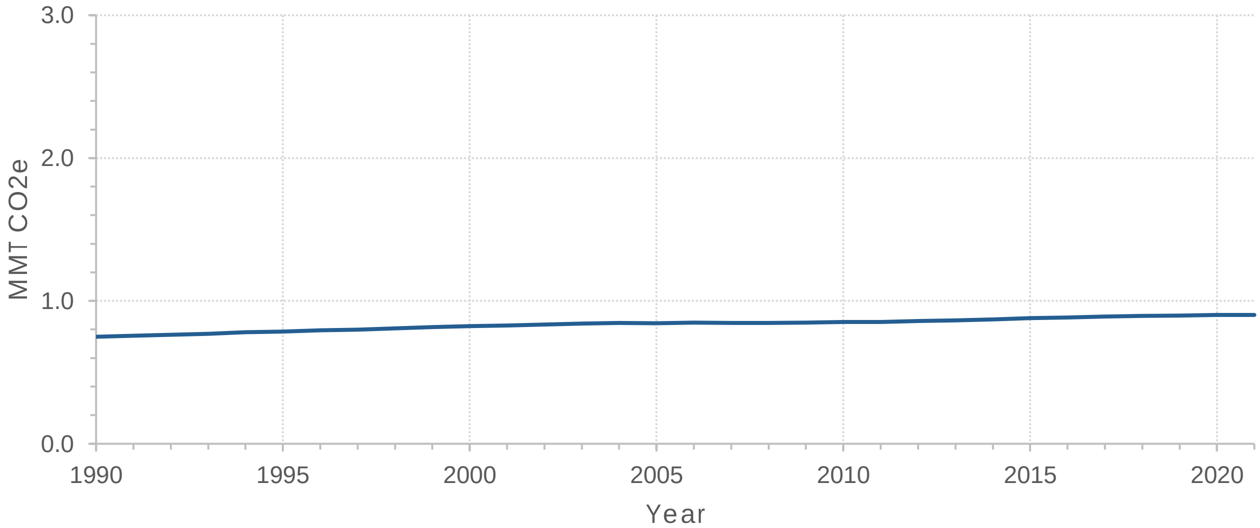
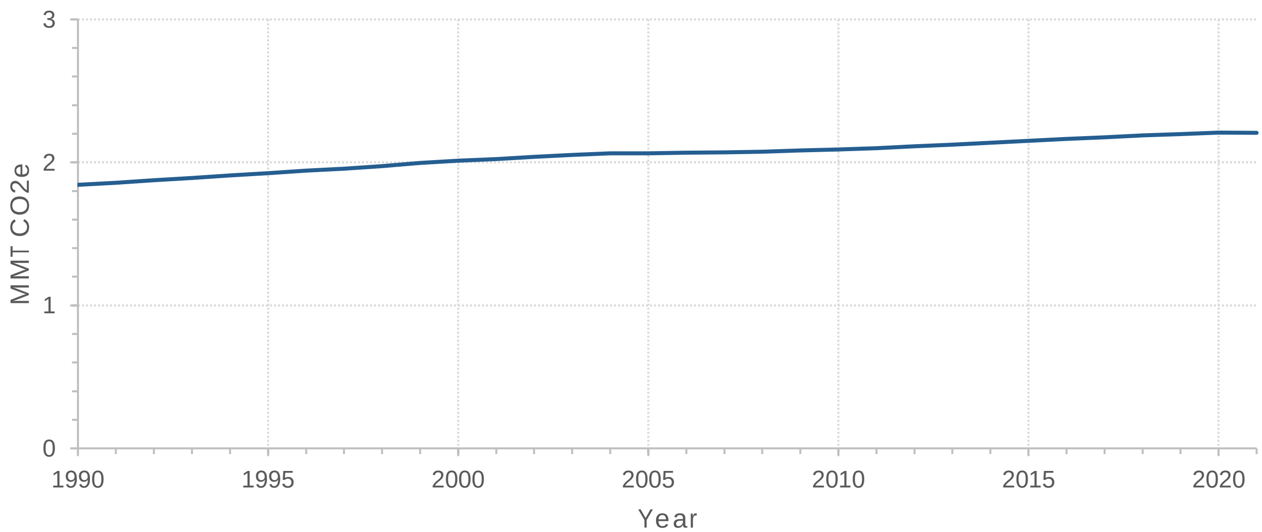


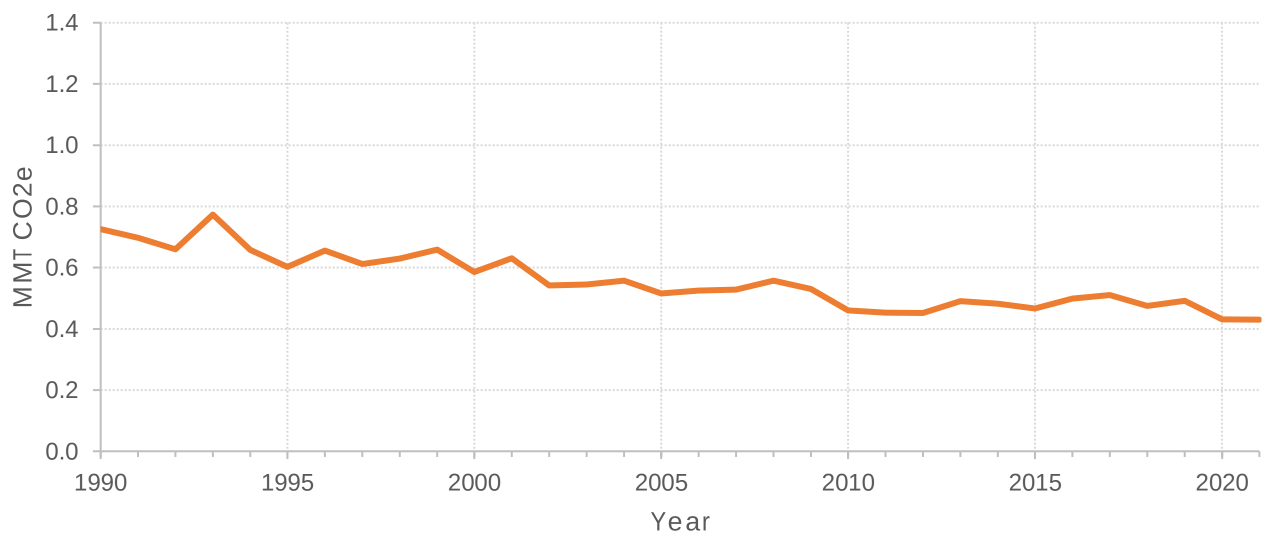
Figure 26. Wastewater treatment emissions (GWP_{20})



4.5 AGRICULTURE (NON-FUEL)

New Jersey's 9,900 farms have an average size of only 76 acres, and yet they make the state a national leader in production of fruits and vegetables.[41] This success is largely a consequence of the state's favorable climate and proximity to major population centers. Livestock operations also take place, but to a much smaller extent than in many other agriculturally-intensive states.[42] Overall, farm activities in the state produce modest non-fuel greenhouse gas emissions. Between 1990 and 2021, these ranged annually from 0.4 to 0.8 MMT CO_2e (GWP_{100}), with a general downward trend across the period (Figure 27, Table A-18). Using a 20-year GWP, emissions ranged from 0.6 to 1.2 MMT CO_2e (GWP_{20}) across the same period (Figure 28, Table A-18). Emissions for 2020 were 0.4 MMT CO_2e (GWP_{100})/0.6 MMT CO_2e (GWP_{20}).[43] Examples of non-fuel emissions include release of nitrous oxide from the soil, carbon dioxide from agricultural lime used to neutralize soil acids, and methane emissions from livestock and manure management. Emissions from fuels consumed at farms, for example to power farm equipment, are included in the fuel-based industrial sector emissions described above, pursuant to the classification method of the US Energy Information Agency (US EIA).

Figure 27. Agriculture (Non-fuel) emissions (GWP_{100})

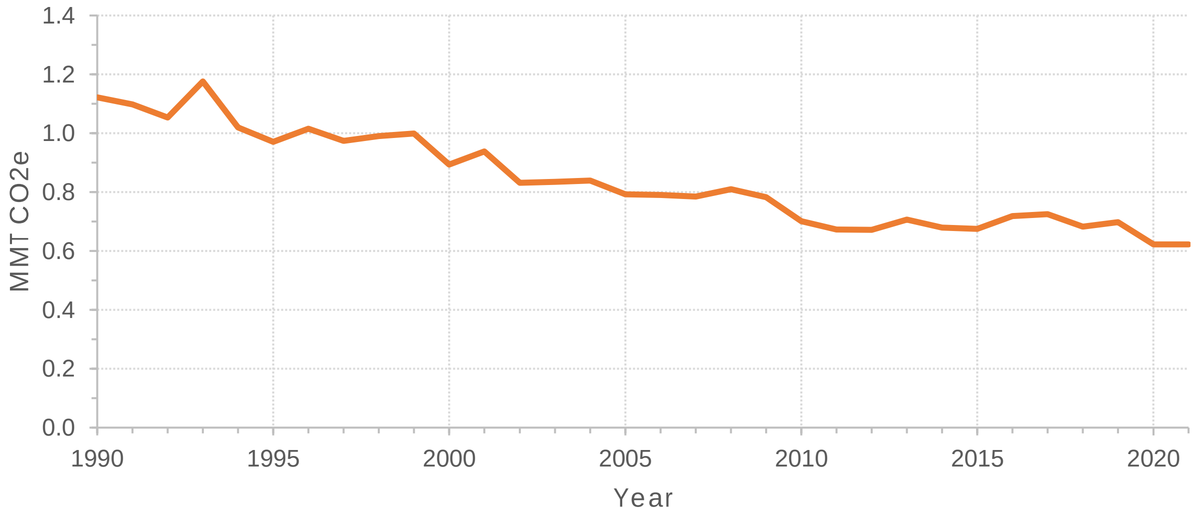


[41] New Jersey is a top producer of eggplant (#1 nationally); spinach (#3); tomatoes (#3); cranberries (#3); asparagus (#4); bell peppers (#3); peaches (#3); blueberries (#6); cucumbers (#6); squash (#7); and sweet corn (#9). The state is also ranked fourth in floriculture sales. Source: 2022 Annual Report and Agricultural Statistics, NJ Department of Agriculture, 2022. https://www.nj.gov/agriculture/pub/general.html. Accessed December 15, 2023.

[42] In January 2021, New Jersey had approximately 25,000 head of cattle and 7,500 hogs. In contrast, Texas cattle numbered in the range of 12.7 million and Iowa hogs 24 million. Livestock agriculture in New Jersey therefore contributes less to climate change than in many other agricultural states. However, New Jersey is committed to reducing climate impacts wherever feasible while maintaining a prosperous agricultural community. Sources: 2022 Annual Report and Agricultural Statistics, NJ Department of Agriculture, 2022. https://www.nj.gov/agriculture/pub/general.html; USDA Annual Cattle Review, Texas, 2023, https://www.nass.usda.gov/Statistics_by_State/Texas/Publications/Current_News_Release/2023_Rls/tx-cattle-review-2023.pdf; 2020 Iowa Pork Industry Report, May 2020, https://www.iowapork.org/filesimages/Documents/Full_Iowa-Pork-Industry-Report.pdf Accessed December 15, 2023.

[43] Non-fuel agricultural emissions data for 2021 was not available from the USEPA State Inventory Tool at the time of this report's preparation. These emissions were therefore assumed to have remained constant since 2020.

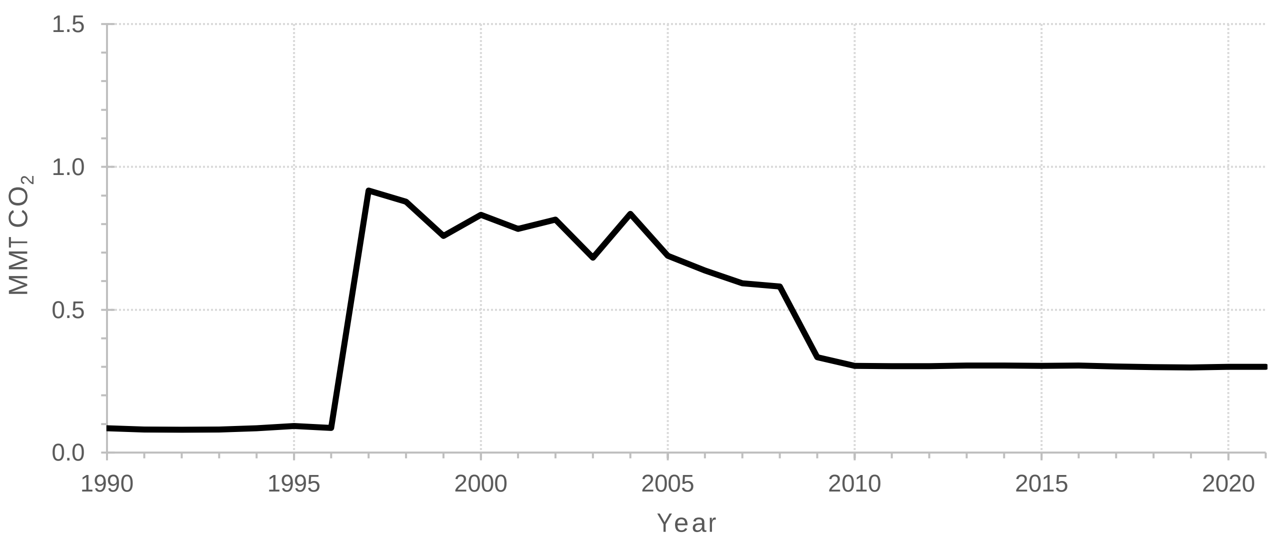
Figure 28. Agriculture (Non-fuel) emissions (GWP_{20})



4.6 NON-FUEL INDUSTRIAL

Certain industrial processes occurring in the state produce carbon dioxide in sufficient quantities to warrant inclusion in the greenhouse gas inventory, including activities related to limestone and dolomite, soda ash, iron and steel production, and urea consumption. Emissions have consistently been below 1.0 MMT CO_2 throughout the period, with iron and steel production being the largest contributors during the peak years between 1997 and 2008. Emissions in 2020 were approximately 0.3 MMT CO_2e (Figure 29; Table A-19).[44] Because the emissions are carbon dioxide, the values are independent of GWP.

Figure 29. Non-fuel Industrial Emissions



[44] Non-fuel industrial emissions data for 2021 was not available from the USEPA State Inventory Tool at the time of this report's preparation. These emissions were therefore assumed to have remained constant since 2020.

4.7 EMISSIONS DUE TO LAND CLEARING

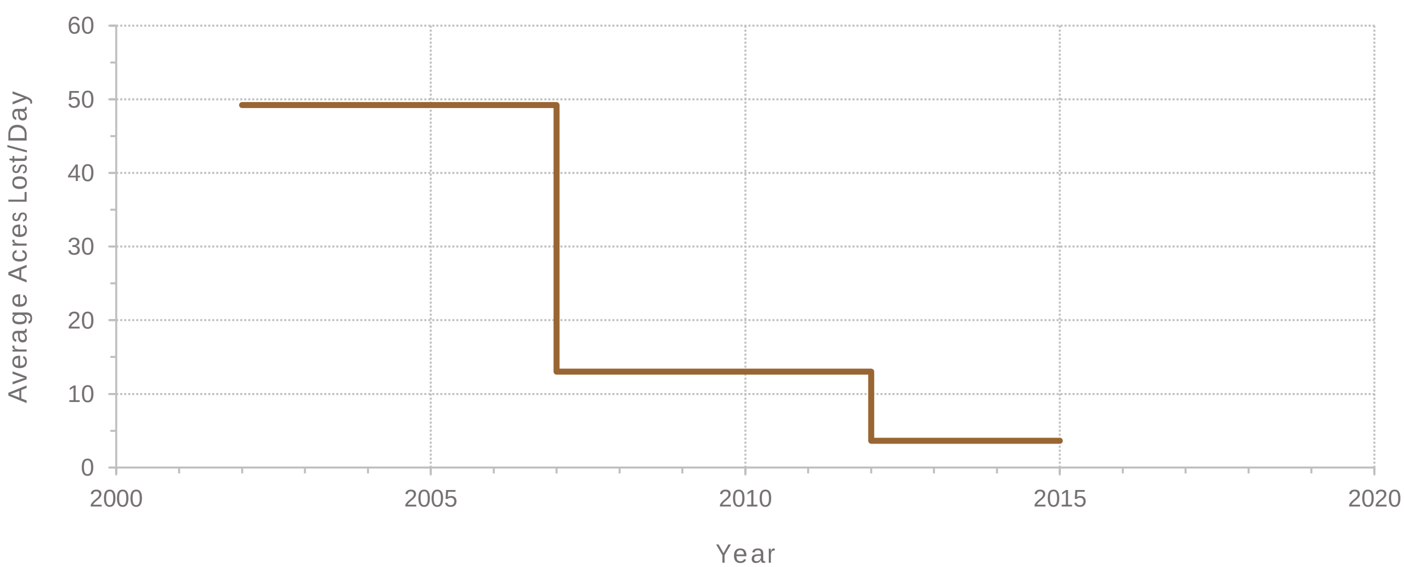
Large stores of carbon exist in the state's forests, wetlands and other biological reserves. When these lands are disturbed through development and urbanization, much of their stored carbon is released to the atmosphere as carbon dioxide, thereby accelerating climate change. The rate at which land is developed is directly influenced by economic, social, and governmental factors.

New Jersey has seen significant reductions in the rate of loss of natural lands (Figure 30), dropping from an average of 49 acres per day between 2002 and 2007 to 4 acres per day between 2012 and 2015. A combination of factors, including the economic recession of 2008, land conservation policies, and shifting demographic patterns, are linked to the slowing rate of loss.

The impact of land use changes on greenhouse gas emissions depends on the types of land affected as well as the overall amount of land converted. For example, salt marshes and tidal wetlands can capture and store as much as ten times as much carbon in a year than forests, on an acre-for-acre basis.[45]

Based on a land use analysis, it is estimated that loss of natural lands in New Jersey results in emissions of 1.0 MMT CO_2e annually, or approximate 1% of the state's gross emissions.

Figure 30. Decreasing rate of loss of forests, wetlands, farmlands and other undeveloped areas.[46]



4.8 SULFUR HEXAFLUORIDE

Sulfur hexafluoride (SF_6) is a long-lived climate pollutant with an exceptionally high global warming potential of 23,500, based on a 100-year time period. Because it can persist in the atmosphere for thousands of years, even small releases of SF_6 can create lasting impacts. In the past, SF_6 was widely used in high voltage electrical equipment because of its insulating and arc-inhibiting properties, and also in lesser amounts in a variety of industrial and scientific applications.

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[45] Pidgeon, E. 2009. Carbon sequestration by coastal marine habitats: Important missing sinks. Pages 47–51 *in* D. I. Laffoley and G. Grimsditch, editors. The management of natural coastal carbon sinks. IUCN, Gland, Switzerland. https://oceanfdn.org/sites/default/files/Laffoley%20The%20Management%20of%20Natural%20Coastal%20Carbon%20Sinks-.pdf

[46] Based on land use data from NJDEP Bureau of Geographic Information Systems

Due to its climate impact, use of SF_6 has decreased significantly since 1990 as older equipment is phased out and applications are revised to minimize its use. In New Jersey, emissions dropped from 0.6 MMT CO_2e (GWP_{100}) in 1990 to 0.08 MMT CO_2e (GWP_{100}) in 2020 (Figure 31; Table A-20).[47] Due to its long lifetime in the atmosphere, the 20-year GWP of SF_6 is lower than its 100-year GWP, meaning that estimates made using the 20-year GWP are less than those found using the 100-year GWP. Based on a 20-year GWP, SF_6 emissions dropped from 0.4 MMT CO_2e (GWP_{20}) in 1990 to 0.06 MMT CO_2e (GWP_{20}) in 2021 (Figure 32; Table A-20).

Figure 31. Sulfur hexafluoride emissions (GWP_{100})

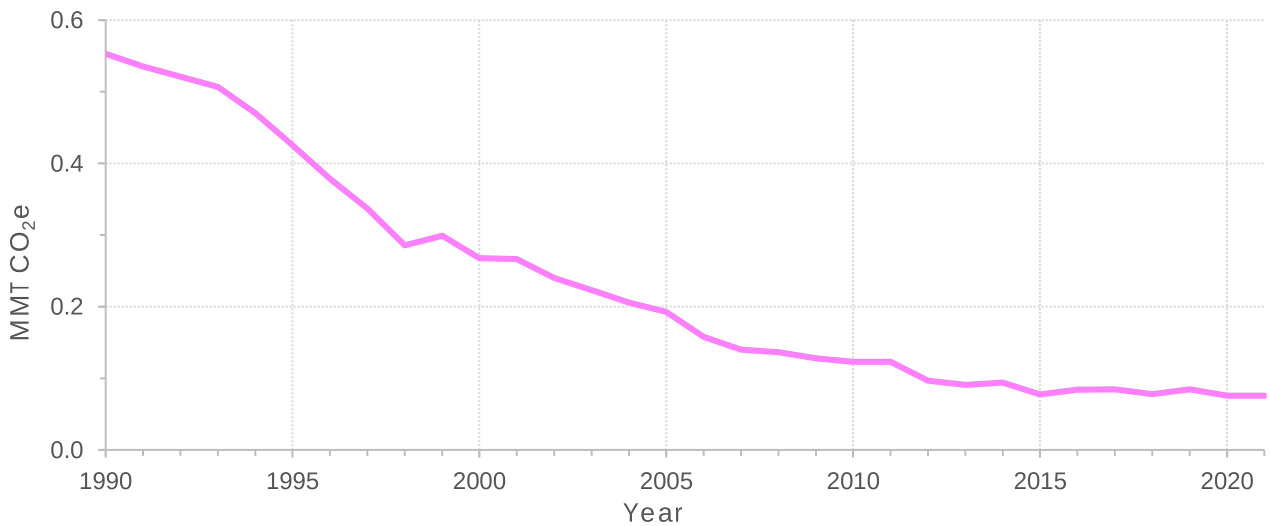
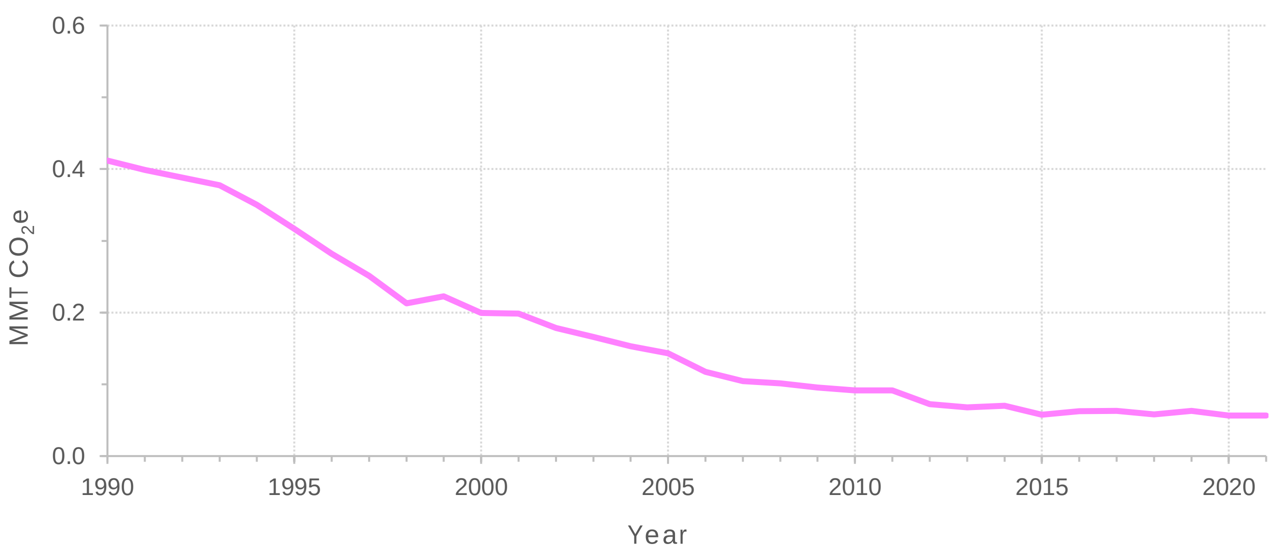


Figure 32. Sulfur hexafluoride emissions (GWP_{20})



[47] Sulfur hexafluoride emissions data for 2021 was not available from the USEPA State Inventory Tool at the time of this report's preparation. These emissions were therefore assumed to have remained constant since 2020.

5.0 CARBON SEQUESTRATION

5.1 CARBON SEQUESTRATION

Atmospheric carbon dioxide is naturally taken up by plants, the carbon being incorporated into biomass and ultimately into the soil. Over long periods, large amounts of carbon dioxide can be removed and incorporated into minerals. In fact, fossil fuels were created from atmospheric carbon dioxide through this process of photosynthetic sequestration and subsequent transformation. Terrestrial and aquatic photosynthesis can therefore reverse the accumulation of free atmospheric carbon dioxide.

New Jersey's natural lands remove a measurable amount of carbon dioxide each year. As determined by land use analysis and through measurement of the rates at which each type of land absorbs and sequesters carbon dioxide from the atmosphere, DEP estimates that approximately 8.1 MMT CO_2e are currently removed annually. This represents approximately 8% of 2021 gross emissions. Actively working to expand natural lands and enhance their performance as sequestration resources will even further accelerate achievement of the state's emissions goals.

6.0 BLACK CARBON

6.1 BLACK CARBON

Black carbon, also known as elemental carbon and soot, is a type of fine particulate matter. The most common sources of black carbon in the atmosphere are associated with the incomplete combustion of hydrocarbons, for example from the burning of diesel fuel or wood, although other processes such as tire wear also contribute. Black carbon typically contains a wide variety of hydrocarbons and metals, and can adsorb other pollutants such as acids and vapors onto its surface.

Several variants of black carbon are known carcinogens in addition to being a significant climate pollutant. Its dark color and the fact it is composed of small, lightweight particles allow it to act in the atmosphere through direct absorption of sunlight, alteration of clouds, and, once deposited on the ground, accelerated melting of snow and ice. Since it is not a gas, it behaves differently in the environment than other climate pollutants. It is quickly removed from the air by settling, generally in a few days to weeks.[48] It also does not remain suspended long enough to mix completely with the global atmosphere. As a result, its effects are greatest close to the source.

Beginning with the public release of the 2014 National Emissions Inventory (NEI)[49], the USEPA has published detailed estimates of black carbon emissions for individual states in over 400 different source categories. However, EPA did not include black carbon quantities in earlier releases of the NEI. Also, the NEI is only released every three years, and, once published, past estimates are not updated to reflect improved assessment methodologies. Thus, this report provides a comprehensive black carbon inventory for New Jersey, covering years 2005 through 2020 (Tables A-2 and A-4; and Appendix E). The methods used to calculate the inventory are comparable to those applied in the 2020 NEI. Additional data for on-road transportation is provided for 2021 based on NJDEP modeling.[50] A detailed discussion of the methods can be found in Appendix B.

Black carbon is a component of the broader class of fine particulate matter having diameter of 2.5 µm or less ($PM_{2.5}$). When fine particulate matter is created, the amount of black carbon that is produced depends on the materials consumed and the process by which the particulates are created. For example, when diesel fuel is burned in an internal combustion engine, the fraction of the particulate matter that is black carbon is approximately 77%, but when natural gas is consumed in a turbine, only about 7% of the fine particulate matter is black carbon.[51] Further, the fraction of $PM_{2.5}$ that is black carbon is distinct from the total amount of $PM_{2.5}$ produced by the process. For example, natural gas produces less $PM_{2.5}$ to begin with compared to diesel, and of that, a smaller fraction of the $PM_{2.5}$ is black carbon.

Substantial reductions in black carbon emissions in the State occurred between 2005 and 2020 due to decreases from the two largest sources, transportation and non-road equipment (Figures 33 and 34; Table A-21). The industrial, residential and electric generation sectors also experienced declines, and the commercial sector (excluding non-road equipment such as forklifts) experienced a very small increase. Results for these sectors will be discussed individually below. Overall, total black carbon emissions dropped from a 2005 high of 5.8 MMT CO_2e (GWP_{100})/20.2 MMT CO_2e (GWP_{20}) to a low in 2020 of 1.7 MMT/6.1 MMT CO_2e (GWP_{20}).[52]

Although there is insufficient data to develop sector-specific estimates for 2018 and 2019, extrapolation of the 2017 to 2020 trend would lead to a continuing decrease, with a 2021 projected total of 1.6 MMT CO_2e (GWP_{100})/5.4 MMT CO_2e (GWP_{20}) if the historic pattern continued. Given the continuing replacement of diesel truck and light-duty engines with cleaner technologies, a continued downward trend in black carbon emissions is anticipated.

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[48] Bond, T. C.; Doherty, S. J.; Fahey, D. W.; Forster, P. M.; Berntsen, T.; DeAngelo, B. J.; Flanner, M. G.; Ghan, S.; Kärcher, B.; Koch, D.; Kinne, S.; Kondo, Y.; Quinn, P. K.; Sarofim, M. C.; Schultz, M. G.; Schulz, M.; Venkataraman, C.; Zhang, H.; Zhang, S.; Bellouin, N.; Guttikunda, S. K. ; Hopke, P. K.; Jacobson, M. Z.; Kaiser, J. W.; Klimont, Z.; Lohmann, U.; Schwarz, J. P.; Shindell, D.; Storelvmo, T.; Warren, S. G.; Zender, C. S., Bounding the role of black carbon in the climate system: A scientific assessment. Journal of Geophysical research: Atmospheres, v. 118, pp. 5380-5552, 2013

[49] https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

[50] NJ uses PM2.5 data from the NEI to calculate black carbon emissions beginning in 2005 using the most recent emissions factors from EPA. However, the NEI is only published every three years, so estimates are not yet available for 2021. However, NJ onroad modeling provides black carbon estimates for 2021, which are presented here.

[51] USEPA SPECIATE 5.2 database. https://www.epa.gov/air-emissions-modeling/speciate-4

[52] The black carbon estimates presented here represent updates from those presented in the GWRA 80x50 report and previous NJ GHG Inventory publications. Significant changes include use of revised models for transportation, wildfires and prescribed burns; and the use of speciation factors from the 2020 USEPA National Emissions Inventory. Additional information on how methods used in the National Emissions Inventory have changed over time can be found at https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei.

Figure 33. Black Carbon Emissions 2005-2020 (GWP_{100})

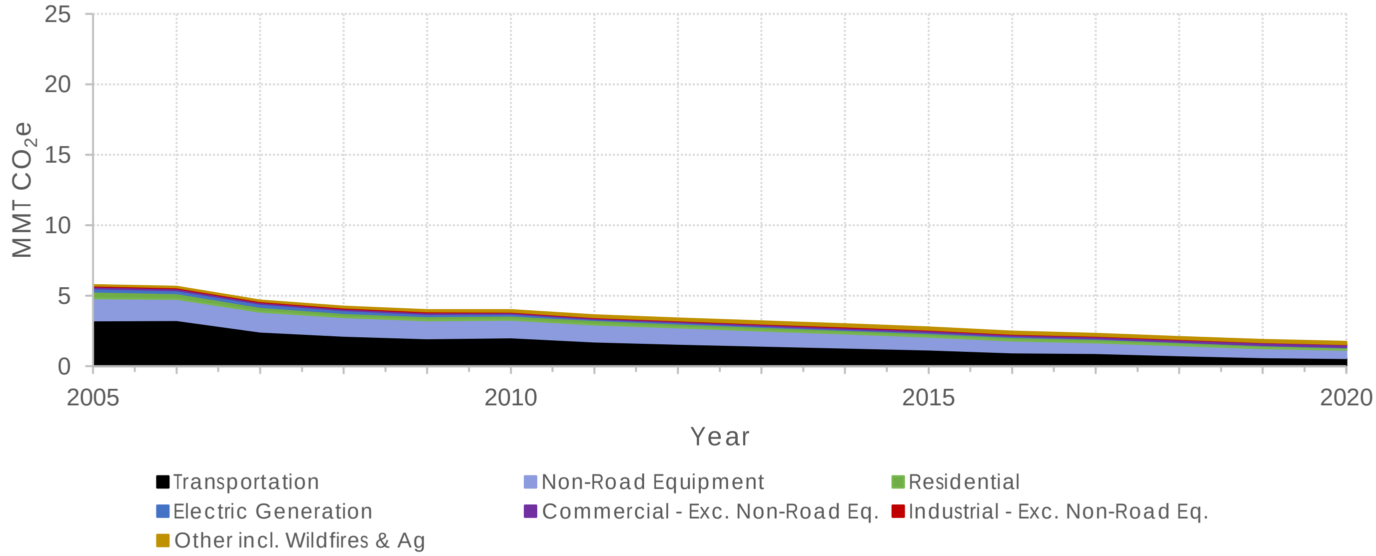
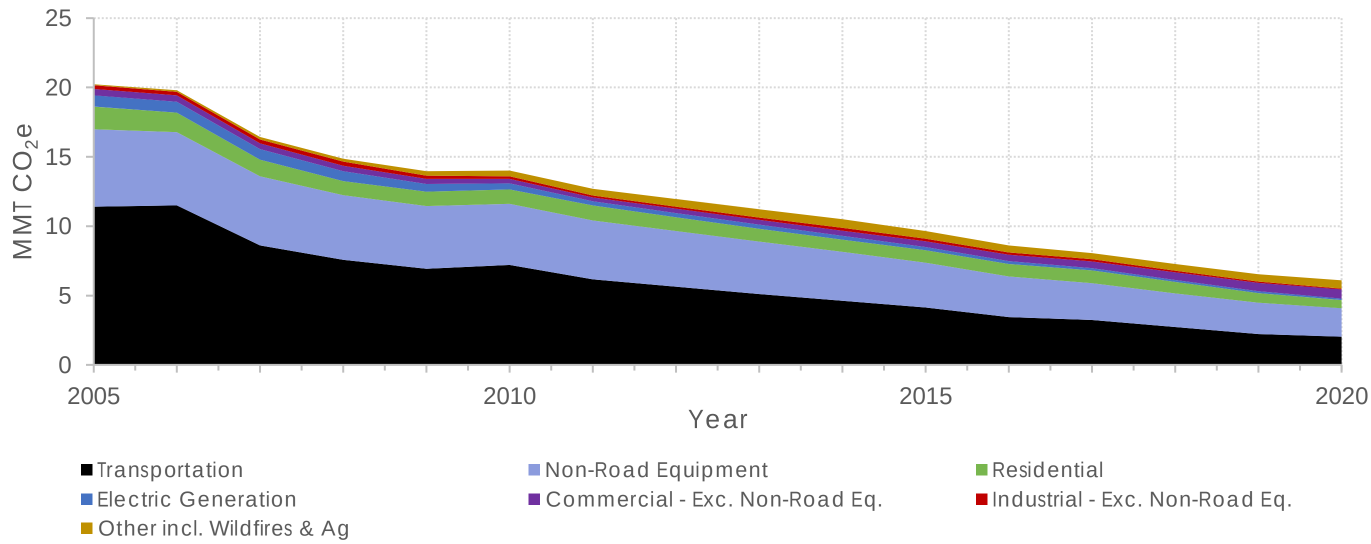


Figure 34. Black Carbon Emissions 2005-2020 (GWP_{20})



Transportation Sector

The transportation sector includes emissions from both on-road and non-road transportation. On-road transportation includes passenger vehicles, such as cars and trucks as well as medium- and heavy-duty vehicles. Non-road transportation includes modes of transportation such as trains, boats, and airplanes. Historically, transportation has been the largest contributor to black carbon in the state. In 2005, it accounted for 56% of black carbon emissions, totaling 3.2 MMT CO_2e (GWP_{100})/11.4 MMT CO_2e (GWP_{20}). However, due to aggressive policies requiring cleaner burning engines, emissions from this sector have dropped dramatically. In 2020, black carbon emissions decreased more than eighty percent to 0.58 MMT CO_2e (GWP_{100})/2.0 MMT CO_2e (GWP_{20}) with transportation accounting for 33% of total black carbon emissions (Figures 35 and 36).

Figure 35 Transportation Sector Black Carbon Emissions (GWP100)

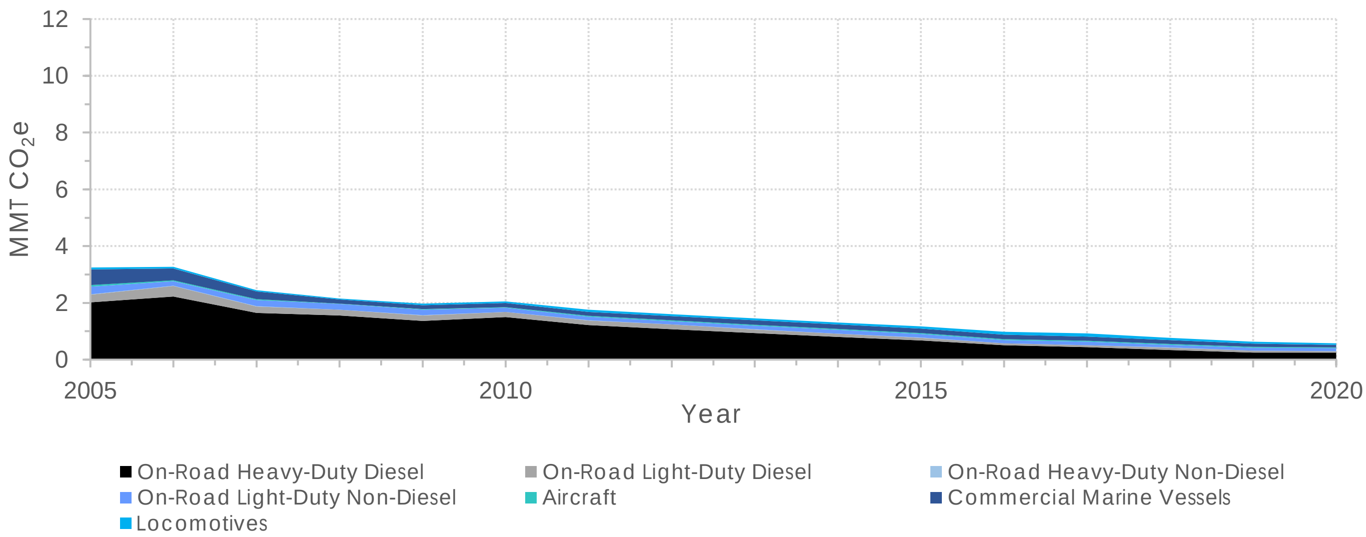
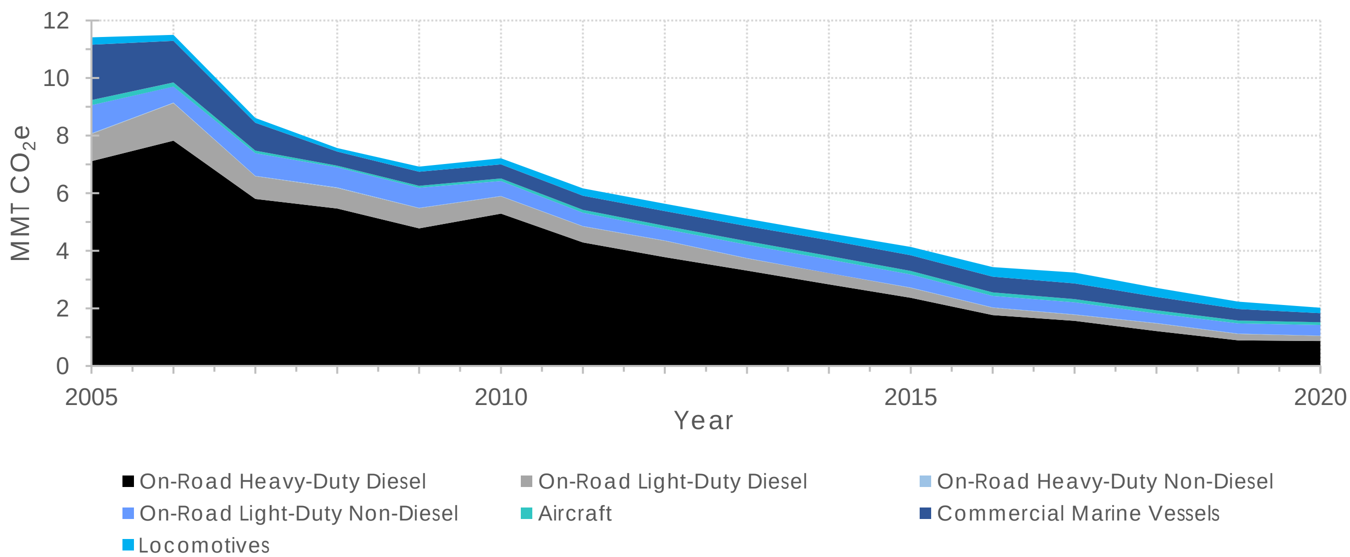


Figure 36 Transportation Sector Black Carbon Emissions (GWP20)



On-Road Transportation

From a high of 2.8 MMT CO_2e (GWP_{100})/9.7 MMT CO_2e (GWP_{20}) in 2006, on-road black carbon emissions fell 85% to 0.40 MMT CO_2e (GWP_{100})/1.4 MMT CO_2e (GWP_{20}) in 2021 (Figures 37 and 38; Table A-22). The majority of on-road black carbon emissions come from diesel-powered vehicles, which also account for the majority of reductions over the period (Figures 39 and 40; Table A-23). The chief force behind these improvements was the federal mandate calling for cleaner engines, coupled with targeted programs facilitating replacement of older equipment. Diesel vehicle emission dropped from 2.6 MMT CO_2e (GWP_{100})/9.1 MMT CO_2e (GWP_{20}) in 2006 to 0.28 MMT CO_2e (GWP_{100})/1.0 MMT CO_2e (GWP_{20}) in 2021. Gasoline-powered (non-diesel) vehicles have also seen steady reductions, dropping from 0.16 MMT CO_2e (GWP_{100})/ 0.58 MMT CO_2e (GWP_{20}) in 2005 to 0.12 (GWP_{100})/0.41 MMT CO_2e (GWP_{20}) in 2021.

Figure 37. On-Road Black Carbon Emissions by Fuel Type (GWP_{100})

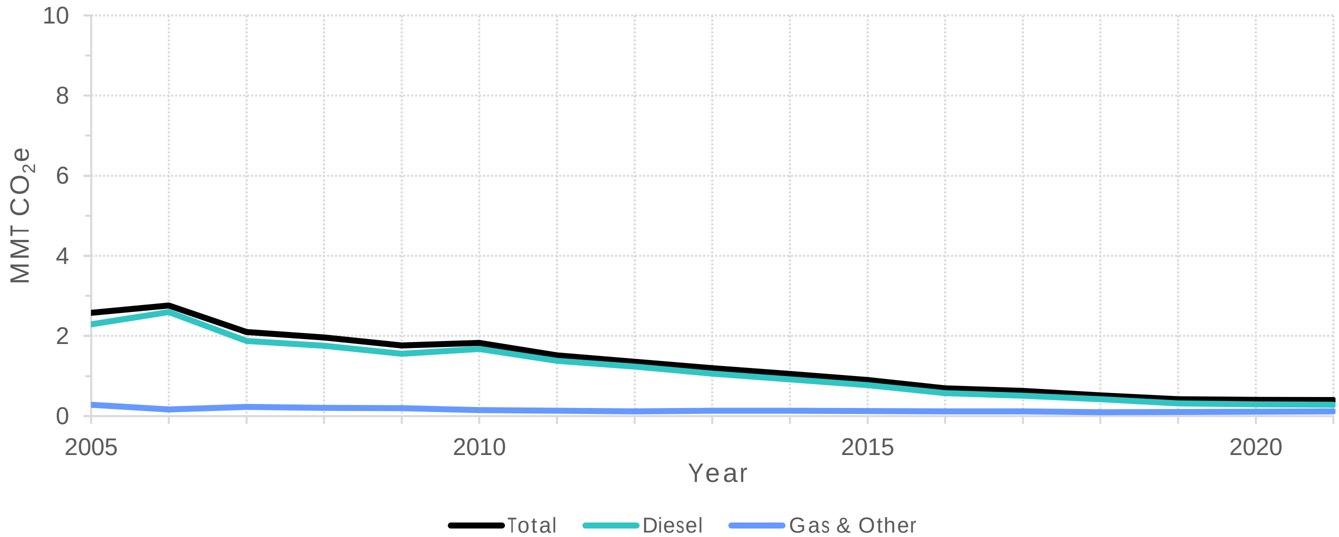


Figure 38. On-Road Black Carbon Emissions by Fuel Type (GWP_{20})

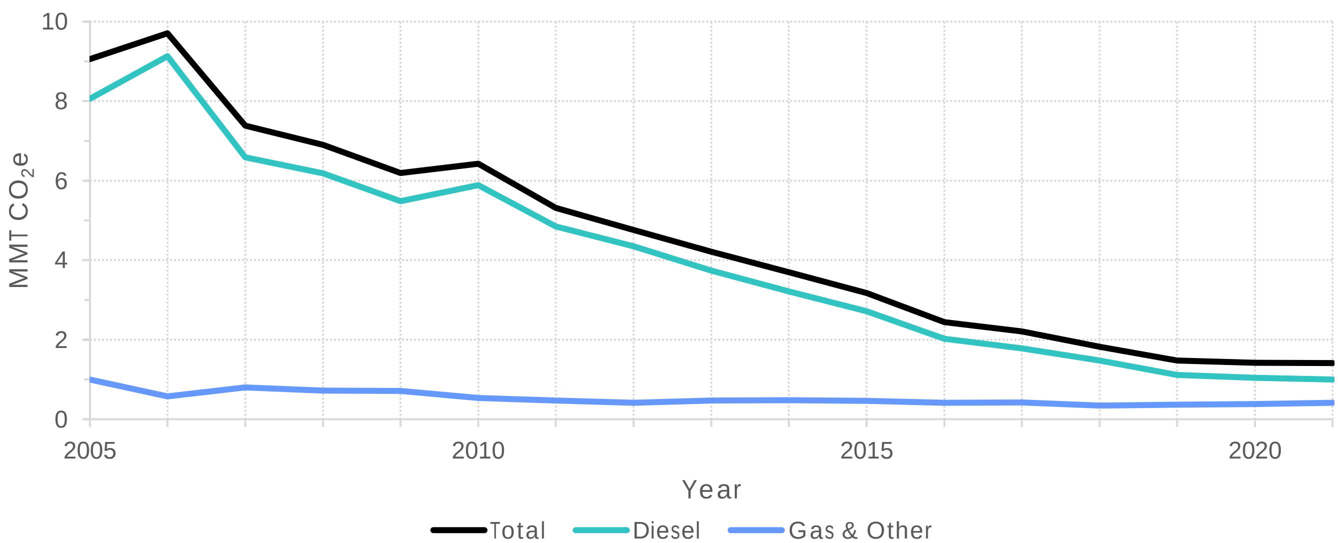


Figure 39. Black Carbon Emissions from Diesel Vehicles (GWP_{100})

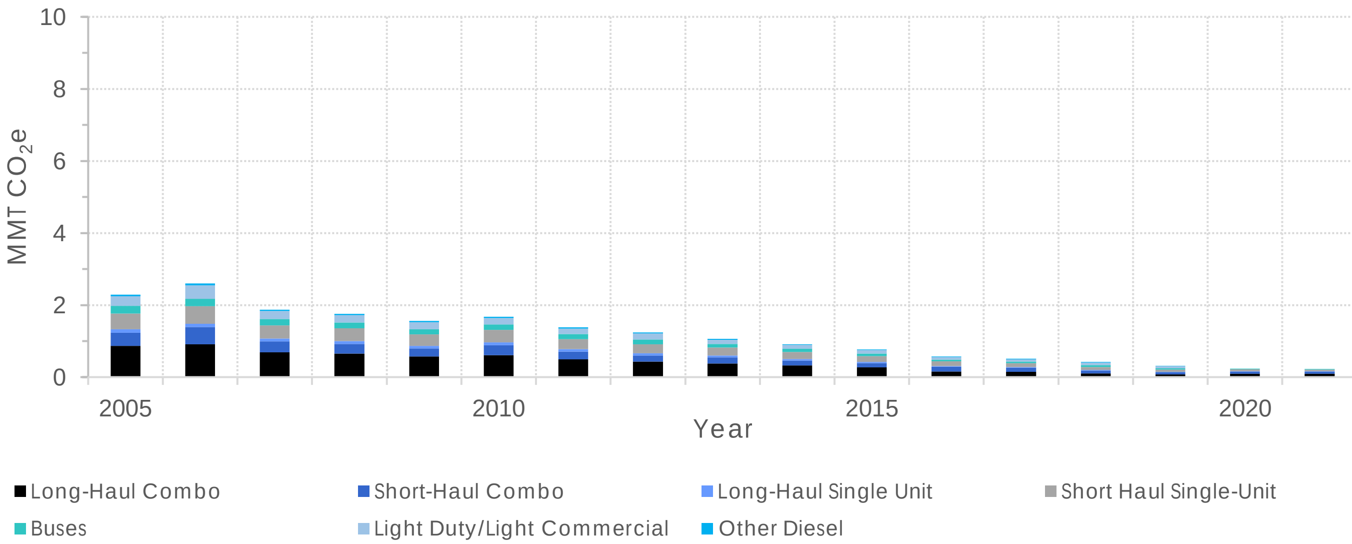
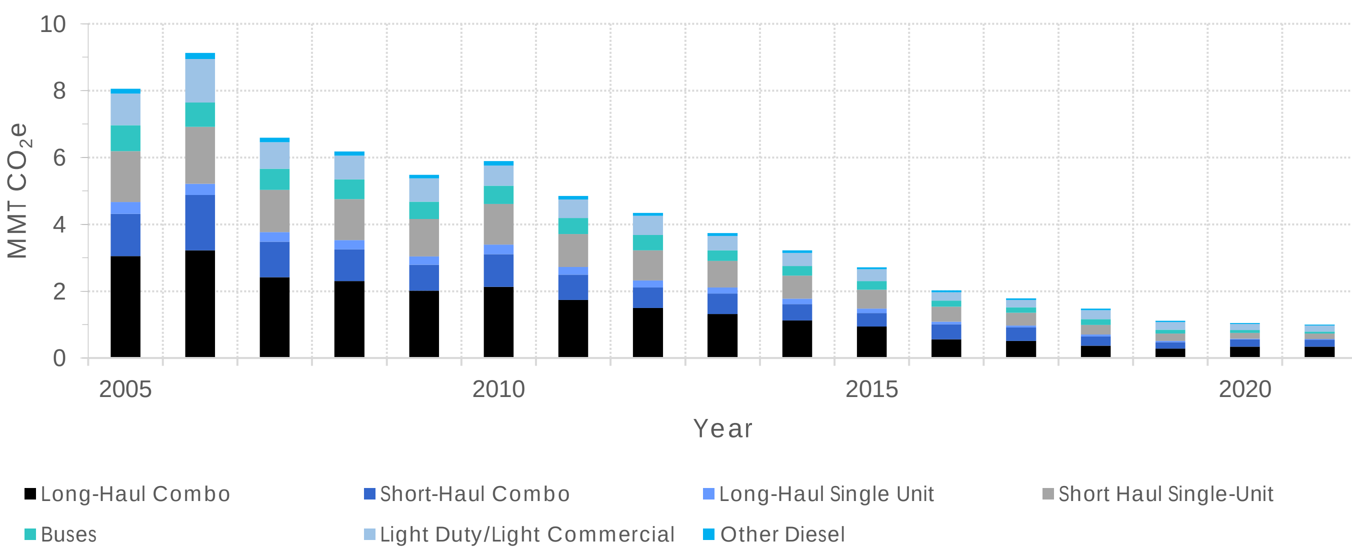


Figure 40. Black Carbon Emissions from Diesel Vehicles (GWP_{20})



Non-Road Transportation

Emissions from non-road transportation are associated with marine, aviation and rail transport. Commercial marine activity accounted for the bulk of black carbon emissions from the non-road transportation sector, with substantial decreases observed through the recession year of 2008 (Figures 41 and 42; Table A-24). In 2020, marine emissions accounted for 52% of the non-road transportation total.

Peak black-carbon emissions in-state aviation emissions occurred in 2005 at 0.05 MMT CO_2e (GWP_{100})/ 0.18 MMT CO_2e (GWP_{20}), dropped to a low of 0.01 MMT CO_2e (GWP_{100})/0.05 MMT CO_2e (GWP_{20}) in 2008, a year marked by a sharp financial downturn, and then rebounded by 2014 to 0.04 MMT CO_2e (GWP_{100})/ 0.13 MMT CO_2e (GWP_{20}). In the years since, black carbon emissions from the aviation sector have changed only slightly, reaching 0.03 MMT CO_2e (GWP_{100})/0.10 MMT CO_2e (GWP_{20}) in 2020. Overall, current emissions are 47% below the 2005 peak. It should be noted that these emissions calculations were based on landings and take offs, and therefore not include emissions occurring as these flights travel across other states, nor do they include emissions from flights that do not stop in New Jersey.

Emissions associated with fossil-powered rail service (locomotives) were 0.07 MMT CO_2e (GWP_{100})/0.25 MMT CO_2e (GWP_{20}) in 2005, reached a low of 0.04 MMT CO_2e (GWP_{100})/0.13 MMT CO_2e (GWP_{20}) in the recession year 2008, and gradually climbed to 0.11 MMT CO_2e (GWP_{100})/ 0.38 MMT CO_2e (GWP_{20}) in 2017. However, by 2020 emissions had dropped to 0.06 MMT CO_2e (GWP_{100})/ 0.19 MMT CO_2e (GWP_{20}). Some of this decrease may reflect pandemic-related closures and curtailments, in addition to the increased use of lower-emitting equipment.

Figure 41. Black Carbon from Non-Road Transportation (GWP_{100})

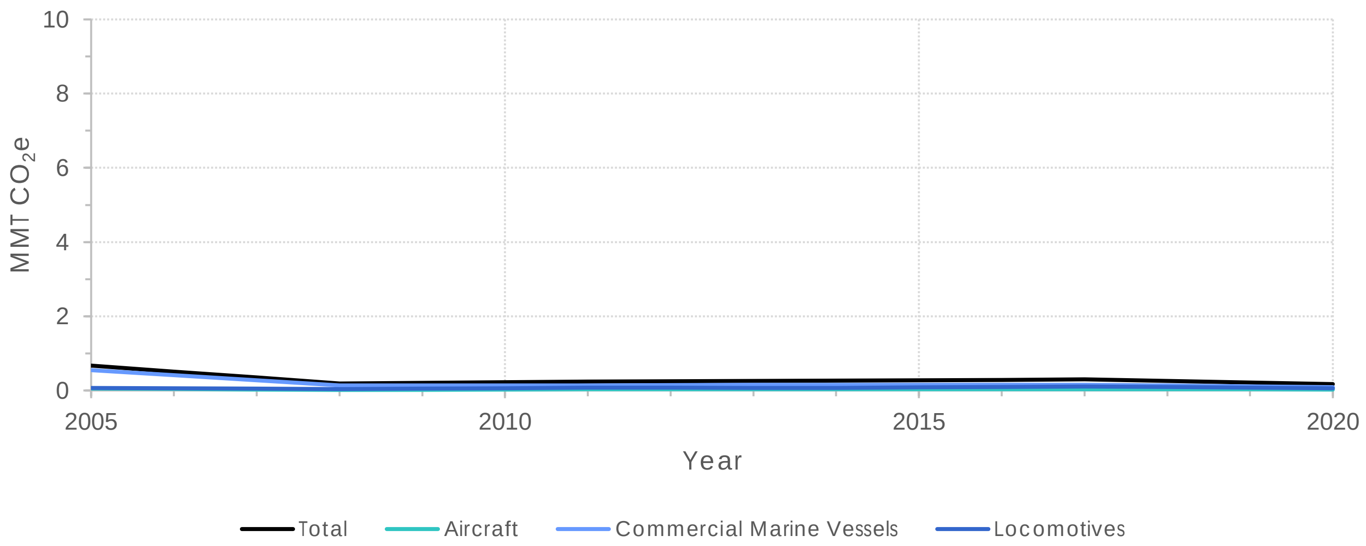
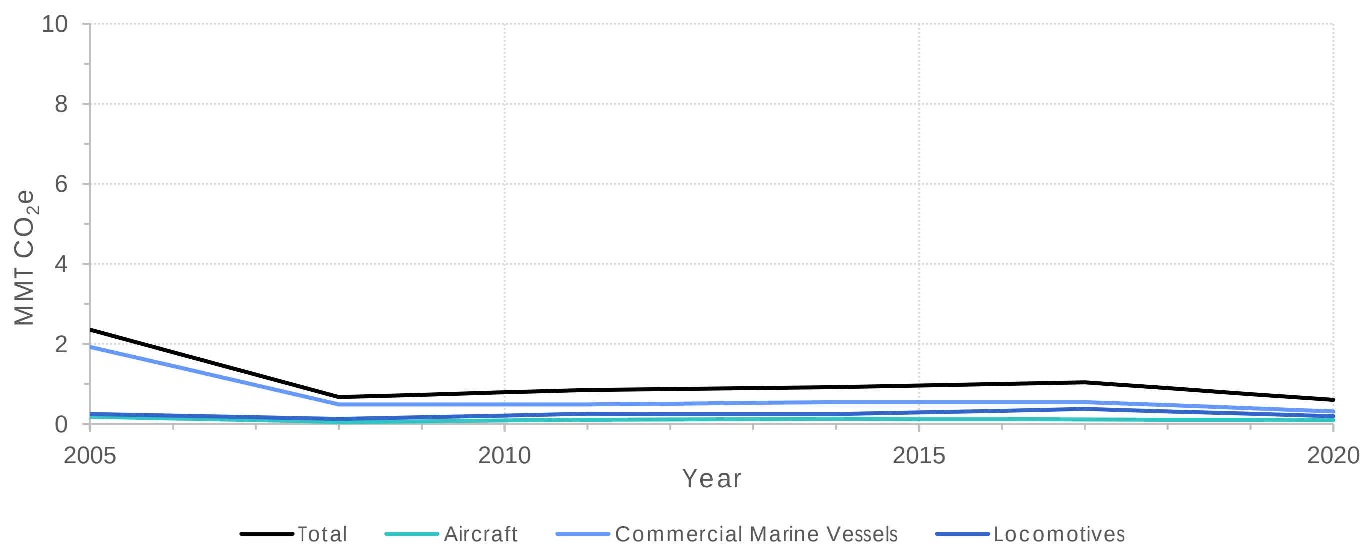


Figure 42. Black Carbon from Non-Road Transportation (GWP_{20})



Non-Road Equipment Sector

Non-road equipment includes bulldozers, excavators, cranes, and other non-road devices moving goods and personnel on site, and generally not used for conventional transportation between sites. Emissions from non-road equipment now equal the total black carbon emissions from the entire transportation sector, reflecting a slower adoption of new, low-emitting diesel technology. However, emissions in this category dropped by more than half between 2005 and 2020, from 1.6 MMT CO_2e (GWP_{100})/ 5.6 MMT CO_2e (GWP_{20}) at the outset to 0.58 MMT CO_2e (GWP_{100})/ 2.1 MMT CO_2e (GWP_{20}) in 2020 (Figures 43 and 44; Table A-25). Diesel-powered equipment was responsible for 81% of the black carbon emissions in this category, suggesting that wider use of low-emitting technologies is in fact leading to greater reductions.

Figure 43. Black Carbon from Non-Road Equipment (GWP_{100})

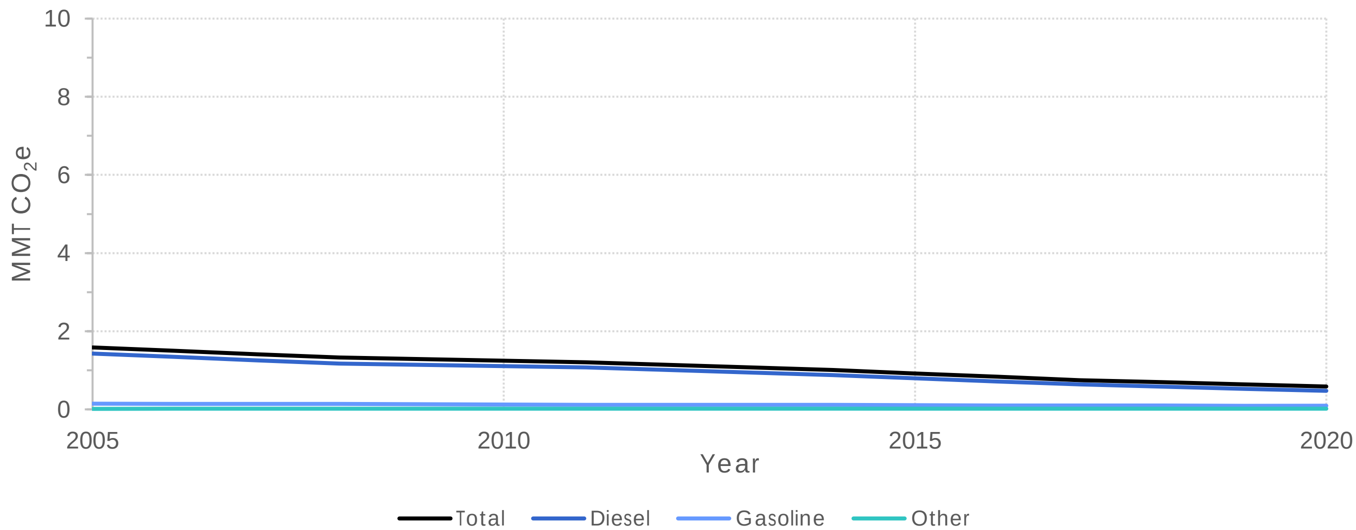
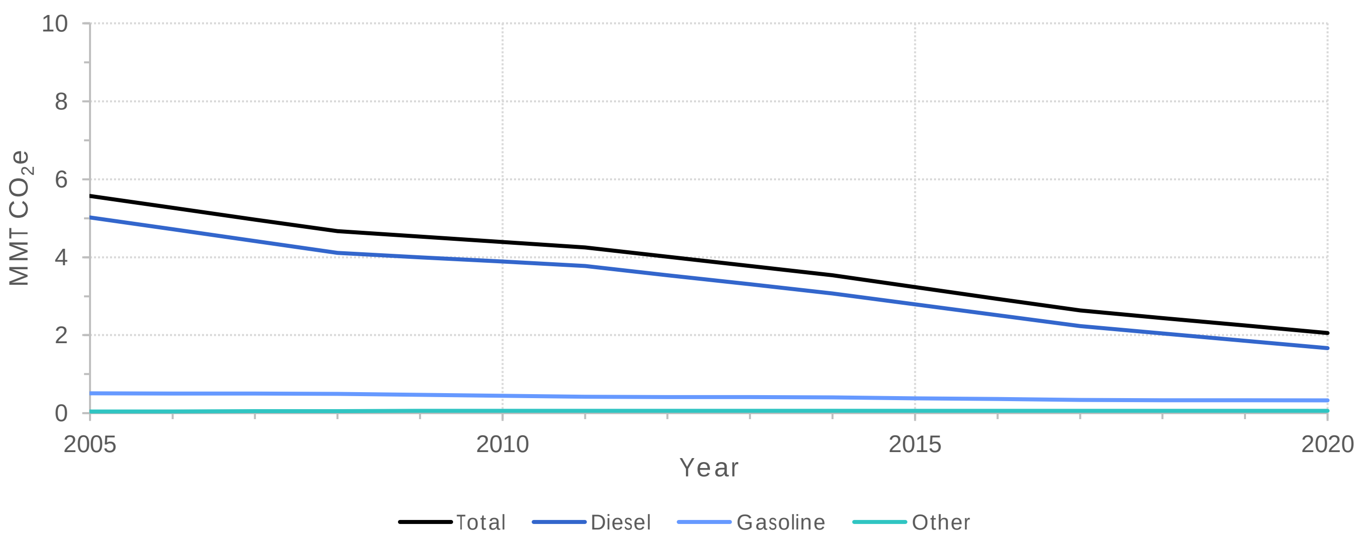


Figure 44. Black Carbon from Non-Road Equipment (GWP_{20})



Electric Generation Sector

In 2020, black carbon from the electric generation sector accounted for 1.7% of total black carbon emissions. Emissions from power plants and related equipment dropped dramatically from 2005 to 2011, and experienced a more gradual decline through 2020 (Figures 45 and 46; Table A-26). The total amounts of black carbon are very small because the state relies heavily on nuclear power and relatively clean combined cycle natural gas technology. Overall, black carbon emissions for the sector fell 87%, from an initial emissions rate of 0.23 MMT CO_2e (GWP_{100})/ 0.82 MMT CO_2e (GWP_{20}) in 2005 to 0.03 MMT CO_2e (GWP_{100})/ 0.07 MMT CO_2e (GWP_{20}) in 2020. Black carbon reductions through 2011 can be attributed to the dramatic decline in coal-fueled electric generation, with coal generation dropping from 11.6 TWh in 2005 to 1.9 TWh in 2012. Meanwhile, natural gas generation rose from 15.4 TWh in 2005 to 28.3 TWh in 2012, and peaked at 43.8 TWh in 2016. Overall, black carbon emissions from natural-gas fueled electric generation decreased slightly from 0.04 MMT CO_2e (GWP_{100})/ 0.12 MMT CO_2e (GWP_{20}) in 2005 to 0.02 MMT CO_2e (GWP_{100})/ 0.07 MMT CO_2e (GWP_{20}) in 2020; this is due in part to increased efficiency of generating sources. Other fuel sources accounted for less than 0.002 MMT CO_2e (GWP_{100})/ 0.007 MMT CO_2e (GWP_{20}) across the period. Black carbon emissions from waste management practices are categorized separately from electricity generation in the underlying EPA data, but may overlap with the Electric Generation sector's "Other Fuels" category with respect to solid waste incineration and the use of landfill gas as a generation fuel. In 2020, waste incineration emitted 0.002 MMT CO_2e (GWP_{100})/ 0.007 MMT CO_2e (GWP_{20}), and landfills emitted 0.001 MMT CO_2e (GWP_{100})/ 0.004 MMT CO_2e (GWP_{20}). These sources were similarly small throughout the period of record.

Figure 45. Electric Generation Sector Black Carbon Emissions (GWP_{100})

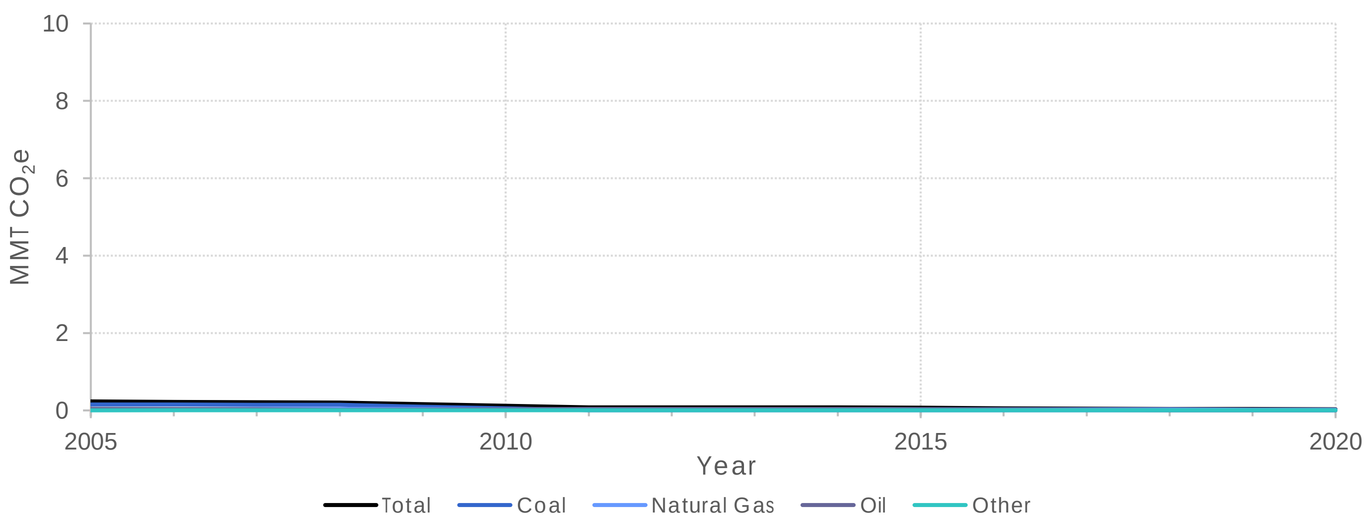
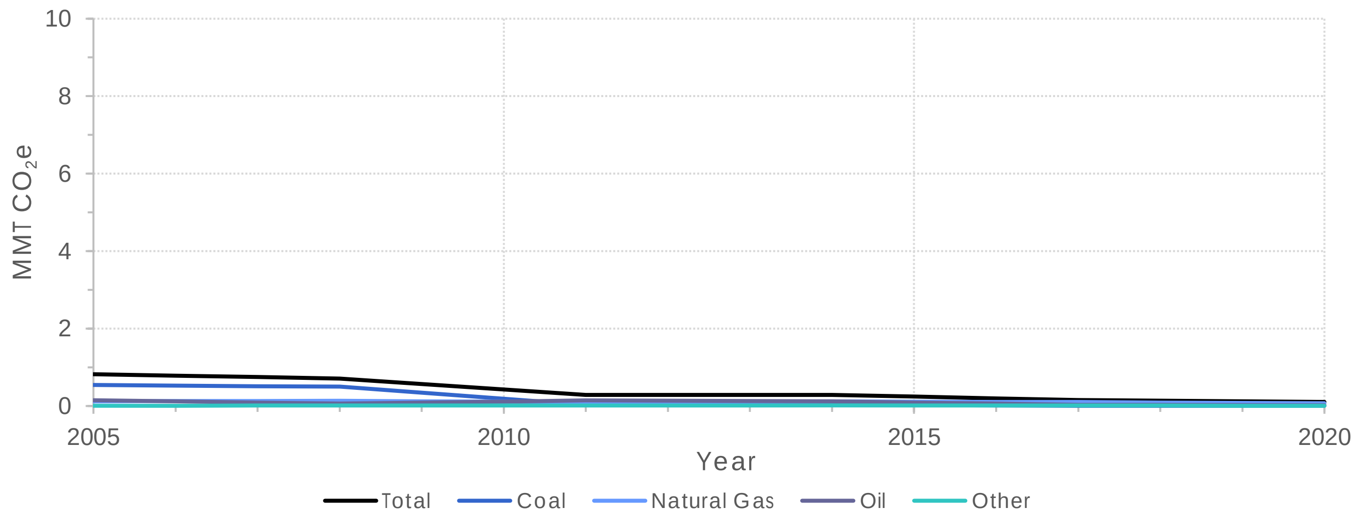


Figure 46. Electric Generation Sector Black Carbon Emissions (GWP_{20})



Residential Sector

In 2020 black carbon emissions from the residential sector made up 10% of total emissions. Residential sector black carbon emissions decreased by over 64%, from an initial total of 0.47 MMT CO_2e (GWP_{100})/ 1.6 MMT CO_2e (GWP_{20}) in 2005 to 0.17 MMT CO_2e (GWP_{100})/ 0.59 MMT CO_2e (GWP_{20}) in 2020 (Figures 47 and 48; Table A-27). The bulk of these emissions (over 90%) came from burning wood in wood stoves, fireplaces, and similar settings. Black carbon emissions from residential oil and natural gas combustion were significantly less. It should be noted that the methods used by USEPA to estimate particulate emissions from fire sources, and subsequently black carbon emissions, have changed considerably over time. Some of the observed variability in the black carbon estimates may therefore be methodological rather than a reflection of year-to-year emissions shifts.

Figure 47. Residential Black Carbon Emissions (GWP_{100})

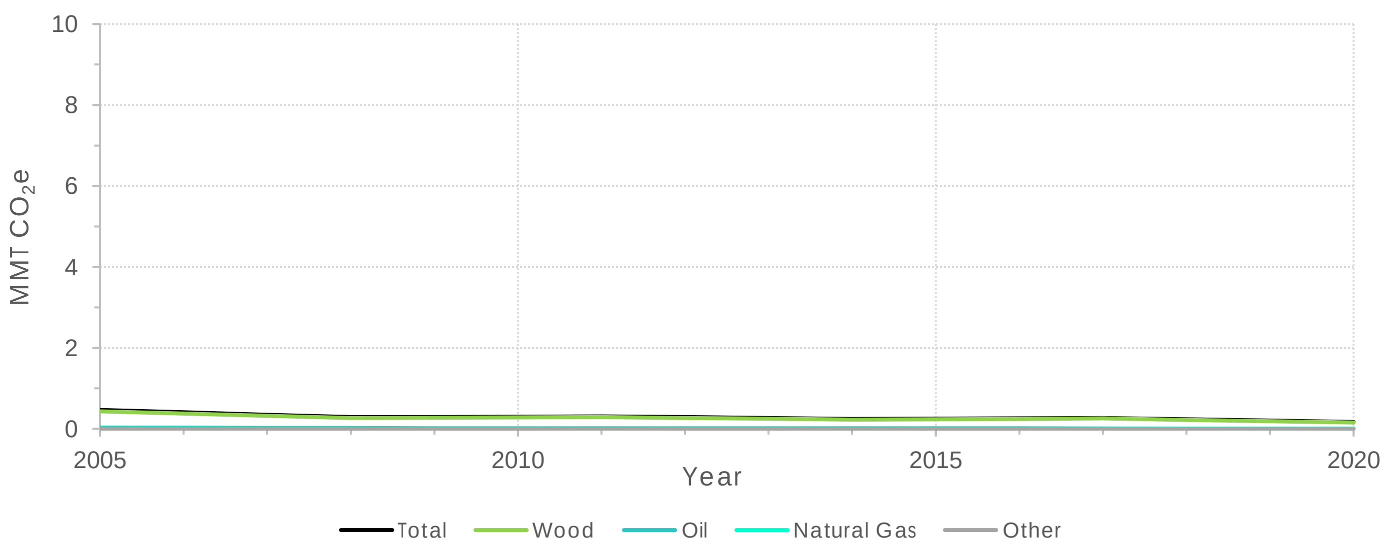
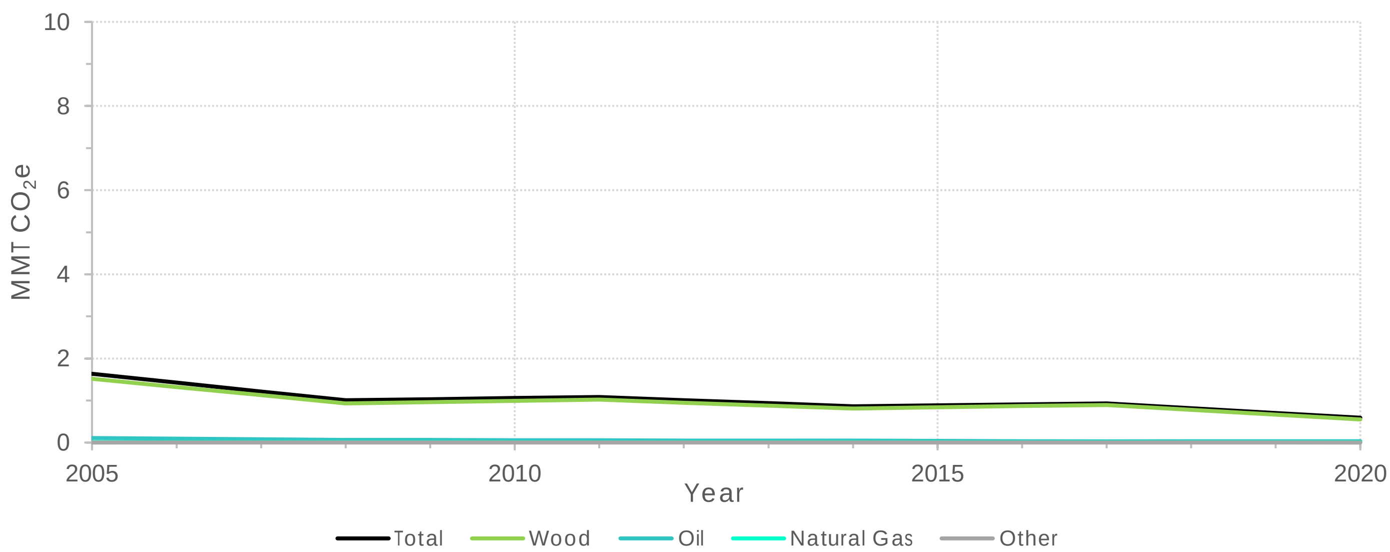


Figure 48. Residential Black Carbon Emissions (GWP_{20})



Commercial Sector, Except Non-Road Equipment

Emissions from the commercial sector increased slightly across the period, from 0.13 MMT CO_2e (GWP_{100})/ 0.46 MMT CO_2e (GWP_{20}) in 2005 to 0.19 MMT CO_2e (GWP_{100})/ 0.66 MMT CO_2e (GWP_{20}) in 2020 (Figures 49 and 50; Table A-28). However, the role of commercial cooking has steadily increased during this timeframe, initially accounting for 57% of emissions in 2005 but rising to 95% by 2020. The corresponding emissions from commercial cooking were 0.08 MMT CO_2e (GWP_{100})/ 0.26 MMT CO_2e (GWP_{20}) in 2005 and 0.18 MMT CO_2e (GWP_{100})/ 0.63 MMT CO_2e (GWP_{20}) in 2020. In contrast, emissions from combustion of oil dropped from 0.05 MMT CO_2e (GWP_{100})/ 0.18 MMT CO_2e (GWP_{20}) in 2005 to only 0.004 MMT CO_2e (GWP_{100})/ 0.02 MMT CO_2e (GWP_{20}) in 2020. Black carbon emissions from other fuels and activities were negligible.

Figure 49. Commercial Sector Black Carbon, Excluding Non-Road Equipment (GWP_{100})

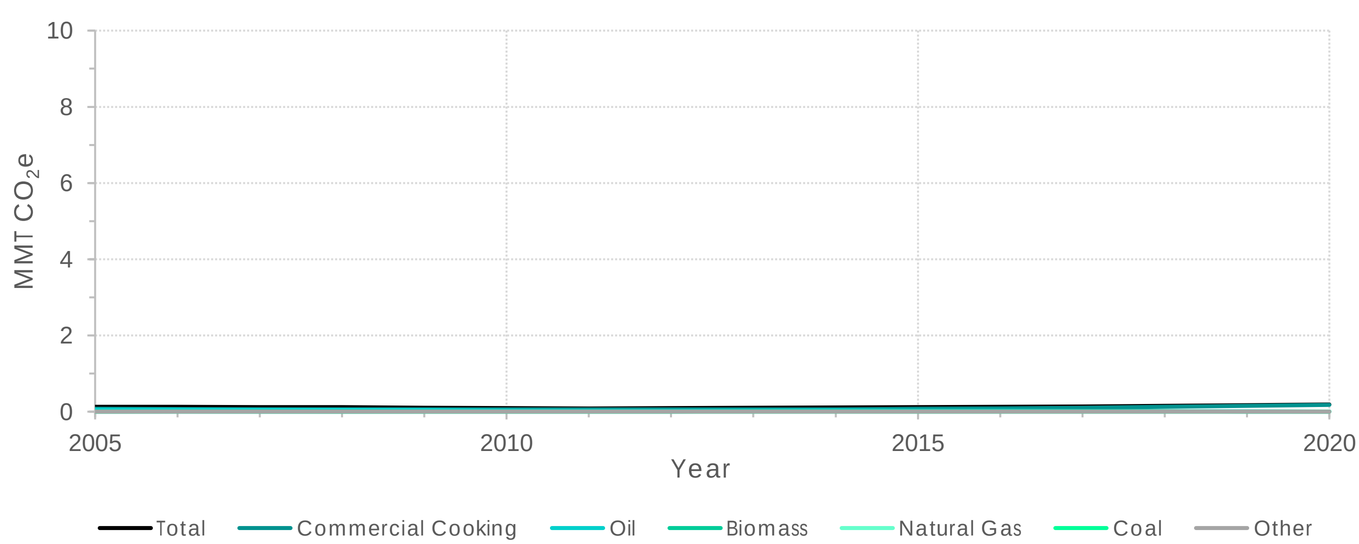
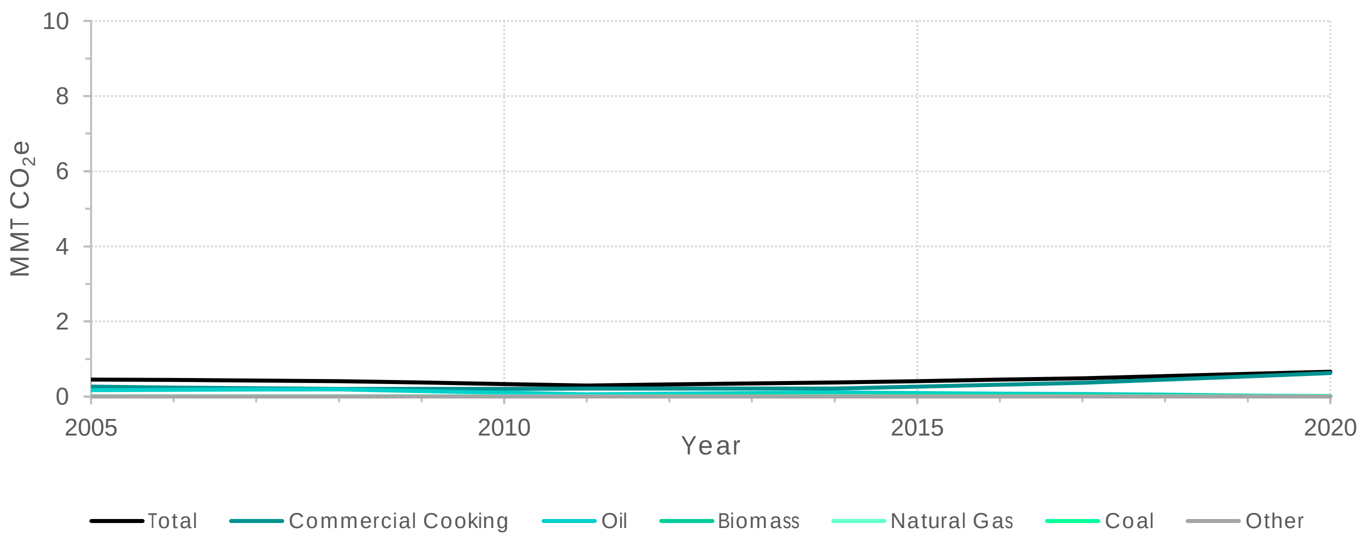


Figure 50. Commercial Sector Black Carbon, Excluding Non-Road Equipment (GWP_{20})

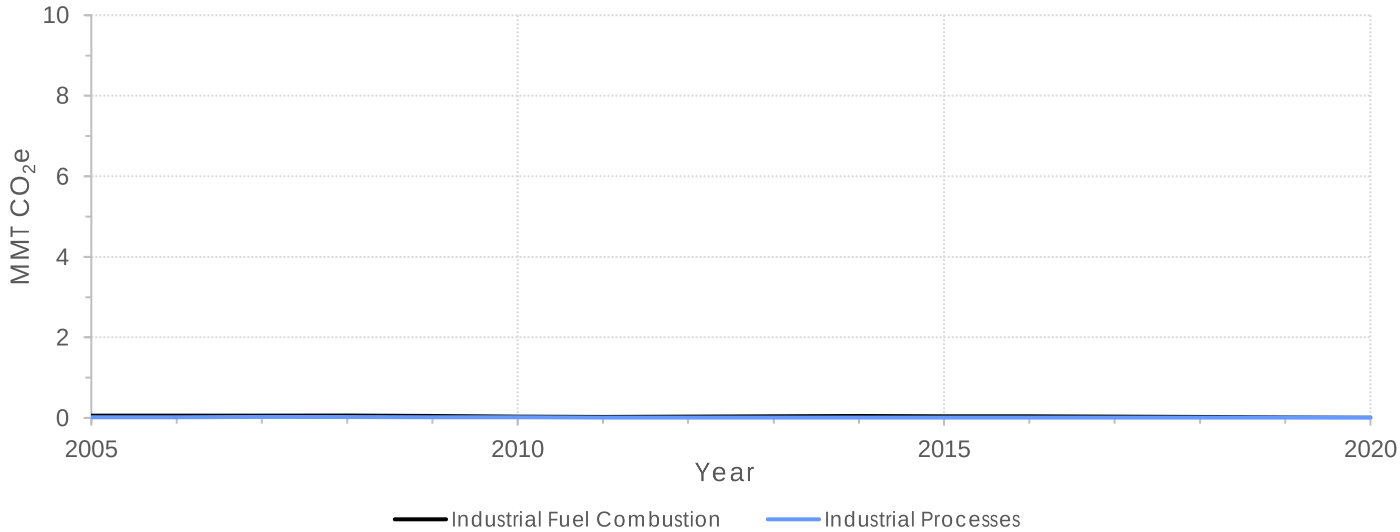


Industrial Sector, Except Non-Road Equipment

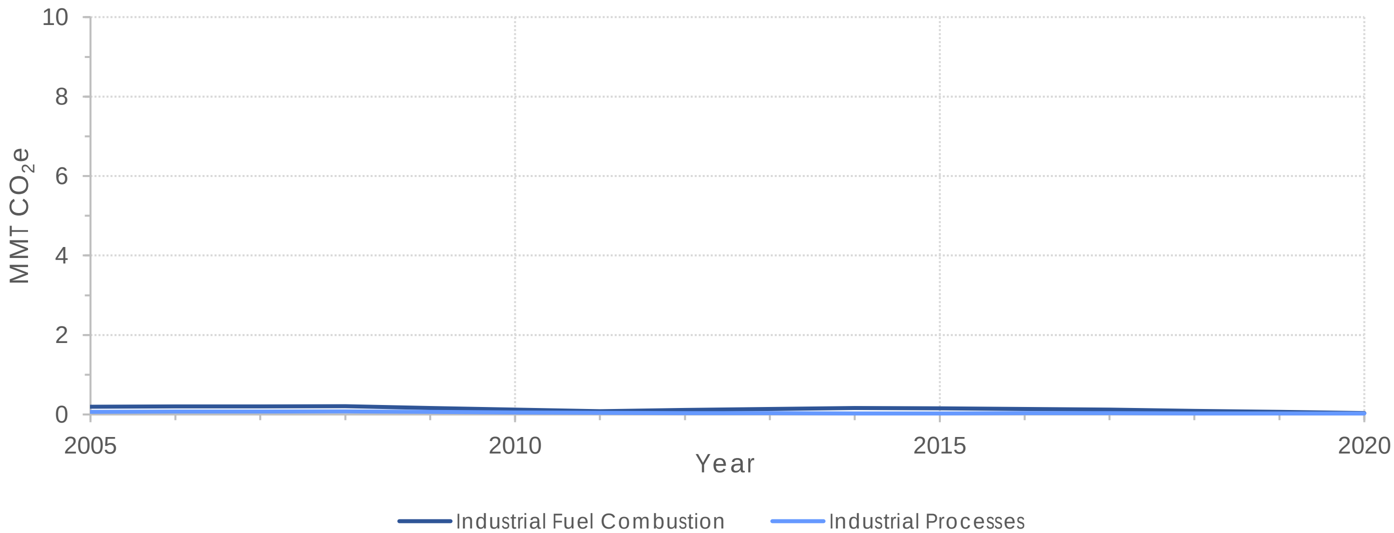
Combined emissions of black carbon from fuel combustion and process operations in the industrial sector were negligible at 0.02 MMT CO_2e (GWP_{100})/ 0.06 MMT CO_2e (GWP_{20}) in 2020, 77% below 2005 emissions of 0.07 MMT CO_2e (GWP_{100})/ 0.26 MMT CO_2e (GWP_{20}) (Figures 51 and 52, Tables A-2 and A-4). Black carbon emissions from the use of fossil fuels in boilers and internal combustion engines decreased overall, from 0.06 MMT CO_2e (GWP_{100})/ 0.19 MMT CO_2e (GWP_{20}) in 2005 to 0.01 MMT CO_2e (GWP_{100})/ 0.04 MMT CO_2e (GWP_{20}) in 2020, although emissions fluctuated during this time (Figures 53 and 54; Table A-29). The bulk of emissions can be attributed to oil fuel, which has gradually fallen out of favor as in industrial energy source. In 2008, oil accounted for 93% of black carbon emissions from industrial fuel combustion, but as its role in this sector ebbed its share of emissions dropped to only 43% by 2020. Coal was only a very minor contributor in 2005 at 0.0002 MMT CO_2e (GWP_{100})/ 0.0006 MMT CO_2e (GWP_{20}), and was entirely absent by 2008.

Black carbon emissions from industrial processes, distinct from fuel combustion, were even smaller and experienced a similar decline. In 2005, process emissions were 0.02 MMT CO_2e (GWP_{100})/ 0.07 MMT CO_2e (GWP_{20}), and fell to 0.007 MMT CO_2e (GWP_{100})/ 0.02 MMT CO_2e (GWP_{20}) by 2020 (Figures 55 and 56; Table A-30). Because of the large number of different processes in use, most are categorized into a large grouping identified as "Other," but notable named sources include petroleum refineries, pulp and paper manufacturing, chemical production, and emissions associated with the storage and transfer of materials.

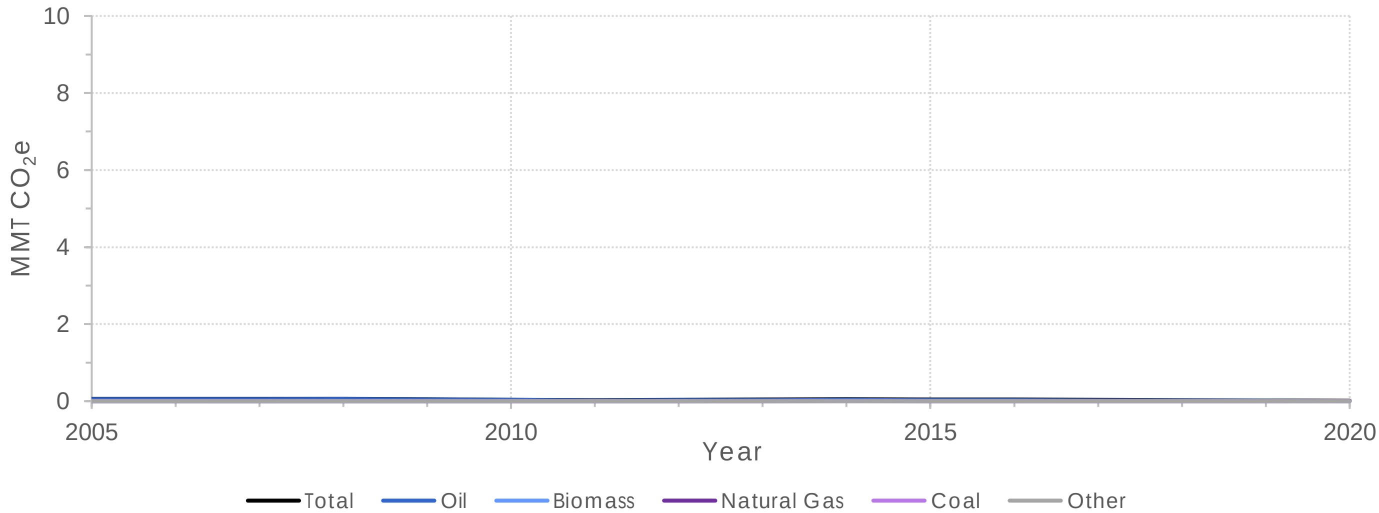
Figure 51. Total Industrial-Sector Black Carbon Emissions, including Fuel Combustion and Process Operations (GWP_{100})



Figures 52. Total Industrial-Sector Black Carbon Emissions, including Fuel Combustion and Process Operations (GWP_{20})



Figures 53. Black Carbon from Industrial Fuel Combustion in Boilers and Internal Combustion Engines (GWP_{100})



Figures 54. Black Carbon from Industrial Fuel Combustion in Boilers and Internal Combustion Engines (GWP_{20})

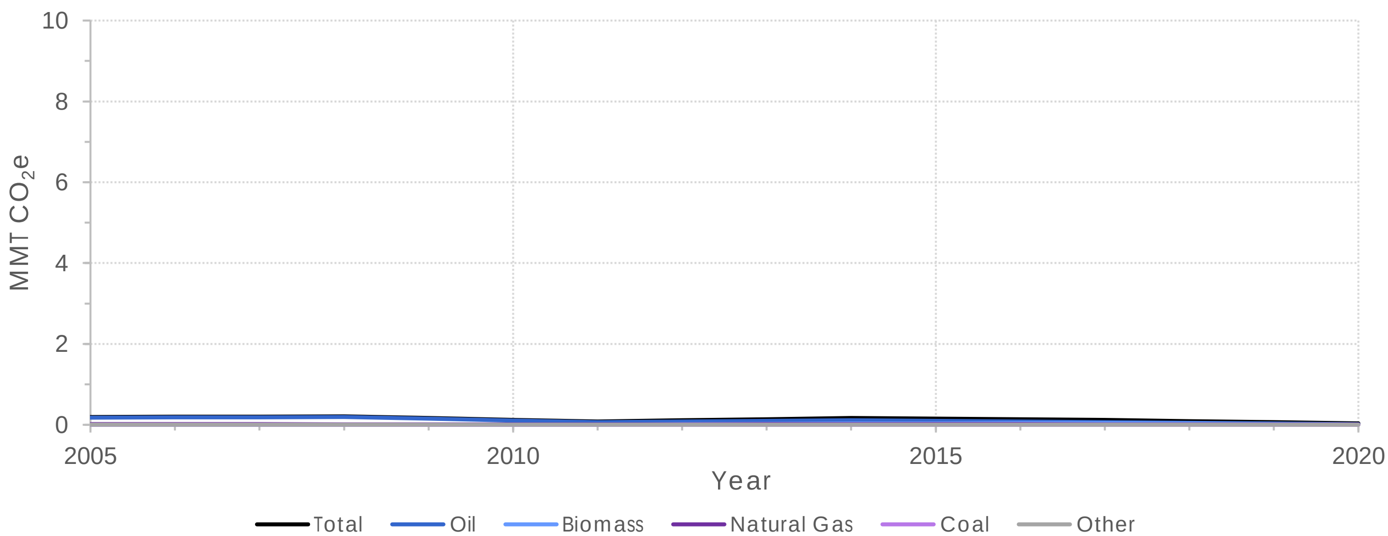


Figure 55. Black Carbon from Industrial Processes (GWP_{100}).[53]

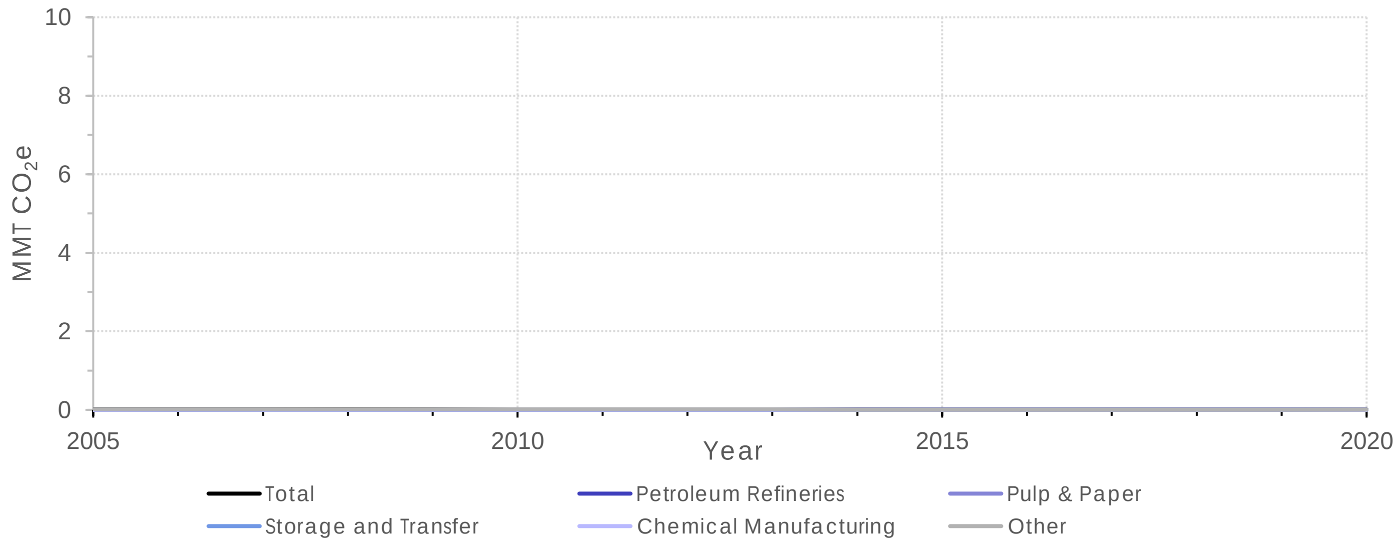
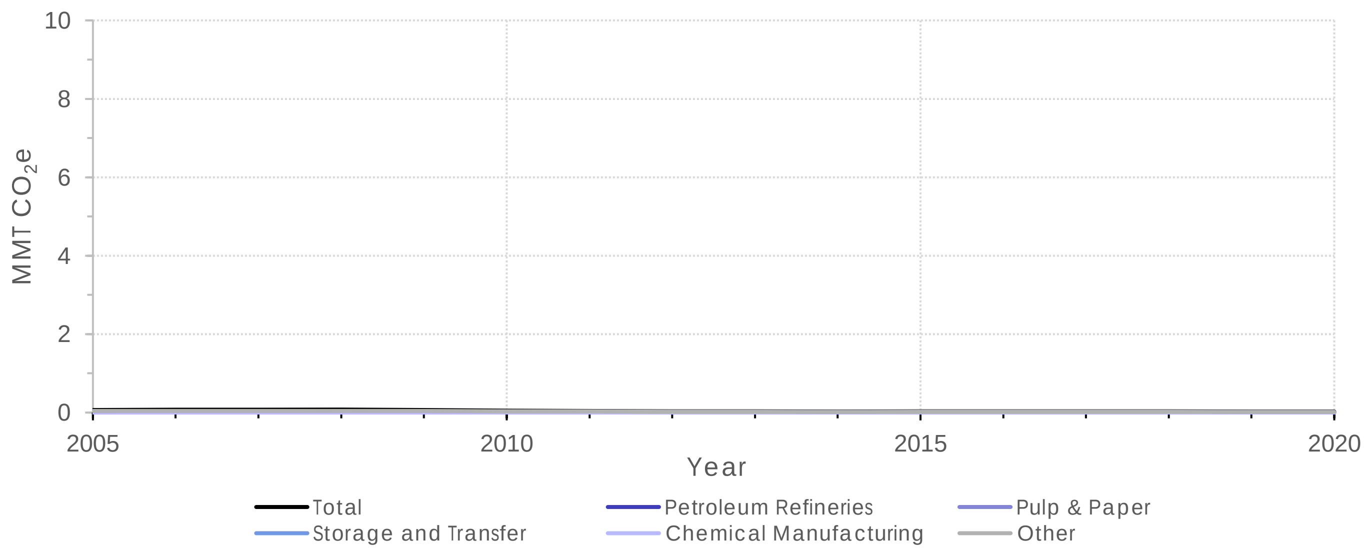


Figure 56. Black Carbon from Industrial Processes (GWP_{20}).[54]



Other Sector: Wildfires, Prescribed Burns, and Related Sources

Open combustion of wood and agricultural residue produces substantial amounts of smoke and accompanying black carbon. While the quantities generated in New Jersey are smaller than those from on-road diesel vehicles and non-road diesel equipment, fire emissions are an important consideration globally. They are also difficult to accurately assess because of their unpredictable behavior and random occurrence. As a result, methods for characterizing open burning have evolved considerably across the period of study and year-to-year comparisons are therefore subject to interpretation. For example, prior to 2008 emissions from wildfires and prescribed burns were combined into a catchall

[53] "Other" industrial process category includes ferrous and non-ferrous metals manufacturing, industrial surface coating and solvent use, mining, and additional sources.
[54] "Other" industrial process category includes ferrous and non-ferrous metals manufacturing, industrial surface coating and solvent use, mining, and additional sources.

category of miscellaneous sources but broken into separate categories in later years. Nonetheless, the results for 2008 onward provide a general indicator of the magnitude of black carbon emissions from these activities. Wildfire emissions averaged 0.01 MMT CO_2e (GWP_{100})/ 0.05 MMT CO_2e (GWP_{20}) annually between 2008 and 2020, but with a wide degree of variability from year to year (Figures 57 and 58; Table A-31). Prescribed burns averaged 0.04 MMT CO_2e (GWP_{100})/ 0.14 MMT CO_2e (GWP_{20}), again with substantial variability. Agricultural burning averaged 0.02 MMT CO_2e (GWP_{100})/ 0.06 MMT CO_2e (GWP_{20}), with a smaller degree of variability. Emissions from agricultural burning arose primarily from combustion associated with forest residues and orchard crops.

Figure 57. Wildfires, Prescribed Burns, and Related Sources (GWP_{100})

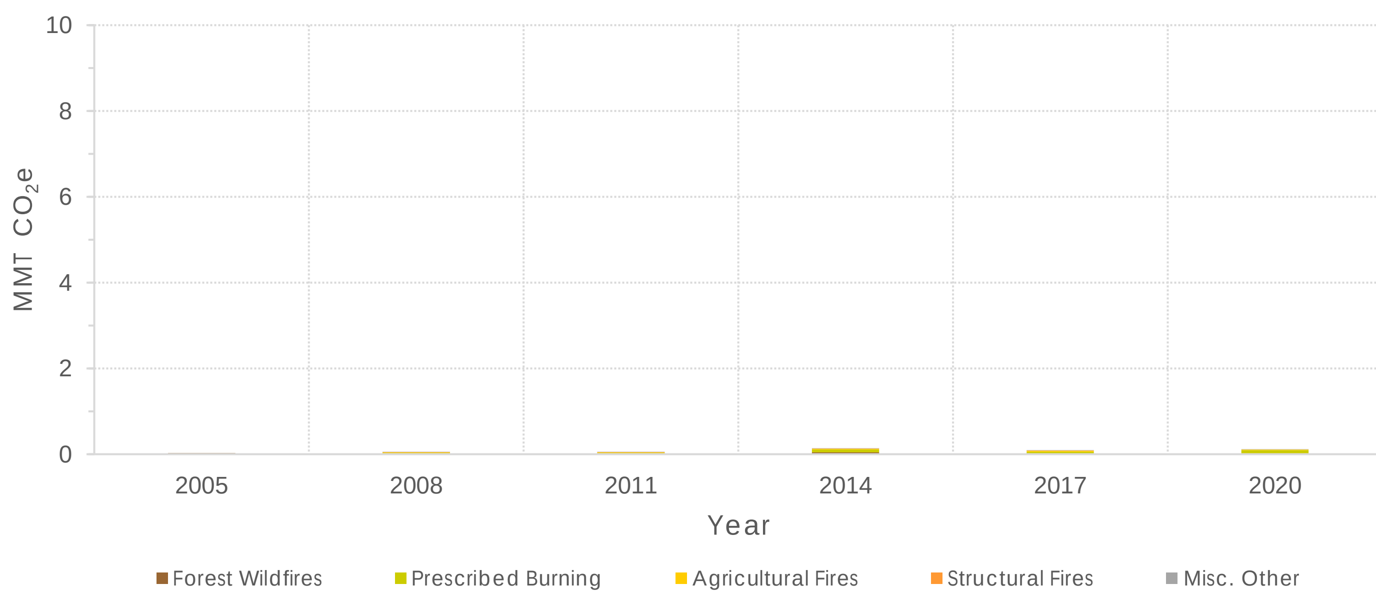
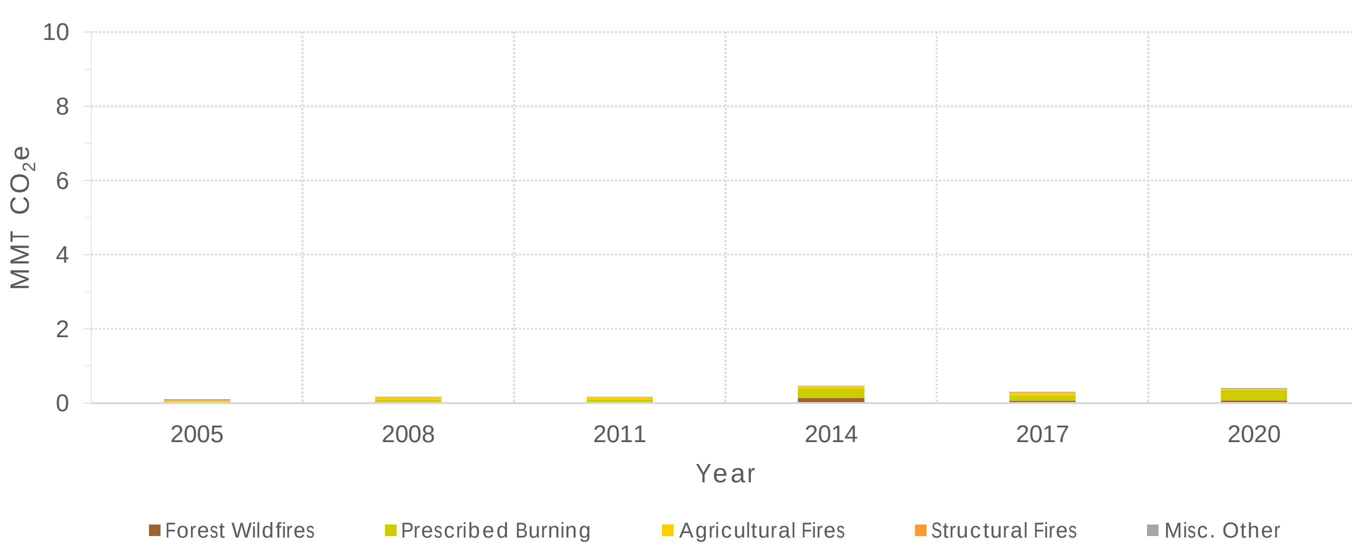


Figure 58. Wildfires, Prescribed Burns, and Related Sources (GWP_{20})



7.0 CONCLUSIONS

7.1 CONCLUSIONS

Since enactment of the Global Warming Response Act in 2007, the State has achieved its GWRA 2020 emissions goal to reduce emissions below the 1990 level. Specifically, the 2021 net emissions of 97.6 MMT CO_2e (GWP_{100}) were 13% below the 1990 level of 112.6 MMT CO_2e.[55] Emissions for 2021 were also 19% below the 2006 level of 121.7 MMT CO_2e. Technological advances and shifts to cleaner fuels led to a substantial 38% reduction in emissions from electricity generation since 2006, most notably due to reduced reliance on coal and an accelerating expansion of renewable energy. Transportation emissions have also dropped by 22%, while onroad black carbon emissions have dropped 86%. Overall, the State has successfully arrested growth in greenhouse gas emissions and achieved tangible reductions, a major departure from the high-emission outcome envisioned in the 2008 Greenhouse Gas Inventory Report under a no-action scenario. Nonetheless, these rates of improvement fall short of the statutory objectives of the GWRA to reduce emissions by 80% before 2050, let alone meet the 50% reduction by 2030 target mandated by Governor Murphy's Executive Order 274. To reach these goals, the State must increase the rate of reduction.

Fortunately, under Governor Murphy's leadership, the State has rapidly progressed through planning into implementation, establishing detailed pathways forward in the 2019 Energy Master Plan and the 2020 GWRA 80x50 Report. New Jersey's drive towards offshore wind, clean transportation, and solar photovoltaics, coupled with investigation of new heating technologies, support for alternative fuels and policies that maintain the viability of our nuclear fleet, represent a clear direction forward.

Looking back at one of the earliest international forums focused on climate change, held by the United Nations World Environment Programme in 1985,[56] the executive director of the Programme at the time, Mostafa K. Tolba, summed it up simply: there must be "a mechanism to get this ball rolling." New Jersey is at the leading edge of an energy and environmental transformation that demonstrates its leadership.

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[55] 2019 emissions based on GWP_{20} were 9% below the 1990 level and 12% below the 2006 level.

[56] World Meteorological Organization (1986). Report of the International Conference on the Assessment of the Role of Carbon Dioxide and of Other Greenhouse Gases in Climate Variations and Associated Impacts, Villach, Austria, 9-15 October 1985. *WMO No. 661.* World Meteorological Organization. Retrieved from https://library.wmo.int/doc_num.php?explnum_id=8512

APPENDIX A. GHG TABLES

Table A-1. NJ GHG Emissions, MMT CO_2e, based on GWP_{100}.[57]

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Transportation	**33.2**	**47.4**	**47.6**	**49.6**	**47.6**	**42.6**	**42.7**	**43.3**	**41.2**	**41.3**	**41.3**	**40.7**	**42.7**	**40.3**	**40.6**	**38.0**	**34.0**	**37.3**
On-Road Gasoline	26.2	34.4	34.5	35.1	34.2	33.3	32.8	32.3	31.6	31.8	32.1	31.7	32.5	31.1	30.4	29.7	24.8	27.0
On-Road Distillate	4.0	8.4	8.4	8.9	7.7	6.2	6.8	7.8	6.7	6.8	7.2	6.8	7.7	6.9	7.2	6.3	6.6	7.3
On-Road CNG and Other	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Aviation	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Marine	1.7	3.2	3.2	4.2	4.3	1.8	1.7	1.7	1.6	1.5	0.7	0.9	1.2	1.1	1.7	0.6	1.1	1.5
Rail (Distillate)	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.4	0.4
Buildings	**26.5**	**28.2**	**23.8**	**27.2**	**26.6**	**26.7**	**25.6**	**25.7**	**23.0**	**25.3**	**28.5**	**26.3**	**23.6**	**23.6**	**26.5**	**25.5**	**23.1**	**24.8**
Residential	15.6	16.9	14.2	16.1	15.9	15.6	14.6	14.0	12.5	14.7	16.2	15.6	13.6	13.9	15.8	15.3	14.1	14.9
Commercial	11.0	11.3	9.6	11.0	10.7	11.1	10.9	11.7	10.5	10.6	12.3	10.7	10.0	9.7	10.7	10.2	9.0	9.9
Fuel-Based Industrial	14.7	13.5	12.0	11.9	10.5	9.1	9.6	10.9	10.8	10.1	8.2	8.0	8.4	7.5	8.0	8.0	7.2	7.6
Electricity	**26.8**	**34.0**	**30.9**	**32.3**	**29.8**	**23.5**	**26.0**	**23.2**	**20.7**	**20.3**	**20.8**	**19.5**	**20.8**	**18.0**	**19.1**	**19.4**	**18.7**	**19.1**
In-State Electric	12.3	19.7	18.5	19.6	19.0	14.9	17.7	15.6	14.7	14.1	16.8	18.4	20.0	17.2	17.9	17.3	13.7	13.5
MSW Incineration	0.1	0.9	0.8	1.0	0.8	0.8	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.9	0.8	0.8
Imported Electric	14.4	13.4	11.6	11.7	10.0	7.7	7.7	6.8	5.2	5.4	3.1	0.4	0.0	0.0	0.4	1.2	4.2	4.8
Halogenated Gases (excl. SF6)		2.2	2.3	2.5	2.7	2.9	3.1	3.4	3.6	3.9	4.1	4.4	4.6	4.8	5.0	5.2	5.3	5.2
SF6	0.6	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Non-Fuel Agriculture	0.7	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4
Natural Gas Trans. & Distr.	3.0	2.9	3.1	3.1	3.1	3.1	3.0	3.0	2.9	2.9	2.9	2.8	2.8	2.7	2.7	2.6	2.5	2.5
Landfills	**9.6**	**4.2**	**4.0**	**3.5**	**4.2**	**4.8**	**5.2**	**4.8**	**3.8**	**4.0**	**4.0**	**4.3**	**4.6**	**5.8**	**6.1**	**6.1**	**6.8**	**6.6**
In-State	5.3	1.8	1.7	1.5	1.8	2.1	2.1	1.9	1.7	1.8	2.0	2.0	2.1	2.3	2.4	2.4	2.5	2.5
Industrial	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Out-of-State	3.8	2.0	1.9	1.6	2.0	2.2	2.7	2.5	1.7	1.9	1.6	2.0	2.1	3.1	3.4	3.4	3.8	3.7
Wastewater Treatment	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Non-Fuel Industrial	0.1	0.7	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Released through Land Clearing	0.6	1.8	1.8	0.3	0.3	0.3	0.3	0.3	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
TOTAL GROSS EMISSIONS	116.6	136.5	127.7	132.4	126.9	114.7	117.4	116.3	108.1	110.6	112.5	108.7	110.3	105.5	110.7	107.6	100.3	105.7
SEQUESTERED	-4.0	-6.0	-6.0	-7.6	-7.6	-7.6	-7.6	-7.6	-7.6	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1
TOTAL NET EMISSIONS	**112.6**	**130.5**	**121.7**	**124.8**	**119.3**	**107.1**	**109.8**	**108.7**	**100.5**	**102.5**	**104.4**	**100.6**	**102.2**	**97.4**	**102.6**	**99.5**	**92.2**	**97.6**

[57] All numbers rounded to the nearest tenth. Subtotals may not agree exactly with sums of the numbers shown due to rounding. More detailed data is presented later in this Appendix and in Appendix E.

Table A-2 NJ Black Carbon Emissions, MMT CO_2e, based on GWP_{100}.[58]

YEAR	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Black Carbon	**5.75**	**5.63**	**4.67**	**4.23**	**3.97**	**3.98**	**3.61**	**3.40**	**3.19**	**2.99**	**2.75**	**2.45**	**2.29**	**2.07**	**1.86**	**1.73**
Transportation	**3.25**	**3.27**	**2.45**	**2.15**	**1.97**	**2.05**	**1.75**	**1.60**	**1.45**	**1.31**	**1.18**	**0.98**	**0.92**	**0.77**	**0.63**	**0.58**
On-Road Transportation	2.58	2.76	2.10	1.96	1.76	1.83	1.51	1.35	1.20	1.05	0.90	0.69	0.63	0.52	0.42	0.40
Non-Road Transportation	0.67	0.51	0.35	0.19	0.21	0.22	0.24	0.25	0.26	0.26	0.27	0.28	0.30	0.25	0.21	0.17
Non-Road Mobile Equipment	1.58	1.50	1.41	1.33	1.29	1.25	1.21	1.14	1.07	1.01	0.92	0.83	0.75	0.69	0.64	0.58
Residential	0.46	0.41	0.35	0.29	0.29	0.30	0.31	0.29	0.27	0.25	0.25	0.26	0.27	0.23	0.20	0.17
Electric Generation	0.23	0.22	0.21	0.20	0.16	0.12	0.08	0.08	0.08	0.08	0.07	0.06	0.04	0.04	0.03	0.03
Commercial - Exc. Non-Road Equipment	0.13	0.13	0.12	0.12	0.11	0.10	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.16	0.17	0.19
Industrial - Exc. Non-Road Eq.	**0.07**	**0.08**	**0.08**	**0.08**	**0.07**	**0.05**	**0.03**	**0.04**	**0.05**	**0.06**	**0.05**	**0.05**	**0.04**	**0.03**	**0.03**	**0.02**
Industrial Fuel Combustion	0.06	0.06	0.06	0.06	0.05	0.04	0.02	0.03	0.04	0.05	0.04	0.04	0.03	0.03	0.02	0.01
Industrial Process Emissions	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Other, including Wildfires & Agriculture	0.02	0.03	0.05	0.06	0.09	0.11	0.14	0.15	0.17	0.18	0.16	0.14	0.13	0.14	0.15	0.17

Note: Black carbon emissions were calculated for years in which $PM_{2.5}$ data was available from the USEPA National Emission Inventory (2005, 2008, 2011, 2014 and 2017). Estimates for intervening years were found through interpolation.

[58] All numbers rounded to the nearest hundredth. Subtotals may not agree exactly with sums of the numbers shown due to rounding. More detailed data is presented later in this Appendix and in Appendix E.

Table A-3. NJ GHG Emissions, MMT CO_2e, based on GWP_{20}.[59]

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Transportation																		
On-Road Gasoline	33.3	47.5	47.9	49.7	47.7	42.7	42.8	43.4	41.3	41.4	41.4	40.8	42.9	40.5	40.7	38.1	34.1	37.4
On-Road Distillate	26.3	34.5	34.8	35.2	34.3	33.4	32.9	32.4	31.7	31.9	32.2	31.8	32.6	31.1	30.5	29.7	24.9	27.0
On-Road CNG and Other	4.0	8.4	8.4	8.9	7.7	6.2	6.8	7.8	6.7	6.8	7.2	6.8	7.7	7.0	7.2	6.3	6.6	7.3
Aviation	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Marine	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Rail (Distillate)	1.7	3.2	3.2	4.2	4.3	1.8	1.7	1.7	1.6	1.5	0.7	0.9	1.2	1.1	1.7	0.6	1.1	1.5
Buildings	26.6	28.3	23.8	27.2	26.6	26.7	25.6	25.7	23.0	25.3	28.5	26.3	23.7	23.7	26.6	25.5	23.1	24.8
Residential	15.6	17.0	14.2	16.2	15.9	15.6	14.7	14.0	12.5	14.8	16.2	15.6	13.6	13.9	15.8	15.3	14.1	14.9
Commercial	11.0	11.3	9.6	11.0	10.7	11.1	10.9	11.7	10.5	10.6	12.3	10.8	10.1	9.7	10.7	10.2	9.0	10.0
Fuel-Based Industrial	14.8	13.5	12.1	11.9	10.6	9.2	9.7	11.0	10.9	10.2	8.2	8.0	8.4	7.5	8.0	8.0	7.2	7.6
Electricity	26.9	34.1	30.9	32.3	29.9	23.5	26.1	23.3	20.7	20.3	20.8	19.6	20.8	18.0	19.2	19.4	18.8	19.1
In-State Electric	12.3	19.8	18.5	19.7	19.1	15.0	17.7	15.7	14.8	14.2	16.9	18.4	20.1	17.2	17.9	17.4	13.7	13.5
MSW Incineration	0.1	0.9	0.8	1.0	0.8	0.8	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.9	0.9	0.9
Imported Electric	14.4	13.5	11.6	11.7	10.0	7.7	7.7	6.8	5.2	5.4	3.1	0.4	0.0	0.0	0.4	1.2	4.2	4.8
Halogenated Gases (excl. SF6)		5.2	5.6	6.0	6.3	6.6	7.2	7.7	8.2	8.7	9.3	9.8	10.4	10.9	11.3	11.9	12.0	11.8
SF6	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Non-Fuel Agriculture	1.1	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6
Natural Gas Trans. & Distr.	9.0	8.7	9.4	9.4	9.3	9.2	9.0	8.9	8.8	8.7	8.7	8.5	8.3	8.2	8.0	7.7	7.6	7.5
Landfills	28.7	12.7	12.1	10.5	12.5	14.3	15.7	14.4	11.5	12.1	11.9	13.0	13.7	17.5	18.3	18.4	20.3	19.7
In-State	15.9	5.5	5.2	4.5	5.4	6.4	6.4	5.6	5.2	5.3	5.9	5.9	6.3	6.9	7.1	7.2	7.6	7.5
Industrial	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1
Out-of-State	11.5	6.0	5.8	4.8	5.9	6.7	8.1	7.6	5.2	5.6	4.9	5.9	6.2	9.4	10.1	10.1	11.5	11.1
Wastewater Treatment	1.8	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Non-Fuel Industrial	0.1	0.7	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Released through Land Clearing	0.6	1.8	1.8	0.3	0.3	0.3	0.3	0.3	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
TOTAL GROSS EMISSIONS	143.4	155.5	147.3	150.8	146.8	135.9	139.7	137.9	127.9	131.0	133.0	130.1	132.5	130.4	136.3	133.4	127.3	132.2
SEQUESTERED	-4.0	-6.0	-6.0	-7.6	-7.6	-7.6	-7.6	-7.6	-7.6	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1
TOTAL NET EMISSIONS	**139.4**	**149.5**	**141.3**	**143.2**	**139.2**	**128.3**	**132.1**	**130.3**	**120.3**	**122.9**	**124.9**	**122.0**	**124.4**	**122.3**	**128.2**	**125.3**	**119.2**	**124.1**

[59] All numbers rounded to the nearest tenth. Subtotals may not agree exactly with sums of the numbers shown due to rounding. More detailed data is presented later in this Appendix and in Appendix E.

Table A-4 NJ Black Carbon Emissions, MMT CO_2e, based on GWP_{20}.[60]

YEAR	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Black Carbon	**20.23**	**19.81**	**16.42**	**14.87**	**13.96**	**14.00**	**12.70**	**11.95**	**11.21**	**10.50**	**9.66**	**8.60**	**8.05**	**7.27**	**6.54**	**6.09**
Transportation	**11.41**	**11.50**	**8.62**	**7.57**	**6.92**	**7.21**	**6.17**	**5.63**	**5.11**	**4.62**	**4.14**	**3.44**	**3.25**	**2.72**	**2.23**	**2.03**
On-Road Transportation	9.06	9.71	7.39	6.90	6.19	6.42	5.32	4.76	4.21	3.70	3.18	2.44	2.21	1.82	1.48	1.42
Non-Road Transportation	2.36	1.79	1.23	0.67	0.73	0.79	0.85	0.87	0.90	0.92	0.96	1.00	1.04	0.89	0.75	0.60
Non-Road Mobile Equipment	5.57	5.27	4.97	4.67	4.53	4.39	4.25	4.01	3.77	3.54	3.23	2.93	2.63	2.44	2.25	2.06
Residential	1.63	1.43	1.22	1.01	1.03	1.06	1.08	1.01	0.94	0.87	0.89	0.91	0.93	0.82	0.71	0.59
Electric Generation	0.82	0.78	0.75	0.71	0.57	0.43	0.29	0.29	0.29	0.29	0.24	0.20	0.15	0.14	0.12	0.11
Commercial - Exc. Non-Road Equipment	0.46	0.44	0.43	0.41	0.37	0.33	0.30	0.32	0.35	0.38	0.42	0.45	0.49	0.55	0.61	0.66
Industrial - Exc. Non-Road Eq.	**0.26**	**0.27**	**0.28**	**0.29**	**0.23**	**0.18**	**0.12**	**0.15**	**0.17**	**0.19**	**0.18**	**0.17**	**0.15**	**0.12**	**0.09**	**0.06**
Industrial Fuel Combustion	0.19	0.20	0.20	0.21	0.17	0.12	0.08	0.11	0.14	0.17	0.15	0.14	0.12	0.09	0.06	0.04
Industrial Process Emissions	0.07	0.07	0.07	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
Other, including Wildfires & Agriculture	0.07	0.12	0.17	0.22	0.31	0.40	0.50	0.54	0.58	0.62	0.56	0.50	0.44	0.49	0.54	0.59

Note: Black carbon emissions were calculated for years in which $PM_{2.5}$ data was available from the USEPA National Emission Inventory (2005, 2008, 2011, 2014 and 2017). Estimates for intervening years were found through interpolation.

[60] All numbers rounded to the nearest hundredth. Subtotals may not agree exactly with sums of the numbers shown due to rounding. More detailed data is presented later in this Appendix and in Appendix E.

Table A-5. On-Road greenhouse gas emissions by vehicle category for 2006, 2018 and 2019 (MMT CO_2e)

GWP_{100}

VEHICLE CATEGORY	YEAR				
	2006	2018	2019	2020	2021
Gas Passenger Vehicles	31.5	27.8	27.1	22.6	24.5
Diesel Freight & Commercial	6.7	5.5	4.8	5.3	5.8
Gas Freight & Commercial	2.9	2.5	2.5	2.2	2.4
Diesel Passenger Vehicles	1.0	0.8	0.8	0.7	0.8
Diesel Buses	0.7	0.9	0.7	0.6	0.6
Gas Buses	0.0	0.1	0.1	0.0	0.1
CNG Trucks & Buses	0.0	0.1	0.1	0.1	0.1
Motor Homes	0.1	0.1	0.0	0.0	0.1

GWP_{20}

VEHICLE CATEGORY	YEAR				
	2006	2018	2019	2020	2021
Gas Passenger Vehicles	31.8	27.9	27.2	22.6	24.6
Diesel Freight & Commercial	6.7	5.5	4.8	5.3	5.8
Gas Freight & Commercial	2.9	2.5	2.5	2.2	2.4
Diesel Passenger Vehicles	1.0	0.8	0.8	0.7	0.8
Diesel Buses	0.7	0.9	0.7	0.6	0.6
Gas Buses	0.0	0.1	0.1	0.0	0.1
CNG Trucks & Buses	0.0	0.2	0.2	0.2	0.2
Motor Homes	0.1	0.1	0.0	0.0	0.1

Table A-6. On-Road greenhouse gas emissions by vehicle type for 2006, 2018 and 2019 (MMT CO_2e) GWP_{100}

FUEL AND VEHICLE TYPE	YEAR				
	2006	2018	2019	2020	2021
Gasoline Motorcycle	0.1479	0.1590	0.1576	0.1338	0.1484
Gasoline Passenger Car	13.4950	11.9015	11.6792	8.6803	9.3653
Gasoline Passenger Truck	17.8863	15.6811	15.2421	13.6834	14.9495
Gasoline Light Commercial Truck	2.3479	1.9967	1.9497	1.7434	1.9182
Gasoline Other Buses	0.0087	0.0188	0.0142	0.0120	0.0159
Gasoline Transit Bus	0.0094	0.0488	0.0372	0.0315	0.0355
Gasoline School Bus	0.0123	0.0070	0.0050	0.0048	0.0052
Gasoline Refuse Truck	0.0062	0.0009	0.0007	0.0003	0.0003
Gasoline Single Unit Short-haul Truck	0.4493	0.4113	0.3859	0.3242	0.3559
Gasoline Single Unit Long-haul Truck	0.0811	0.1173	0.1097	0.0984	0.1077
Gasoline Motor Home	0.0397	0.0293	0.0276	0.0255	0.0291
Gasoline Combination Short-haul Truck	0.0026	0.0001	0.0000	0.0000	0.0000
Diesel Passenger Car	0.0546	0.0962	0.0925	0.0665	0.0716
Diesel Passenger Truck	0.9471	0.7048	0.7163	0.6729	0.7750
Diesel Light Commercial Truck	0.3049	0.1603	0.1524	0.1380	0.1517
Diesel Other Buses	0.1612	0.1281	0.0942	0.0700	0.0874
Diesel Transit Bus	0.2312	0.3449	0.2554	0.2040	0.2253
Diesel School Bus	0.2945	0.4286	0.3149	0.2937	0.3169
Diesel Refuse Truck	0.1320	0.1106	0.1025	0.0951	0.1075
Diesel Single Unit Short-haul Truck	1.4924	1.5271	1.4090	1.1700	1.2734
Diesel Single Unit Long-haul Truck	0.3329	0.4253	0.3898	0.3464	0.3748
Diesel Motor Home	0.0147	0.0214	0.0205	0.0194	0.0221
Diesel Combination Short-haul Truck	1.4403	1.0616	0.9208	1.1240	1.2956
Diesel Combination Long-haul Truck	2.9951	2.2150	1.8463	2.4263	2.6148
CNG Other Buses	0.0175	0.0137	0.0101	0.0075	0.0097
CNG Transit Bus	0.0165	0.0384	0.0283	0.0221	0.0251
CNG School Bus	0.0009	0.0056	0.0044	0.0046	0.0054
CNG Refuse Truck	0.0001	0.0132	0.0154	0.0178	0.0232
CNG Single Unit Short-haul Truck	0.0017	0.0249	0.0259	0.0233	0.0277
CNG Single Unit Long-haul Truck	0.0003	0.0079	0.0079	0.0077	0.0091
CNG Motor Home	0.0000	0.0000	0.0000	0.0000	0.0000
CNG Combination Short-haul Truck	0.0000	0.0217	0.0224	0.0289	0.0385
E-85 Passenger Car	0.0000	0.0080	0.0080	0.0083	0.0063
E-85 Passenger Truck	0.0000	0.0420	0.0408	0.0502	0.0387
E-85 Light Commercial Truck	0.0000	0.0061	0.0058	0.0070	0.0053

GWP_{20}

FUEL AND VEHICLE TYPE	YEAR				
	2006	2018	2019	2020	2021
Gasoline Motorcycle	0.1531	0.1618	0.1601	0.1359	0.1513
Gasoline Passenger Car	13.6184	11.9280	11.7019	8.6981	9.3878
Gasoline Passenger Truck	18.0548	15.7141	15.2705	13.7073	14.9806
Gasoline Light Commercial Truck	2.3719	2.0026	1.9545	1.7476	1.9234
Gasoline Other Buses	0.0087	0.0189	0.0142	0.0120	0.0160
Gasoline Transit Bus	0.0094	0.0489	0.0373	0.0316	0.0356
Gasoline School Bus	0.0125	0.0071	0.0050	0.0048	0.0052
Gasoline Refuse Truck	0.0063	0.0009	0.0007	0.0003	0.0003
Gasoline Single Unit Short-haul Truck	0.4549	0.4127	0.3871	0.3251	0.3571
Gasoline Single Unit Long-haul Truck	0.0818	0.1175	0.1099	0.0985	0.1078
Gasoline Motor Home	0.0403	0.0295	0.0277	0.0256	0.0292
Gasoline Combination Short-haul Truck	0.0027	0.0001	0.0000	0.0000	0.0000
Diesel Passenger Car	0.0546	0.0963	0.0925	0.0665	0.0722
Diesel Passenger Truck	0.9471	0.7059	0.7174	0.6741	0.7775
Diesel Light Commercial Truck	0.3049	0.1606	0.1527	0.1383	0.1521
Diesel Other Buses	0.1612	0.1282	0.0942	0.0701	0.0875
Diesel Transit Bus	0.2312	0.3451	0.2556	0.2041	0.2255
Diesel School Bus	0.2945	0.4292	0.3153	0.2942	0.3175
Diesel Refuse Truck	0.1320	0.1107	0.1026	0.0952	0.1076
Diesel Single Unit Short-haul Truck	1.4924	1.5310	1.4128	1.1736	1.2779
Diesel Single Unit Long-haul Truck	0.3329	0.4258	0.3902	0.3468	0.3752
Diesel Motor Home	0.0147	0.0215	0.0205	0.0194	0.0221
Diesel Combination Short-haul Truck	1.4403	1.0627	0.9217	1.1250	1.2969
Diesel Combination Long-haul Truck	2.9951	2.2167	1.8477	2.4279	2.6169
CNG Other Buses	0.0231	0.0187	0.0140	0.0106	0.0148
CNG Transit Bus	0.0222	0.0526	0.0391	0.0306	0.0370
CNG School Bus	0.0010	0.0078	0.0061	0.0066	0.0084
CNG Refuse Truck	0.0001	0.0173	0.0203	0.0242	0.0336
CNG Single Unit Short-haul Truck	0.0020	0.0331	0.0347	0.0318	0.0407
CNG Single Unit Long-haul Truck	0.0003	0.0106	0.0107	0.0105	0.0133
CNG Motor Home	0.0000	0.0000	0.0000	0.0000	0.0000
CNG Combination Short-haul Truck	0.0000	0.0278	0.0288	0.0376	0.0537
E-85 Passenger Car	0.0000	0.0081	0.0080	0.0084	0.0064
E-85 Passenger Truck	0.0000	0.0422	0.0410	0.0504	0.0388
E-85 Light Commercial Truck	0.0000	0.0061	0.0059	0.0071	0.0053

Table A-7. Marine emissions (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Gasoline Recreational Boats	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4
Diesel Recreational Boats	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Diesel Ships & Non-Recreational Boats	0.1	0.1	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Residual Fuel	1.0	1.1	1.7	1.2	1.2	1.6	1.1	0.6	0.4	0.8	2.9	1.3	2.3	0.9	1.5	2.5	2.6	3.4
Total	**1.7**	**1.7**	**2.4**	**1.9**	**2.0**	**2.3**	**1.8**	**1.4**	**1.1**	**1.6**	**3.7**	**2.1**	**3.1**	**1.7**	**2.2**	**3.2**	**3.2**	**4.2**

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Gasoline Recreational Boats	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4
Diesel Recreational Boats	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Diesel Ships & Non-Recreational Boats	0.1	0.1	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Residual Fuel	1.0	1.1	1.7	1.3	1.2	1.6	1.1	0.6	0.4	0.8	2.9	1.3	2.3	0.9	1.5	2.5	2.6	3.5
Total	**1.7**	**1.7**	**2.4**	**1.9**	**2.0**	**2.3**	**1.8**	**1.4**	**1.1**	**1.6**	**3.7**	**2.1**	**3.1**	**1.7**	**2.2**	**3.2**	**3.2**	**4.2**

Table A-8. Rail emissions from distillate (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rail Emissions	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.4	0.3

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rail Emissions	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.4	0.3

Table A-9. Emissions from electricity generation (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
In-State Generation	12.3	19.7	18.5	19.6	19.0	14.9	17.7	15.6	14.7	14.1	16.8	18.4	20.0	17.2	17.9	17.3	13.7	13.5
MSW Incineration	0.1	0.9	0.8	1.0	0.8	0.8	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.9	0.8	0.8
Imported Electricity	14.4	13.4	11.6	11.7	10.0	7.7	7.7	6.8	5.2	5.4	3.1	0.4	0.0	0.0	0.4	1.2	4.2	4.8
Total	**26.8**	**34.0**	**30.9**	**32.3**	**29.8**	**23.5**	**26.0**	**23.2**	**20.7**	**20.3**	**20.8**	**19.5**	**20.8**	**18.0**	**19.1**	**19.4**	**18.7**	**19.1**

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
In-State Generation	12.3	19.8	18.5	19.7	19.1	15.0	17.7	15.7	14.8	14.2	16.9	18.4	20.1	17.2	17.9	17.4	13.7	13.5
MSW Incineration	0.1	0.9	0.8	1.0	0.8	0.8	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.9	0.9	0.9
Imported Electricity	14.4	13.5	11.6	11.7	10.0	7.7	7.7	6.8	5.2	5.4	3.1	0.4	0.0	0.0	0.4	1.2	4.2	4.8
Total	**26.9**	**34.1**	**30.9**	**32.3**	**29.9**	**23.5**	**26.1**	**23.3**	**20.7**	**20.3**	**20.8**	**19.6**	**20.8**	**18.0**	**19.2**	**19.4**	**18.8**	**19.1**

Table A-10. Residential greenhouse gas emissions (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distillate Fuel Oil	5.9	3.8	3.0	3.2	3.4	2.8	2.3	2.0	1.8	1.9	2.1	2.1	1.4	1.4	1.8	1.8	1.5	1.8
Propane	0.2	0.3	0.2	0.3	0.4	0.4	0.4	0.4	0.2	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.2	0.3
Kerosene	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas	9.3	12.8	10.9	12.5	12.1	12.4	11.9	11.6	10.4	12.6	13.8	13.2	11.9	12.3	13.7	13.2	12.4	12.8
Total	**15.6**	**16.9**	**14.2**	**16.1**	**15.9**	**15.6**	**14.6**	**14.0**	**12.5**	**14.7**	**16.2**	**15.6**	**13.6**	**13.9**	**15.8**	**15.3**	**14.1**	**14.9**

GWP20

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distillate Fuel Oil	5.9	3.8	3.1	3.2	3.4	2.9	2.3	2.0	1.8	1.9	2.1	2.1	1.4	1.4	1.8	1.8	1.5	1.8
Propane	0.2	0.3	0.2	0.3	0.4	0.4	0.4	0.4	0.2	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.2	0.3
Kerosene	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas	9.3	12.8	10.9	12.6	12.1	12.4	12.0	11.7	10.5	12.6	13.8	13.2	12.0	12.3	13.7	13.2	12.4	12.8
Total	**15.6**	**17.0**	**14.2**	**16.2**	**15.9**	**15.6**	**14.7**	**14.0**	**12.5**	**14.8**	**16.2**	**15.6**	**13.6**	**13.9**	**15.8**	**15.3**	**14.1**	**14.9**

Table A-11. Commercial greenhouse gas emissions (MMT CO_2e)

GWP100

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coal	0.02	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distillate Fuel Oil	3.6	1.5	0.9	1.4	1.0	1.0	0.8	1.1	0.8	0.9	0.9	0.8	0.7	0.6	0.6	0.7	0.5	0.8
Propane	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Kerosene	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gasoline	0.3	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.05	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Natural Gas	6.3	9.4	8.4	9.3	9.3	9.9	9.9	10.5	9.5	9.6	11.2	9.1	8.5	8.2	9.2	8.6	7.6	8.3
Residual Fuel Oil	0.7	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**11.0**	**11.3**	**9.6**	**11.0**	**10.7**	**11.1**	**10.9**	**11.7**	**10.5**	**10.6**	**12.3**	**10.7**	**10.0**	**9.7**	**10.7**	**10.2**	**9.0**	**9.9**

GWP20

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coal	0.02	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distillate Fuel Oil	3.6	1.5	0.9	1.4	1.1	1.0	0.8	1.1	0.8	0.9	0.9	0.8	0.7	0.6	0.6	0.7	0.5	0.8
Propane	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Kerosene	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gasoline	0.3	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.05	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Natural Gas	6.3	9.4	8.4	9.3	9.3	9.9	9.9	10.5	9.5	9.6	11.2	9.1	8.5	8.2	9.3	8.6	7.6	8.3
Residual Fuel Oil	0.7	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**11.0**	**11.3**	**9.6**	**11.0**	**10.7**	**11.1**	**10.9**	**11.7**	**10.5**	**10.6**	**12.3**	**10.8**	**10.1**	**9.7**	**10.7**	**10.2**	**9.0**	**10.0**

Table A-12. Industrial greenhouse gas emissions from fuel consumption (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coal	0.7	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distillate Fuel Oil	1.5	0.8	1.0	0.8	0.8	0.8	0.7	0.9	0.8	0.7	0.9	0.9	0.9	0.7	0.7	0.7	0.6	0.8
Kerosene	0.1	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gasoline	0.2	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5
Natural Gas	4.9	4.1	3.6	3.5	3.0	2.6	2.7	2.7	3.0	3.4	3.4	3.1	3.4	3.0	3.5	3.6	3.2	3.3
Petroleum Coke	3.0	3.6	3.1	3.3	3.4	3.1	2.3	3.3	2.8	2.0								
Residual Oil	1.7	0.2	0.2	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Still Gas	2.0	3.5	3.4	3.3	2.7	2.0	2.0	2.1	2.5	2.4	2.4	2.3	2.4	2.1	2.1	2.0	1.7	1.8
Hydrocarbon Gas Liquids	0.7	0.1	0.1	0.2	0.1	0.0	1.4	1.4	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Total	**14.7**	**13.5**	**12.0**	**11.9**	**10.5**	**9.1**	**9.6**	**10.9**	**10.8**	**10.1**	**8.2**	**8.0**	**8.4**	**7.5**	**8.0**	**8.0**	**7.2**	**7.6**

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coal	0.7	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distillate Fuel Oil	1.5	0.8	1.0	0.9	0.8	0.8	0.7	0.9	0.8	0.7	0.9	0.9	0.9	0.7	0.7	0.7	0.6	0.8
Kerosene	0.1	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gasoline	0.2	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5
Natural Gas	4.9	4.1	3.6	3.5	3.0	2.7	2.7	2.7	3.0	3.4	3.4	3.1	3.4	3.0	3.5	3.6	3.3	3.3
Petroleum Coke	3.1	3.7	3.2	3.4	3.5	3.1	2.4	3.4	2.9	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residual Oil	1.7	0.2	0.2	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Still Gas	2.0	3.5	3.4	3.3	2.7	2.0	2.1	2.1	2.5	2.4	2.4	2.3	2.5	2.1	2.1	2.0	1.7	1.8
Hydrocarbon Gas Liquids	0.7	0.2	0.1	0.2	0.1	0.1	1.2	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Total	**14.9**	**13.6**	**12.1**	**12.0**	**10.6**	**9.2**	**9.6**	**10.9**	**10.8**	**10.1**	**8.1**	**7.9**	**8.3**	**7.4**	**7.9**	**7.9**	**7.1**	**7.5**

Table A-13. HFC emissions by source type and category (GWP_{100})

SOURCE	CATEGORY	YEAR																
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Commercial Refrigeration	Refrigeration	0.37	0.43	0.50	0.57	0.64	0.77	0.90	1.02	1.14	1.25	1.36	1.47	1.57	1.66	1.75	1.80	1.78
Industrial Refrigeration	Refrigeration	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.08
Domestic Refrigeration	Refrigeration	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05
Stationary Commercial AC > 50 lbs.	AC - Stationary	0.07	0.08	0.09	0.10	0.11	0.13	0.14	0.16	0.17	0.18	0.20	0.22	0.23	0.24	0.26	0.27	0.28
Stationary Commercial AC <50 lbs.	AC - Stationary	0.00	0.00	0.00	0.00	0.00	0.05	0.10	0.16	0.22	0.28	0.34	0.39	0.45	0.51	0.56	0.62	0.67
Stationary Residential Heat Pumps	AC - Stationary	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.06	0.07	0.09	0.10	0.12
Stationary Residential Central AC	AC - Stationary	0.02	0.02	0.03	0.03	0.04	0.07	0.09	0.12	0.16	0.19	0.23	0.27	0.32	0.36	0.40	0.45	0.49
Stationary Residential Room Unit AC	AC - Stationary	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.11	0.13	0.14	0.16	0.17	0.26	0.27	0.29
Light-duty MVAC	AC- Mobile	1.05	1.13	1.19	1.21	1.23	1.20	1.21	1.18	1.17	1.14	1.08	1.02	0.96	0.88	0.80	0.72	0.64
Heavy-duty MVAC	AC- Mobile	0.19	0.19	0.19	0.19	0.20	0.21	0.21	0.21	0.22	0.22	0.23	0.24	0.24	0.25	0.26	0.26	0.26
Transport Refrigeration	AC- Mobile	0.07	0.08	0.10	0.11	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.14
Foam	Foams	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.16	0.16	0.19	0.18	0.15
Aerosol Propellants	Aerosols	0.29	0.29	0.29	0.32	0.33	0.34	0.35	0.35	0.36	0.35	0.35	0.35	0.36	0.36	0.36	0.25	0.13
Solvents and Fire Suppressant	Other	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Total		**2.2**	**2.3**	**2.5**	**2.7**	**2.9**	**3.1**	**3.4**	**3.6**	**3.9**	**4.1**	**4.4**	**4.6**	**4.8**	**5.0**	**5.2**	**5.3**	**5.2**
BY CATEGORY																		
Refrigeration		0.41	0.47	0.55	0.62	0.70	0.84	0.97	1.10	1.22	1.35	1.46	1.57	1.68	1.78	1.87	1.92	1.91
Air Conditioning - Stationary		0.09	0.11	0.13	0.17	0.19	0.30	0.41	0.53	0.66	0.80	0.94	1.08	1.22	1.35	1.56	1.71	1.84
Air Conditioning - Mobile		1.31	1.40	1.47	1.51	1.54	1.54	1.54	1.52	1.51	1.49	1.44	1.39	1.34	1.27	1.20	1.12	1.05
Foams		0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.16	0.16	0.19	0.18	0.15
Aerosol Propellants		0.29	0.29	0.29	0.32	0.33	0.34	0.35	0.35	0.36	0.35	0.35	0.35	0.36	0.36	0.36	0.25	0.13
Solvents and Fire Suppressants		0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

Table A-14. HFC emissions by source type and category (GWP_{20})

SOURCE	CATEGORY	YEAR																
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Commercial Refrigeration	Refrigeration	0.90	1.03	1.18	1.34	1.50	1.78	2.04	2.30	2.54	2.81	3.06	3.31	3.54	3.77	3.98	4.10	4.05
Industrial Refrigeration	Refrigeration	0.05	0.05	0.06	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.16	0.17	0.18
Domestic Refrigeration	Refrigeration	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Stationary Commercial AC > 50 lbs.	AC - Stationary	0.16	0.18	0.21	0.24	0.26	0.29	0.32	0.35	0.38	0.41	0.45	0.49	0.52	0.56	0.59	0.62	0.64
Stationary Commercial AC <50 lbs.	AC - Stationary	0.00	0.00	0.00	0.00	0.00	0.12	0.24	0.36	0.49	0.62	0.75	0.89	1.02	1.15	1.27	1.41	1.52
Stationary Residential Heat Pumps	AC - Stationary	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.06	0.08	0.10	0.13	0.13	0.16	0.19	0.23	0.26
Stationary Residential Central AC	AC - Stationary	0.04	0.05	0.06	0.08	0.09	0.15	0.21	0.28	0.35	0.43	0.52	0.62	0.71	0.81	0.91	1.02	1.12
Stationary Residential Room Unit AC	AC - Stationary	0.02	0.03	0.04	0.06	0.09	0.11	0.14	0.18	0.21	0.25	0.28	0.32	0.36	0.39	0.58	0.62	0.66
Light-duty MVAC	AC- Mobile	2.54	2.69	2.82	2.84	2.85	2.77	2.76	2.66	2.62	2.55	2.43	2.30	2.17	2.00	1.82	1.64	1.47
Heavy-duty MVAC	AC- Mobile	0.46	0.45	0.44	0.45	0.46	0.48	0.47	0.48	0.48	0.50	0.52	0.54	0.55	0.57	0.59	0.59	0.59
Transport Refrigeration	AC- Mobile	0.16	0.20	0.23	0.26	0.28	0.29	0.29	0.29	0.29	0.30	0.30	0.30	0.31	0.31	0.32	0.32	0.33
Foam	Foams	0.01	0.01	0.01	0.02	0.02	0.04	0.06	0.09	0.11	0.14	0.20	0.29	0.36	0.36	0.42	0.42	0.34
Aerosol Propellants	Aerosols	0.70	0.69	0.69	0.75	0.77	0.79	0.79	0.80	0.80	0.79	0.80	0.80	0.80	0.81	0.81	0.56	0.31
Solvents and Fire Suppressant	Other	0.15	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Total		**5.2**	**5.6**	**6.0**	**6.3**	**6.6**	**7.2**	**7.7**	**8.2**	**8.7**	**9.3**	**9.8**	**10.4**	**10.9**	**11.3**	**11.9**	**12.0**	**11.8**
BY CATEGORY																		
Refrigeration		0.99	1.14	1.30	1.46	1.64	1.94	2.22	2.49	2.74	3.02	3.28	3.55	3.80	4.03	4.26	4.38	4.35
Air Conditioning - Stationary		0.21	0.26	0.32	0.39	0.45	0.69	0.94	1.21	1.49	1.79	2.11	2.45	2.75	3.07	3.54	3.90	4.21
Air Conditioning - Mobile		3.16	3.34	3.49	3.55	3.59	3.54	3.52	3.43	3.39	3.35	3.24	3.14	3.03	2.88	2.72	2.56	2.39
Foams		0.01	0.01	0.01	0.02	0.02	0.04	0.06	0.09	0.11	0.14	0.20	0.29	0.36	0.36	0.42	0.42	0.34
Aerosol Propellants		0.70	0.69	0.69	0.75	0.77	0.79	0.79	0.80	0.80	0.79	0.80	0.80	0.80	0.81	0.81	0.56	0.31
Solvents and Fire Suppressants		0.15	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16

Table A-15. Natural Gas Transmission and Distribution (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Transmission	0.15	0.25	0.28	0.28	0.28	0.25	0.25	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Distribution	2.84	2.65	2.86	2.85	2.82	2.80	2.76	2.74	2.71	2.68	2.66	2.61	2.55	2.50	2.42	2.36	2.32	2.27
Total	**3.00**	**2.90**	**3.14**	**3.13**	**3.10**	**3.05**	**3.02**	**2.97**	**2.94**	**2.91**	**2.89**	**2.83**	**2.78**	**2.72**	**2.65**	**2.58**	**2.54**	**2.49**

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Transmission	0.46	0.75	0.84	0.84	0.84	0.75	0.75	0.67	0.67	0.67	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Distribution	8.53	7.94	8.57	8.55	8.47	8.40	8.29	8.23	8.14	8.05	7.99	7.82	7.66	7.49	7.27	7.07	6.95	6.80
Total	**8.99**	**8.69**	**9.41**	**9.38**	**9.30**	**9.16**	**9.05**	**8.90**	**8.81**	**8.73**	**8.66**	**8.50**	**8.34**	**8.17**	**7.95**	**7.75**	**7.63**	**7.48**

Table A-16. Landfill Emissions (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
In-State MSW LF	5.3	1.8	1.7	1.5	1.8	2.1	2.1	1.9	1.7	1.8	2.0	2.0	2.1	2.3	2.4	2.4	2.5	2.5
Industrial LF	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
MSW Export	3.8	2.0	1.9	1.6	2.0	2.2	2.7	2.5	1.7	1.9	1.6	2.0	2.1	3.1	3.4	3.4	3.8	3.7
Total	9.6	4.2	4.0	3.5	4.2	4.8	5.2	4.8	3.8	4.0	4.0	4.3	4.6	5.8	6.1	6.1	6.8	6.6

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
In-State MSW LF	15.9	5.5	5.2	4.5	5.4	6.4	6.4	5.6	5.2	5.3	5.9	5.9	6.3	6.9	7.1	7.2	7.6	7.5
Industrial LF	11.5	6.0	5.8	4.8	5.9	6.7	8.1	7.6	5.2	5.6	4.9	5.9	6.2	9.4	10.1	10.1	11.5	11.1
MSW Export	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1
Total	28.7	12.7	12.1	10.5	12.5	14.3	15.7	14.4	11.5	12.1	11.9	13.0	13.7	17.5	18.3	18.4	20.3	19.7

Table A-17. Wastewater treatment emissions (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Wastewater Treatment	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Wastewater Treatment	1.8	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2

Table A-18. Non-fuel agricultural emissions (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Non-Fuel Agriculture	0.7	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Non-Fuel Agriculture	1.1	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6

Table A-19. Non-fuel industrial emissions of carbon dioxide (MMT CO_2)

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Non-Fuel Industrial CO_2	0.1	0.7	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Table A-20. Sulfur hexafluoride emissions (MMT CO_2e)

GWP_{100}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Sulfur Hexafluoride	0.6	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

GWP_{20}

YEAR	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Sulfur Hexafluoride	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table A-21. Black carbon emissions by sector (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Transportation	3.25	3.27	2.15	1.75	1.31	0.92	0.58
Non-Road Equipment	1.58	1.50	1.33	1.21	1.01	0.75	0.58
Residential	0.46	0.41	0.29	0.31	0.25	0.27	0.17
Electric Generation	0.23	0.22	0.20	0.08	0.08	0.04	0.03
Commercial [1]	0.13	0.13	0.12	0.08	0.11	0.14	0.19
Industrial [1]	0.07	0.08	0.08	0.03	0.06	0.04	0.02
Other [2]	0.02	0.03	0.06	0.14	0.18	0.13	0.17
Total	**5.75**	**5.63**	**4.23**	**3.61**	**2.99**	**2.29**	**1.73**

[1] Except non-road equipment
[2] Includes wildfires and agriculture

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Transportation	11.41	11.50	7.57	6.17	4.62	3.25	2.03
Non-Road Equipment	5.57	5.27	4.67	4.25	3.54	2.63	2.06
Residential	1.63	1.43	1.01	1.08	0.87	0.93	0.59
Electric Generation	0.82	0.78	0.71	0.29	0.29	0.15	0.11
Commercial [1]	0.46	0.44	0.41	0.30	0.38	0.49	0.66
Industrial [1]	0.26	0.27	0.29	0.12	0.19	0.15	0.06
Other [2]	0.07	0.12	0.22	0.50	0.62	0.44	0.59
Total	**20.23**	**19.81**	**14.87**	**12.70**	**10.50**	**8.05**	**6.09**

[1] Except non-road equipment
[2] Includes wildfires and agriculture

Table A-22. On-road black carbon emissions (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2018	2019	2020	2021
Diesel Heavy Duty	2.02	2.23	1.55	1.22	0.80	0.44	0.34	0.25	0.25	0.23
Diesel Light Duty	0.27	0.37	0.20	0.16	0.11	0.06	0.08	0.06	0.05	0.05
Non-Diesel Heavy Duty	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-Diesel Light Duty	0.28	0.16	0.20	0.13	0.13	0.12	0.09	0.10	0.11	0.11
Total On-Road	**2.58**	**2.76**	**1.96**	**1.51**	**1.05**	**0.63**	**0.52**	**0.42**	**0.40**	**0.40**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2018	2019	2020	2021
Diesel Heavy Duty	7.12	7.83	5.47	4.29	2.83	1.56	1.21	0.89	0.86	0.82
Diesel Light Duty	0.94	1.31	0.72	0.56	0.39	0.22	0.27	0.23	0.18	0.18
Non-Diesel Heavy Duty	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Non-Diesel Light Duty	0.97	0.56	0.71	0.46	0.47	0.41	0.33	0.36	0.37	0.40
Total On-Road	**9.06**	**9.71**	**6.90**	**5.32**	**3.70**	**2.21**	**1.82**	**1.48**	**1.42**	**1.41**

Table A-23. Largest Sources of Black Carbon from On-Road Diesel Vehicles (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2018	2019	2020	2021
Long-Haul Combo	0.87	0.92	0.65	0.50	0.32	0.14	0.11	0.08	0.10	0.10
Short-Haul Combo	0.36	0.47	0.27	0.21	0.14	0.11	0.08	0.06	0.06	0.06
Long-Haul Single Unit	0.10	0.09	0.08	0.06	0.05	0.02	0.02	0.01	0.01	0.01
Short Haul Single-Unit	0.43	0.48	0.35	0.28	0.20	0.11	0.08	0.06	0.05	0.04
Buses	0.22	0.21	0.17	0.14	0.08	0.04	0.05	0.03	0.02	0.02
Light Duty/Light Commercial	0.27	0.37	0.20	0.16	0.11	0.06	0.08	0.06	0.05	0.05
Other Diesel	0.04	0.05	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.01
Total On-Road Diesel	**2.29**	**2.60**	**1.76**	**1.38**	**0.91**	**0.51**	**0.42**	**0.32**	**0.30**	**0.28**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2018	2019	2020	2021
Long-Haul Combo	3.05	3.22	2.30	1.74	1.13	0.51	0.37	0.28	0.34	0.34
Short-Haul Combo	1.27	1.66	0.95	0.75	0.49	0.40	0.27	0.20	0.22	0.22
Long-Haul Single Unit	0.36	0.33	0.28	0.23	0.16	0.06	0.05	0.04	0.02	0.02
Short Haul Single-Unit	1.52	1.70	1.22	0.99	0.69	0.38	0.29	0.22	0.17	0.16
Buses	0.77	0.73	0.59	0.48	0.29	0.15	0.17	0.12	0.08	0.06
Light Duty/Light Commercial	0.94	1.31	0.72	0.56	0.39	0.22	0.27	0.23	0.18	0.18
Other Diesel	0.15	0.18	0.12	0.10	0.07	0.05	0.05	0.04	0.03	0.03
Total On-Road Diesel	**8.06**	**9.13**	**6.18**	**4.85**	**3.22**	**1.78**	**1.48**	**1.11**	**1.04**	**1.00**

Table A-24. Non-road Transportation Black Carbon Emissions (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Aircraft	0.052	0.039	0.014	0.031	0.036	0.033	0.028
Commercial Marine Vessels	0.547	0.411	0.140	0.138	0.156	0.156	0.089
Locomotives	0.071	0.060	0.036	0.073	0.070	0.107	0.055
Total Non-Road Transportation	**0.670**	**0.510**	**0.190**	**0.242**	**0.262**	**0.296**	**0.172**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Aircraft	0.182	0.138	0.050	0.108	0.128	0.115	0.097
Commercial Marine Vessels	1.924	1.447	0.492	0.486	0.547	0.548	0.313
Locomotives	0.250	0.209	0.127	0.256	0.246	0.377	0.193
Total Non-Road Transportation	**2.356**	**1.794**	**0.669**	**0.850**	**0.921**	**1.040**	**0.603**

Table A-25. Non-Road Equipment Black Carbon Emissions. (MMT CO2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Diesel	1.43	1.34	1.17	1.07	0.87	0.64	0.47
Gasoline	0.14	0.14	0.14	0.12	0.12	0.10	0.09
Other	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Total Non-Road Equipment	**1.58**	**1.50**	**1.33**	**1.21**	**1.01**	**0.75**	**0.58**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Diesel	5.02	4.72	4.11	3.77	3.07	2.24	1.67
Gasoline	0.51	0.50	0.50	0.42	0.41	0.34	0.33
Other	0.04	0.05	0.06	0.06	0.06	0.06	0.06
Total Non-Road Equipment	**5.57**	**5.27**	**4.67**	**4.25**	**3.54**	**2.63**	**2.06**

Table A-26. Electric Sector Black Carbon Emissions (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coal	0.155	0.150	0.142	0.008	0.008	0.002	0.002
Natural Gas	0.035	0.036	0.039	0.028	0.035	0.029	0.020
Oil	0.042	0.034	0.017	0.041	0.034	0.009	0.005
Other	0.002	0.003	0.004	0.004	0.005	0.003	0.002
Total Electric Generation	**0.234**	**0.223**	**0.202**	**0.081**	**0.082**	**0.044**	**0.030**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coal	0.544	0.528	0.498	0.029	0.029	0.009	0.007
Natural Gas	0.122	0.127	0.136	0.098	0.122	0.101	0.072
Oil	0.149	0.119	0.060	0.145	0.121	0.033	0.019
Other	0.007	0.009	0.015	0.014	0.016	0.012	0.007
Total Electric Generation	**0.821**	**0.784**	**0.709**	**0.286**	**0.289**	**0.154**	**0.106**

Table A-27. Residential Black Carbon Emissions (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Natural Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Oil	0.031	0.027	0.018	0.015	0.013	0.008	0.009
Other	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wood	0.431	0.376	0.265	0.290	0.230	0.254	0.156
Total Residential	**0.465**	**0.405**	**0.286**	**0.308**	**0.246**	**0.265**	**0.168**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Natural Gas	0.009	0.009	0.009	0.009	0.010	0.009	0.009
Oil	0.108	0.094	0.064	0.053	0.046	0.029	0.031
Other	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Wood	1.516	1.322	0.933	1.020	0.809	0.895	0.550
Total Residential	**1.635**	**1.426**	**1.007**	**1.082**	**0.865**	**0.934**	**0.591**

Table A-28. Black carbon emissions from the Commercial Sector, except non-road equipment. (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Commercial Cooking	0.075	0.069	0.058	0.061	0.060	0.105	0.179
Biomass	0.000	0.000	0.000	0.002	0.010	0.011	0.003
Coal	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural Gas	0.004	0.004	0.004	0.003	0.005	0.004	0.002
Oil	0.050	0.052	0.055	0.018	0.032	0.019	0.004
Other	0.001	0.001	0.001	0.001	0.001	0.000	0.000
Total Commercial	**0.130**	**0.126**	**0.117**	**0.084**	**0.107**	**0.139**	**0.189**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Commercial Cooking	0.262	0.243	0.204	0.213	0.212	0.370	0.628
Biomass	0.000	0.000	0.000	0.006	0.036	0.040	0.010
Coal	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Natural Gas	0.015	0.014	0.013	0.012	0.016	0.013	0.008
Oil	0.177	0.182	0.193	0.063	0.112	0.067	0.015
Other	0.002	0.002	0.002	0.002	0.002	0.001	0.001
Total Commercial	**0.457**	**0.442**	**0.412**	**0.296**	**0.378**	**0.490**	**0.663**

Table A-29. Black carbon from industrial fuel combustion (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Biomass	0.000	0.000	0.000	0.002	0.010	0.011	0.003
Coal	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural Gas	0.004	0.004	0.004	0.003	0.005	0.004	0.002
Oil	0.050	0.052	0.055	0.018	0.032	0.019	0.004
Other	0.001	0.001	0.001	0.001	0.001	0.000	0.000
Total Industrial Fuel Combustion	**0.055**	**0.057**	**0.059**	**0.024**	**0.047**	**0.034**	**0.010**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Biomass	0.000	0.000	0.000	0.006	0.036	0.040	0.010
Coal	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Natural Gas	0.015	0.014	0.013	0.012	0.016	0.013	0.008
Oil	0.177	0.182	0.193	0.063	0.112	0.067	0.015
Other	0.002	0.002	0.002	0.002	0.002	0.001	0.001
Total Industrial Fuel Combustion	**0.195**	**0.199**	**0.208**	**0.083**	**0.166**	**0.120**	**0.035**

Table A-30. Industrial Process Black Carbon (metric tonnes (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Cement Mfg.	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000
Chemical Mfg.	0.00092	0.00077	0.00048	0.00080	0.00031	0.00028	0.00025
Ferrous Metals	0.00068	0.00059	0.00040	0.00013	0.00012	0.00010	0.00009
Mining	0.00200	0.00221	0.00262	0.00211	0.00001	0.00001	0.00000
Other	0.00870	0.00860	0.00840	0.00661	0.00542	0.00630	0.00453
Non-ferrous Metals	0.00020	0.00017	0.00013	0.00009	0.00015	0.00012	0.00010
Oil & Gas Production	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Petroleum Refineries	0.00493	0.00621	0.00876	0.00109	0.00121	0.00106	0.00122
Pulp & Paper	0.00132	0.00098	0.00029	0.00009	0.00046	0.00056	0.00016
Storage and Transfer	0.00050	0.00047	0.00040	0.00032	0.00015	0.00035	0.00058
Industrial Surface Coating & Solvent Use	0.00029	0.00033	0.00042	0.00013	0.00013	0.00009	0.00008
Total Industrial Processes	**0.01955**	**0.02033**	**0.02191**	**0.01137**	**0.00795**	**0.00887**	**0.00702**

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Cement Mfg.	0.00005	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000
Chemical Mfg.	0.00324	0.00272	0.00169	0.00281	0.00109	0.00097	0.00087
Ferrous Metals	0.00238	0.00206	0.00142	0.00044	0.00044	0.00035	0.00032
Mining	0.00703	0.00776	0.00921	0.00741	0.00004	0.00005	0.00002
Other	0.03061	0.03025	0.02954	0.02326	0.01904	0.02215	0.01594
Non-ferrous Metals	0.00069	0.00061	0.00045	0.00032	0.00051	0.00041	0.00037
Oil & Gas Production	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001
Petroleum Refineries	0.01732	0.02182	0.03082	0.00384	0.00425	0.00373	0.00427
Pulp & Paper	0.00464	0.00343	0.00101	0.00032	0.00160	0.00196	0.00057
Storage and Transfer	0.00175	0.00164	0.00142	0.00112	0.00053	0.00124	0.00204
Industrial Surface Coating & Solvent Use	0.00102	0.00117	0.00148	0.00046	0.00046	0.00032	0.00027
Total Industrial Processes	**0.06874**	**0.07150**	**0.07704**	**0.04000**	**0.02797**	**0.03118**	**0.02468**

Table A-31. Wildfires, Prescribed Burns, and Related Sources (MMT CO_2e)

GWP_{100}

Year	2005	2006	2008	2011	2014	2017	2020
Forest Wildfires[1]	0.000	0.009	0.028	0.007	0.138	0.061	0.075
Prescribed Burning[1]	0.000	0.021	0.062	0.092	0.254	0.148	0.268
Agricultural Fires	0.064	0.065	0.066	0.059	0.056	0.070	0.037
Structural Fires	0.011	0.010	0.008	0.012	0.011	0.022	0.000
Misc. Other	0.027	0.021	0.010	0.007	0.006	0.007	0.024
Total	**0.075**	**0.105**	**0.164**	**0.170**	**0.459**	**0.300**	**0.381**

[1] Wildfires and prescribed burns included in “Misc. Other” category prior to 2008.

GWP_{20}

Year	2005	2006	2008	2011	2014	2017	2020
Forest Wildfires[1]	0.000	0.009	0.028	0.007	0.138	0.061	0.075
Prescribed Burning[1]	0.000	0.021	0.062	0.092	0.254	0.148	0.268
Agricultural Fires	0.064	0.065	0.066	0.059	0.056	0.070	0.037
Structural Fires	0.011	0.010	0.008	0.012	0.011	0.022	0.000
Misc. Other	0.027	0.021	0.010	0.007	0.006	0.007	0.024
Total	**0.075**	**0.105**	**0.164**	**0.170**	**0.459**	**0.300**	**0.381**

[1] Wildfires and prescribed burns included in "Misc. Other" category prior to 2008.

APPENDIX B. METHODS

B.1. GLOBAL WARMING POTENTIALS

Global Warming Potentials (GWP) values used in preparation of the inventory (Table B-1) were taken from the IPCC Fifth Assessment Report (AR5),[61] with two exceptions. GWP values for HFCs were taken from the IPCC Fourth Assessment Report (AR4),[62] and GWP values for black carbon were taken from Bond, et al. (2013).[63] Use of GWP_{100} values from AR5 is the standard for conducting national assessments pursuant to international reporting requirements and is consistent with USEPA methodology. As discussed below, HFC emissions were estimated using the US Climate Alliance SLCP Tool, which is based on AR4 GWPs and had not been updated to AR5 at the time of this report's preparation. However, AR5 GWP values for HFCs are generally slightly lower than those from AR4 (on average 18%), and so the emissions estimates presented here should be conservative, that is, they should be slightly greater than estimates based on AR5. The SLCP Tool was preferred over the estimate published in the USEPA state-level inventory[64] because the SLCP Tool provides individual estimates for subcategories such as commercial refrigeration and residential heat pumps, a powerful insight for policy development. This is believed to only have a small impact on emissions calculations. In fact, New Jersey's 2021 HFC emissions estimate of 5.2 MMT CO_2e (based on AR4 GWP_{100}) was only 8% greater than USEPA's estimate of 4.8 MMT CO_2e (based on AR5 GWP_{100}). This close agreement between the two methodologies supports use of the more detailed profile from the SLCP Tool. With respect to black carbon, Bond, et al. (2013) was chosen for GWP values because it is a comprehensive evaluation and was cited in both IPCC AR5 and AR6.

Table B-1 Global Warming Potentials

Climate Pollutant	GWP_{100}	GWP_{20}	Reference
Carbon Dioxide (CO_2)	1	1	IPCC AR5 Chapter 8, Appendix Table 8.A.1
Methane (CH_4)	28	84	IPCC AR5 Chapter 8, Appendix Table 8.A.1
Nitrous Oxide (N_2O)	265	264	IPCC AR5 Chapter 8, Appendix Table 8.A.1
Sulfur Hexafluoride (SF_6)	23,500	17,500	IPCC AR5 Chapter 8, Appendix Table 8.A.1
Hydrofluorocarbons	See Reference	See Reference	IPCC AR4 Table 2.14
Black Carbon	910	3200	Bond, et al., 2013

B.2. COMMERCIAL, FUEL-BASED INDUSTRIAL, AND RESIDENTIAL SECTOR EMISSIONS

Residential, commercial and fuel-based industrial sector emissions were estimated by multiplying the amounts of applicable fuels sold within these sectors by appropriate emissions factors. Fuel sales data was provided by the US Energy

[61] Table 8.A.1 in Chapter 8 Appendix, IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

[62] Table 2.14 in IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

[63] Bond, T.C., et al., 2013, Bounding the role of black carbon in the climate system: A scientific assessment, J. Geophysical Research: Atmospheres, 118, 5380–5552. This reference is cited in IPCC AR5 and in the subsequent 2021 IPCC *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*.

[64] USEPA, 2023, Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1991-2021. https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals

Information Agency (USEIA) State Energy Data System[65] (Tables B-2, B-3 and B-4). Emissions factors were from the USEPA.[66] Emissions factors were adjusted to include methane and nitrous oxide in addition to carbon dioxide.

In accordance with USEPA and IPCC practice, emissions of CO_2 from wood are not included because they are considered biogenic, meaning that they arise from natural sources rather than fossil fuels and do not represent a net increase in atmospheric carbon dioxide.[67] Emissions from loss of wooded land are addressed in the measurement of carbon fluxes associated with clearing of land, which is a separate category in the inventory.

Fuel ethanol is not included because the majority is produced from biogenic materials such as grain. It is also primarily used as a blending agent for motor gasoline, and is therefore considered in the emissions estimates for that fuel.

Within the industrial sector, petroleum coke is generated as a biproduct of hydrocarbon fracking at refineries. This material can be combusted as a fuel, thereby contributing to emissions, or it can be used as a feedstock in the manufacture of devices such as electrodes. The USEIA documents the sale of petroleum coke in New Jersey, and the USEPA default method for emissions calculations assumes that much of this material is combusted within the state. Consistent with this protocol, for years prior to 2014 this report assumes that all petroleum coke sold in the state was combusted and contributed to emissions. However, the NJDEP has documented that petroleum coke has not been combusted in the state starting in 2014, and that the material is exported out of the state for use as a feedstock. Industrial emissions estimates for 2014 and subsequent years therefore exclude petroleum coke.

Hydrocarbon gas liquids (HGLs) are a category of fuel that includes propane, butane, and a number of related compounds. In 2010, USEIA made significant changes to its methods for estimating individual HGL components and also separated out certain materials.[68] This is reflected in the emissions record.

Table B-2. EIA Fuel Consumption Categories for the Residential Sector.[69]

Data Category Name	EIA Mnemonic Series Name (MSN)
Coal consumed by the residential sector	CLRCB
Distillate fuel oil consumed by the residential sector	DFRCB
Hydrocarbon gas liquids consumed by the residential sector (propane)	HLRCB
Kerosene consumed by the residential sector	KSRCB
Natural gas consumed by (delivered to) the residential sector	NGRCB

Table B-3. EIA Fuel Consumption Categories for the Commercial Sector.[70]

Data Category Name	EIA Mnemonic Series Name (MSN)
Coal consumed by the commercial sector	CLCCB
Distillate fuel oil consumed by the commercial sector	DFCCB
Hydrocarbon gas liquids consumed by the commercial sector (propane)	HLCCB

[65] https://www.eia.gov/state/seds/
[66] https://www.epa.gov/climateleadership/ghg-emission-factors-hub
[67] IPCC, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Section 8.2.1.
USEPA, 2023. Inventory of U.S. Greenhouse Gas Emissions and Sinks, EPA430-R-23-002, Section 3.10.
Extremely small amounts of methane and nitrous oxide can be produced during combustion of wood, but the quantities are not considered large enough to significantly affect the overall totals in this report and are not included. However, wood combustion is included in the black carbon analysis in this report.
[68] USEIA, Technical Notes on the State Energy Data System: Consumption, Section 4, Petroleum, Hydrocarbon Gas Liquids
[69] The MSN codes shown in this table identify the data fields in the USEIA data that were used to calculate emissions. See https://www.eia.gov/state/seds/ for additional information.
[70] The MSN codes shown in this table identify the data fields in the USEIA data that were used to calculate emissions. See https://www.eia.gov/state/seds/ for additional information.

Kerosene price in the commercial sector	KSCCB
Motor gasoline consumed by the commercial sector	MGCCB
Natural gas consumed by (delivered to) the commercial sector	NGCCB
Residual fuel oil consumed by the commercial sector	RFCCB

Table B-4. EIA Fuel Consumption Categories for the Industrial Sector.[71]

Data Category Name	EIA Mnemonic Series Name (MSN)
Coal consumed by the industrial sector	CLICB
Distillate fuel oil consumed by the industrial sector	DFICB
Kerosene consumed by the industrial sector	KSICB
Motor gasoline consumed by the industrial sector	MGICB
Natural gas consumed by (delivered to) the industrial sector	NGICB
Petroleum coke consumed by the industrial sector, only included through 2013. Zero for subsequent years.	PCICB
Residual fuel oil consumed by the industrial sector	RFICB
Still gas consumed by the industrial sector	SGICB
Hydrocarbon gas liquids (HGL) consumed by the industrial sector	
For years through 2009, HGL is:	
Hydrocarbon gas liquids consumed by the industrial sector	HLICB
For years 2010 onward, HGL is the sum of:	
Butylene from refineries consumed by the industrial sector	BQICB
Butylene from refineries consumed by the industrial sector	BYICB
Ethane consumed by the industrial sector	EQICB
Ethylene from refineries consumed by the industrial sector	EYICB
Isobutane consumed by the industrial sector	IQICB
Isobutylene from refineries consumed by the industrial sector	IYICB
Natural gasoline (pentanes plus) consumed by the industrial sector	PPICB
Propane consumed by the industrial sector	PQICB
Propylene from refineries consumed by the industrial sector	PYICB

B.3. TRANSPORTATION

On-Road Transportation

On-road emissions estimates for 2006 and for 2018 through 2021 were found using the third release of the USEPA MOtor Vehicle Emission Simulator transportation emissions model for on-road estimates. MOVES3 produces detailed emissions profiles using specific, county-by-county information on vehicle types and ages, miles traveled by each of numerous vehicle categories, and regional fuel characteristics.

Estimates for 1990, 2005, and 2007-2017, were based on USEIA fuel sales data for the entire transportation sector, apportioned to the on-road sector and then scaled to align with MOVES3 output. Specifically, the USEIA fuel sales estimates for each applicable fuel type in the transportation sector were apportioned to on-road transportation based on

[71] The MSN codes shown in this table identify the data fields in the USEIA data that were used to calculate emissions. See https://www.eia.gov/state/seds/ for additional information.

Table 3-13 of the USEPA Inventory of US Greenhouse Gas Emissions and Sinks report.[72] As an example, in 2006, 98.9% of gasoline emissions in the transportation sector were attributed by USEPA to on-road vehicles, with the remainder arising from boats. This fraction (98.9%) was then assumed to equal the fraction of transportation-sector gasoline used in New Jersey for on-road use. A preliminary emissions estimate for each applicable fuel type was then found by multiplying NJ on-road fuel consumption by the respective emissions factor. Fuels considered included motor gasoline, distillate fuel oil (diesel), natural gas (CNG), and propane.

These initial fuel-based emissions estimates were then compared with MOVE3 output for the years 2006 and 2018. For 2006, on-road emissions estimate based on fuel sales was 7.9% greater than the MOVES3 estimate, and in 2018, the fuel-based estimate was 5.6% greater than the MOVES3 estimate.[73] To align estimates based on fuel sales with those from MOVES3, these adjustment factors based on the ratio of MOVES3 to fuel estimates were interpolated for years between 2006 and 2018 and applied to the fuel-based estimates for those intervening years. For 1990 and 2005, the adjustment factor for 2006 was applied.

Aviation

USEIA jet fuel sales data for New Jersey includes some fuel used at New York airports. USEIA acknowledges this limitation and has indicated that their data has not been corrected to account for this.[74] A second challenge is that total fuel sales are a poor proxy for actual in-state emissions because substantial quantities of commercial jet fuel are consumed in flight outside the state. Both of the above considerations lead to greatly overstated emissions estimates when EIA fuel sales data is used. A prior analysis by NJDEP[75] concluded that aviation emissions occurring within the state total approximately 1.0 MMT CO_2e annually (based on either GWP_{100} or GWP_{20}). This figure is generally consistent with the estimates of 0.81 MMT CO_2e for 2017 and 0.55 MMT CO2e for 2020 published by USEPA in the National Emissions Inventories.[76] The NEI estimates were based on the Federal Aviation Administration's Aviation Environmental Design Tool (AEDT) model, which quantifies emissions based on landing and takeoff activity and aircraft performance data rather than records of bulk fuel sales. The NEI estimates include emissions from commercial, general, and military aviation sources within the state. Although the NEI estimate does not include methane or nitrous oxide, emissions of these components are expected to be small.

Marine Transportation

Marine emissions estimates were based on USEIA fuel sales data for residual oil, distillate fuel, and gasoline in the transportation sector. Fuel was apportioned to domestic marine activity based on fuel application data in Table 3-13 of the USEPA Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2021 (2023).[77] These fuel quantities were then multiplied by emissions factors for the fuel type to account for CO_2, methane, and nitrous oxide. Because fuel sales data is only applicable to transactions in the state of New Jersey, estimates do not account for fuel brought to New Jersey from elsewhere or purchased in the state and then carried away for use elsewhere. Fluctuations in apparent emissions may therefore represent changes in market activity rather than underlying marine activity.

Rail Transportation

USEIA data on in-state sales of distillate fuel do not accurately reflect rail activity because much of rail transit is interstate. Fuel may therefore be easily purchased from vendors out-of-state and used in New Jersey as needed. Specifically, these

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[72] USEPA, 2023, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021. U.S. Environmental Protection Agency, EPA 430-R-23-002, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021, and associated data file "2023 Energy Tables" at https://www.epa.gov/system/files/other-files/2023-05/Energy.zip

[73] Fuel-based emissions may differ from those based on MOVES3 due to factors such as out-of-state vehicles refueling in New Jersey and returning to their home state, and imprecision in the emissions factors applied to fuel sales estimates.

[74] USEIA, Technical Notes, State Energy Data 2019: Consumption. Section 4, pages 57-58, Jet Fuel, Note 3. https://www.eia.gov/state/seds/seds-technical-notes-complete.php?sid=US#Consumption

[75] New Jersey Greenhouse Gas Inventory and Reference Case Projections 1990-2020, November 2008, Appendix C. https://dep.nj.gov/ghg/

[76] Sum of CO_2 emissions for SCC codes 2275050011, 2275050012, 227506001, 2275060012, 2275020000 and 2275001000. Data from the 2017 and 2020 National Emissions Inventories is available at https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei. The 2017 estimate did not include emissions from all individual sources and actual emissions may therefore have been slightly greater than reported.

[77] USEPA, 2023, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021. U.S. Environmental Protection Agency, EPA 430-R-23-002, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021, and associated data file "2023 Energy Tables" at https://www.epa.gov/system/files/other-files/2023-05/Energy.zip

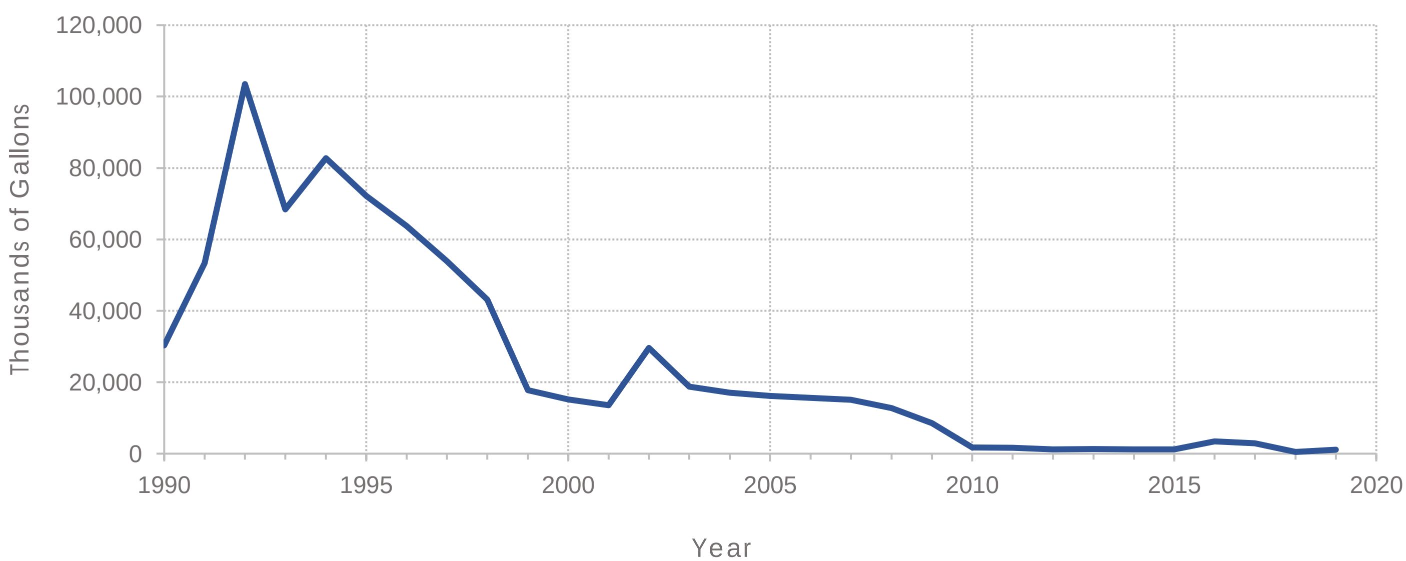
records show that very little distillate fuel is sold inside in the state for rail use.[78] (Figure B-1) Similar effects can be seen in Delaware and Maryland sales records, while Pennsylvania and New York sales often increase when the other states decrease. However, the combined sales quantities across the region[79] have remained relatively constant for many years (Figure B-2).

In order to reduce the influence of interstate transfers, New Jersey rail distillate consumption was approximated by multiplying New Jersey's total distillate sales (for all sectors) by the fraction of distillate sold regionally for rail use.[80] This metric responds to overall changes in New Jersey distillate sales across all sectors, including rail, and to regional transitions in rail operations, but will not precisely reflect the benefits of rail electrification actions taken in New Jersey. It also does not account for interstate transfers of fuel into or out of the overall region. Evaluation of specific policies may therefore require individual assessments of effectiveness. Nonetheless, the approach used here does provide a general indication of rail fuel consumption in the state.

To evaluate the accuracy of this approach, estimated emissions for 2016 were compared to estimates based on in-state fuel consumption data provided previously to the Department by individual rail carriers. Estimates from the two methods agreed within 0.2%.[81]

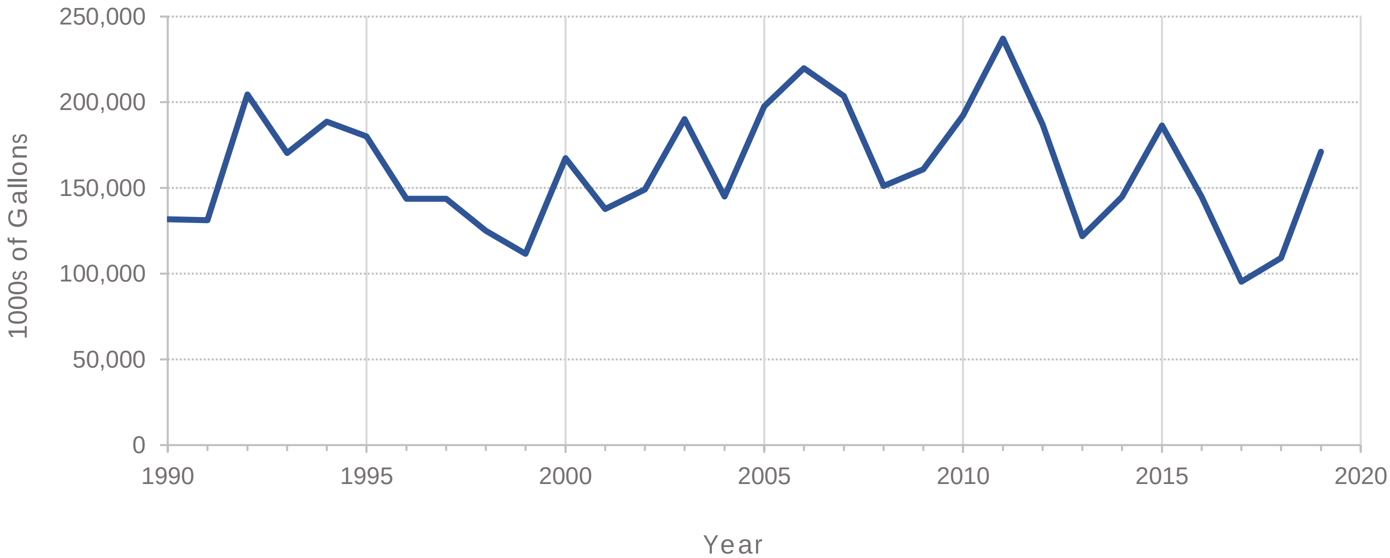
USEIA has suspended publication of the fuel oil sales data used to prepare the emissions estimate for the sector. 2021 emissions were therefore assumed to equal the rail sector emissions for 2020, which is reasonable given the small size and consistency of this sector's emissions over the period of record.

Figure B-1. Sales of distillate fuel to the rail sector recorded in New Jersey



[78] Based on USEIA Fuel Oil and Kerosene Sales (FOKS) data. https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=KD0VALSNJ1&f=A
[79] USEIA defines the PADD 1B region as NJ, NY, PA, DE, MD and the District of Columbia.
[80] Calculated using USEIA Fuel Oil and Kerosene Sales (FOKS) data. The energy content per barrel of distillate for each given year was taken from the USEIA State Energy Data System, MSN Code DFTCK.
[81] The underlying uncertainties in the data are likely greater than this close level of agreement suggests.

Figure B-2. Sales of distillate fuel to the rail sector recorded in the EIA PADD 1B region



B.4. ELECTRICITY

Emissions from In-State Generating Facilities

For 2005 onward, carbon dioxide and methane mass emissions for in-state electric generating facilities filing under NAICS codes 221112 and 22111 were taken from the NJDEP Emissions Statement Database. To find nitrous oxide emissions, the implied thermal input based on CO_2 emissions statement data was divided by the USEPA emissions factor for natural gas.[82] Although coal was used more extensively in earlier years, the assumption of all natural gas did not alter the overall emissions estimates due to the small quantities of N_2O involved. Estimated N_2O emissions were then found by multiplying the implied thermal input by USEPA emissions factors for N_2O. CO_2e was found by multiplying mass amounts of CO_2, CH_4 and N_2O by their corresponding GWP and summing.

Emissions from Imported Electricity

Imported electricity was found by subtracting the amount of electricity generated in the state from the amount of retail electricity sold in New Jersey, based on USEIA data.[83] For each individual year from 2005 onward, CO_2e emissions rates were calculated based on grid emissions data from the PJM GATS system mix table.[84] Specifically, for each fuel type listed in PJM GATS, the amount of power produced (in MWh) and the mass of CO_2 generated (in pounds) is listed. For a given fuel, the amount of power input necessary to generate the quantity of CO_2 listed was calculated using IPCC CO_2 emissions factors.[85] Mass emissions of methane and nitrous oxide were then found by applying corresponding IPCC emissions factors based on the energy input amount as calculated above.[86] CO_2e quantities for methane and nitrous oxide were found using corresponding GWPs (both 100 year and 20 year). The total CO_2e of methane produced and the total CO_2e of nitrous oxide produced were found by summing the contributions of the given gas from all fuels. Emissions rates of CO_2, methane and nitrous oxide per MWh generated were found by dividing the respective CO_2e values for each gas by the overall total power produced. The overall rate of CO_2e generation was taken as the sum of the CO_2e production rates for each of the three gases. Emission rates were further increased by 7% to account for transmission losses.

Emissions from imported electricity for a given year were found by multiplying the amount of imported electricity for that year by the adjusted PJM emissions factor for that year as calculated above. Estimates for years prior to 2005 used the 2005 PJM emissions factor. The emissions factors were based on the annual emissions from the entirety of the PJM grid area.

Emissions from Solid Waste Incineration

Waste-to-energy emissions for 2005 onward were based on in-state carbon dioxide and methane mass emissions data submitted to the NJDEP Emissions Statement Database under NAICS code 562213. Thermal input was estimated from CO_2 emissions using the USEPA CO_2 emissions factor for municipal solid waste, and N_2O was then estimated by multiplying the thermal input by the MSW emissions factor for N_2O. Mass amounts for CO_2, CH_4 and N_2O were multiplied by their respective GWP and the amounts summed to find the total emissions on a CO_2e basis. Carbon dioxide from biological sources (biogenic waste) was excluded based on IPCC guidance. To find non-biogenic emissions, the fraction of biogenic to total emissions was assumed equal to the ratio of biogenic to total fuel input, in MMBTUs, as reported on USEIA Form 923. Specifically, the sum of biogenic fuel energy inputs under fuel code MSB was divided by the sum of all fuel energy inputs used at the solid waste incinerator to find the biogenic ratio. Quantities of fossil fuels used at the facilities, including distillate, natural gas, and other gases, were less than 0.4% of total energy input, with the remainder being solid waste. The non-biogenic fraction was taken as the balance (1 - biogenic fraction). Total emissions from the solid waste incinerators (in CO_2e) were multiplied by the non-biogenic fraction to find the applicable greenhouse gas emissions identified in the report.

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[82] https://www.epa.gov/climateleadership/ghg-emission-factors-hub

[83] Retail sales data was from USEIA SEDS https://www.eia.gov/state/seds/seds-data-complete.php. Retail sales data is listed under Mnemonic Series Name (MSN) ESTCP. Annual generation data was from https://www.eia.gov/electricity/data/state/ "Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923)"

[84] https://gats.pjm-eis.com/gats2/PublicReports/PJMSystemMix

[85] 2006 IPCC Guidelines for GHG Inventories Vol. 2, Energy, pages 1.23 and 1.24. https://www.ipcc-nggip.iges.or.jp/public/2006gl

[86] 2006 IPCC Guidelines for GHG Inventories Vol. 2, Energy, pages 2.16 and 2.17. https://www.ipcc-nggip.iges.or.jp/public/2006gl

Solar Photovoltaic Capacity and Output

Installed solar capacity was taken from the NJBPU Solar Activity Reports.[87] Solar PV power output was estimated using the NJBPU ten-year average Specific Energy Production (SEP) factor of 1,154 MWh power/MW capacity.[88] Power production other than solar PV was from USEIA generation data.[89]

B.5. NON-ENERGY EMISSIONS

Halogenated Gases (excluding sulfur hexafluoride)

HFC emissions were based on the US Climate Alliance (USCA) GHG Inventory Tool for HFCs, Methane and Black Carbon (July 24, 2019). The tool was prepared by the California Air Resources Board (CARB) using their F-Gas Emission Inventory Model. CARB converted output from the F-Gas model to a per person, per household or per vehicle basis, depending on use, and then applied those values to individual USCA states, including New Jersey. Reductions due to SNAP and Kigali policy implementation from the USCA tool were then adjusted to align with New Jersey SNAP[90] and federal Kigali implementation dates.

Non-Fuel Agricultural Emissions

Non-fuel agricultural emissions were found using the USEPA State Inventory Tool's 2023 Carbon Dioxide, Methane and Nitrous Oxide Emissions from Agriculture module.[91] Default inputs were used. Emissions estimates include enteric fermentation, manure management, agricultural soils, urea fertilization, and agricultural residue burning. Due to the unavailability of data for 2021 in the USEPA State Inventory Tool at the time of publication, the value of 2020 was carried over to 2021. Given the consistently small size of this source category, this assumption is considered to have little if any impact on the overall state emissions total.

Natural Gas Transmission and Distribution

Emissions from natural gas transmission and distribution were found using the USEPA State Inventory Tool's 2023 Emissions from Natural Gas and Oil Systems module. The numbers of transmission compressor stations for 2002 onward were based on the NJ Emission Statement Database. For prior years, the number was prorated from the 2002 value based on the number of miles of transmission pipeline. The number of miles of transmission pipeline, miles and types of distribution pipelines, and numbers and types of service connections were obtained from the US Department of Public Safety Hazardous Materials and Safety Administration.[92] Default values were used for other inputs to the State Inventory Tool.

Landfills

In-state landfill emissions and industrial landfill emissions were found using the USEPA State Inventory Tool (SIT) 2023 Solid Waste Module. The module uses a first order decay calculation based on historical landfill deposits. Landfilled waste quantities for 1960 through 1984 were the default values provided in the module. Quantities for 1985 through 2003 were calculated from the NJ 2006 Solid Waste Management Plan, Table A-1, adjusted for waste-to-energy disposal using waste incineration data from USEIA forms 906 and 923. The quantity for 2004 was the EPA SIT default, which is based on annual solid waste survey data published by Biocycle magazine. Quantities for 2005 onward were provided by the NJDEP Bureau of Solid Waste Permitting. Other inputs to the module such as flaring, landfill-gas-to-energy diversion and soil oxidation rates were default values provided in the Tool by USEPA.

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87 NJBPU, "REPORTS - INSTALLED - November 2021.xlsx." https://njcleanenergy.com/renewable-energy/project-activity-reports/project-activity-reports

88 The SEP was taken from NJBPU, Monthly Report on Status toward Attainment of the 5.1% Milestone for Closure of the SREC Program, February 7, 2020, and was in turn based on data provided by PJM-EIS. https://njcleanenergy.com/files/file/Notice%20on%205-1%20Percent%20Milestone.pdf

89 https://www.eia.gov/electricity/data/state/annual_generation_state.xls

90 New Jersey SNAP law, P.L. 2019 c. 507.

91 USEPA State Inventory and Projection Tool, Version 2023.2, June 2023

92 https://www.phmsa.dot.gov/

For out-of-state waste disposal, waste disposal quantities for 2005 onward were provided by the NJDEP Bureau of Solid Waste Permitting. For prior years, the amount was taken from the 2006 NJ Solid Waste Management Plan, Table A-1. To find emissions, the ratio of waste disposed of out of state to waste disposed of at in-state landfills was found. Where necessary, adjustments for in-state incineration were made as noted above. The quantity of waste disposed of out-of-state was unavailable for 2004, so the ratio for that year was found by averaging the values for 2003 and 2005. Out-of-state emissions were found by multiplying in-state landfill emissions by the ratio of out-of-state to in-state landfill waste disposal quantities.

Wastewater Treatment

Emissions from wastewater treatment processes were calculated using the Wastewater module from the USEPA 2023 State Inventory Tool.[93] State population data was adjusted based on US Census data.[94] Otherwise, USEPA default inputs were used for all calculations.

Non-Fuel Industrial Emissions

Releases of carbon-dioxide from industrial processes, other than those associated with consumption of fuel, were found using the Industrial Process Module from the USEPA 2023 State Inventory Tool. USEPA default values were used for all calculations. Due to unavailability of 2021 data in the SIT, the 2020 emissions estimate was carried over to 2021. Given the consistency and small size of this source category's emissions, this was judged to have had little if any effect on the state emissions total.

Emissions Due to Land Clearing

The impacts of land clearing relied on land use change estimates for major land use categories based on land use land cover (LULC) data. For the developed/urban land category, a metric used in land-use zoning regulations called *floor area ratio* (FAR) is utilized. According to the planning literature, FAR is "a mathematical formula that determines how many square feet can be developed on a property in proportion to the lot area. The property area is multiplied by the FAR factor; with the result being the maximum floor area allowed for a building on the lot." FAR is the ratio of two measures: average floor size, and average lot size. The source of data for these is the U.S. Census Bureau. For years since 1992, data for the Northeast are used. Prior to 1992, average data for the entire U.S. are used. For simplicity, data for new single family houses are used as proxy for building structures. The other parameter to be computed is the share of forest land against the total of bare or barren and forest land combined. This serves as proxy for vegetative cover. Multiplying the developed/urban land increase by the FAR factor and the vegetative cover parameter yields an estimate of the biomass carbon loss. This result is then added to the biomass and soil carbon losses from the other land uses as calculated in the *Sequestration* component of the inventory. This yields the aggregated carbon loss due to land conversion. The estimate is converted to the carbon dioxide equivalent by multiplying it by 3.67, the ratio of the molecular weight of carbon dioxide to the atomic weight of carbon.

Sulfur Hexafluoride (SF_6)

Sulfur hexafluoride emissions were found using the USEPA State Inventory Tool's 2023 Industrial Process module with default inputs. Due to the lack of 2021 data in the SIT at the time of publication, the 2020 value was carried over to 2021. This was considered reasonable due to the small emissions from this source category and the consistency of the historical record.

B.6. CARBON SEQUESTRATION

The natural carbon sequestration estimate in the NJ GHG Inventory was based on Land Use and Land Use Change (LULUC) using NJDEP GIS data for developed/urban land, crop/grass land (agricultural land), upland forest, bare land, and wetlands. The carbon stock change method was used to calculate sequestration (carbon removed per acre per year) based on land

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[93] Emissions arising from consumption of fuel at water and wastewater treatment plants is included in the Commercial Sector calculations.
[94] https://www2.census.gov/programs-surveys/popest/tables/2020-2022/state/totals/NST-EST2022-POP.xlsx, with interpolation for 2011-2019

use change from one period to another. NJDEP GIS data is updated at multi-year intervals, and annual emission rates in the GHG Inventory Report are revised when updated GIS data becomes available. The most recent NJDEP GIS data is for 2015. Carbon stock changes were computed based on an estimate of forest biomass at 49 metric tons per acre is based on Lathrop, et al. (2011).[95] Lathrop (2011) also concluded that forest soil carbon is 40% of the total forest carbon amount. Other biomass quantities and rate of change factors are from Chapter H of New Jersey GHG Inventory and Reference Case Projections 1990-2020 (November 2008), which in turn were adapted from IPCC and other sources.[96]

B.7. BLACK CARBON

Black carbon is a component of the broader class of fine particulate matter having diameter of 2.5 µm or less ($PM_{2.5}$). When fine particulate matter is created, the amount of black carbon that is produced depends on the materials consumed and the processes by which the particulates are created. The proportion of black carbon in a particulate emission is referred to as the speciation factor (SF), and this factor can be used to estimate black carbon emissions from $PM_{2.5}$ emissions data. Specifically, knowing the emissions of $PM_{2.5}$ from a particular activity, the black carbon can be estimated by multiplying the amount of $PM_{2.5}$ by the speciation factor:

$$BC = PM_{2.5} \times SF$$

where
BC is the mass of black carbon,
$PM_{2.5}$ is the mass of particulate matter with diameter of 2.5 µm or less, and
SF is the speciation factor.

[95] R.G. Lathrop, B. Clough, A. Cotrell, J. Ehrenfeld, F. Felder, Edwin J. Green, D. Specca, C. Vail, M. Vodak, M. Xu, Y. Zhang, Assessing the Potential for New Jersey Forests to Sequester Carbon and Contribute to Greenhouse Gas Emissions Avoidance. Rutgers University, March 2011. https://crssa.rutgers.edu/projects/carbon/RU_Forest_Carbon_final.pdf. Accessed January 20, 2022.

[96] [a] Biomass carbon density: 38 metric tons (Mt)/acre (forest), 4 Mt/acre (grassland), 2 Mt/acre (bare land), 1.2 Mt/acre (cropland); [b] soil carbon density: 8 Mt/acre (bare land) and 24 Mt/acre (forest land); [c] biomass density increase: 1% per year; [d] soil carbon density increase: 1% per year; and [e] amount of carbon stored in forest products: 12 Mt/acre. Assumed 50% of forest removal converted to wood products. Factor used to convert wood volume to weight: 3 pounds per board foot.

The quantity of CO_2e is found by multiplying the mass of black carbon by its global warming potential (GWP_{100} or GWP_{20}).

The USEPA has assembled an extensive database of speciation factors based on a wide range of research studies,[97] and $PM_{2.5}$ data has been collected for many years as part of the NEI. It is therefore possible to estimate historical black carbon emissions using $PM_{2.5}$ records from the NEI. USEPA used this method to calculate black carbon emissions in the 2014 and later NEIs. In most cases, this was done by directly multiplying $PM_{2.5}$ by the speciation factor. For black carbon emissions from on-road activities USEPA used the MOVES model, which applies speciation methods internally under a range of conditions.

In preparing its historical analysis, DEP applied the same speciation factors used by USEPA for the 2020 NEI to NEI $PM_{2.5}$ data[98] for 2005, 2008, 2011, 2014 and 2017. Although the 2014 and 2017 NEIs included black carbon data as originally published, estimates were recalculated here using the most recent speciation factors from USEPA to assure consistency and accuracy. NJDEP also used 2020 NEI $PM_{2.5}$ data to develop black carbon estimates and then compared those estimates to published values in the NEI as a verification of NJDEP methodology.

USEPA's 2020 speciation factor list did not include factors for all source categories in the 2020 NEI, and those factors were estimated by taking the ratio of black carbon and $PM_{2.5}$ values published in the 2020 NEI. Also, certain categories in older releases of the NEI were later reclassified, and in those cases speciation factors from the 2020 NEI for similar sources were applied.

For on-road source categories, NJDEP used the MOVES3 transportation emissions model for years 2006 and 2018 through 2021, the most recent release at the time the calculations were completed. MOVES is the current standard for regulatory submissions to the USEPA, and is the successor to earlier models such as MOBILE and MOVES 2014.[99] For other years, on-road emissions estimates were taken from the USEPA EQUATES program.[100] On-road emissions from the EQUATES program are also based on MOVES3, but because of its national scope it relies on representative data and national default inputs. In particular, input data available to USEPA for years prior to 2011 were limited, increasing the level of uncertainty in those results. DEP developed input data and ran MOVES3 for each individual county, while EQUATES estimated emissions rates for six representative counties and then applied those rates to the remaining parts of the State. A further consideration is that EQUATES only ran MOVES3 for the NEI years (2002, 2005, 2008, 2011, 2014 and 2017) and then adjusted those figures to find values for the adjacent years. In particular, their 2006 estimate is based on 2005 results that were adjusted for the later year. The adjustments for adjacent years created small discontinuities in the EQUATES output where estimates for three years appear to move up and down together. Nonetheless, the EQUATES data provides valuable insight into overall emissions trends and is used for those years where DEP MOVE3 data is not available. 2017 NEI on-road data was not used because it relied on the earlier MOVES 2014b model. Otherwise, the methods used for on-road estimates from EQUATES and the 2017 NEI were similar, and their results differed by only 4.8% (Figure B-3).

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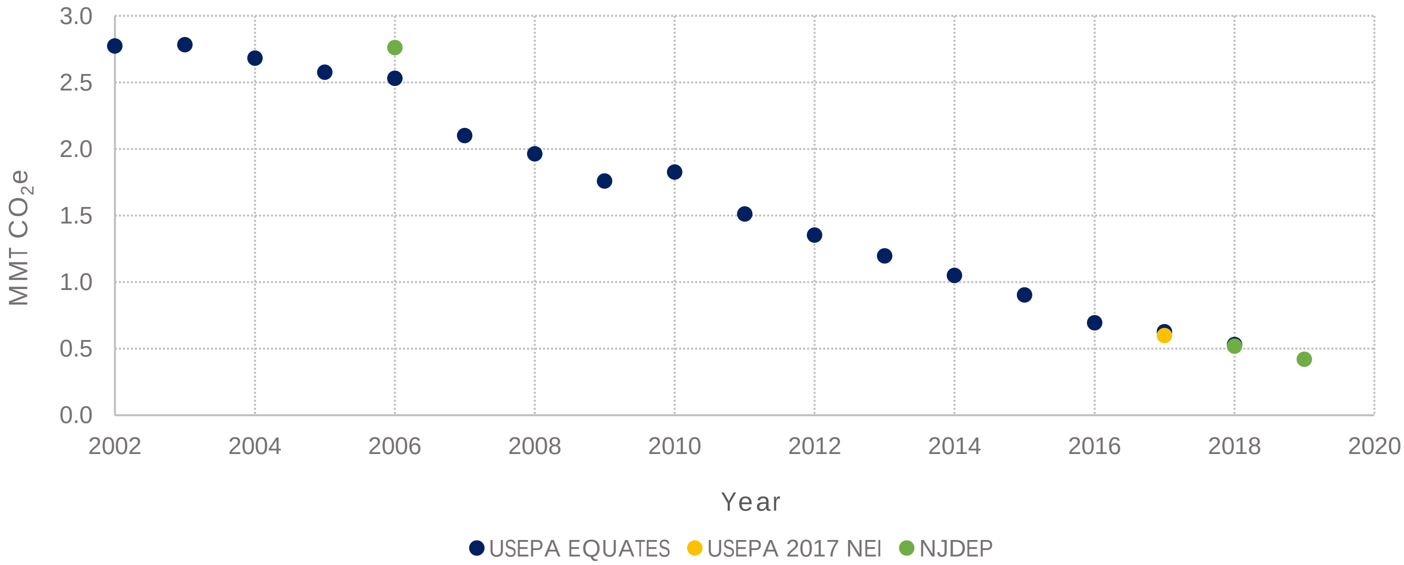
[97] https://www.epa.gov/air-emissions-modeling/speciate-4

[98] The list is formally known as the Augmentation Profile Assignment Factors list. NJDEP accessed the list May 11, 2021, and the file included any updates through that time. Factors may therefore have differed slightly from those used in the 2017 NEI.

[99] https://www.epa.gov/moves

[100] https://www.epa.gov/cmaq/equates

Figure B-3. Comparison of USEPA EQUATES and DEP MOVES3 On-Road Black Carbon Estimates, 2002-2019 (GWP_{100})

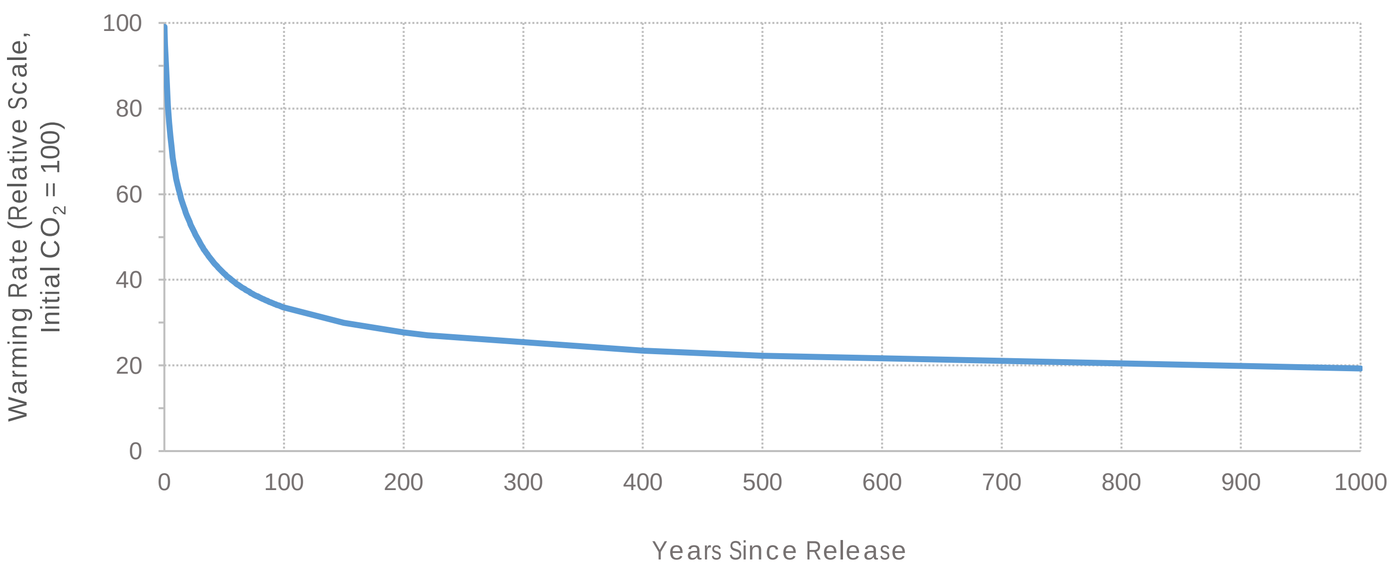


APPENDIX C. GLOBAL WARMING POTENTIAL

Climate Pollutants and Their Role in Global Warming

Carbon dioxide (CO_2) is by far the dominant gas contributing to climate change in the United States, and is responsible for 79% of the nation's climate impact.[101] In addition to being released in large quantities in the U.S. and by human civilization as a whole, once CO_2 has been released to the atmosphere only about 66% is removed by oceanic and terrestrial processes. The remaining 34% stays in the atmosphere for very long periods, on the order of centuries and even millennia.[102] Over shorter lengths of time, CO_2 appears as an almost constant source of warming because the atmospheric concentration declines so slowly. In other words, after a given amount of CO_2 is released to the atmosphere, it adds more and more heat to the environment every year for centuries afterward (Figure C-1). Stopping avoidable releases of CO_2 is therefore the of greatest importance to reduce the amount of global damage.

Figure C-1. Persistence of Warming Impacts from a Pulse Release of CO_2.[103]



Other gases contribute to global warming in much the same way as CO_2. For example, they can influence the heat balance of the earth by absorbing incoming solar radiation (in particular, visible and infrared light), and can also block the earth from radiating energy back into space. But the exact frequencies of radiation that are captured by a molecule depend on its structure, so each greenhouse gas has its own unique absorption spectrum. Greater absorption, or increased concentration, leads to greater warming. The sum across all relevant wavelengths, referred to as radiative forcing, is a major determinant of how much impact a gas will have on the environment.

One critical difference among GHGs is the time scale of their impact. Specifically, while CO_2 acts over very long time scales, many other climate gases are removed relatively quickly from the atmosphere. For example, methane only remains in the atmosphere about 9 years, and many HFCs act over time spans of days to decades.[104] Such compounds are referred

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[101] USEPA, 2023, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021. U.S. Environmental Protection Agency, EPA 430-R-23-002, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021, Table ES-2.

[102] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Section 5.2.1.2.
Archer, David; Eby, Michael; Brovkin, Victor; Ridgwell, Andy; Cao, Long [Carnegie Institution ; Mikolajewicz, Uwe ; Caldeira, Ken; Matsumoto, Katsumi; Munhoven, Guy; Montenegro, Alvaro; Tokos, Kathy, 2009; Annual Review of Earth and Planetary Sciences; Volume 37, Pages117-134. https://orbi.uliege.be/handle/2268/12933. Accessed 8/23/2021

[103] Hansen, J., et al., Dangerous human-made interference with climate: a GISS model E study. Atmos. Chem. Phys., 7, 2287–2312, 2007 www.atmos-chem-phys.net/7/2287/2007/

[104] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Tables 6.1 and 6.2, and Section 6.3.1.

to as short lived climate pollutants (SLCPs) or short lived climate forcers (SLCFs). Conversely, there are long-lived greenhouse gases (LLGHGs) such as carbon tetrafluoride (CF_4) that remain in the atmosphere for thousands of years.

Because SLCPs only remain in the atmosphere a relatively short time, they do not mix completely throughout the planet's atmosphere before they break down. As a result, regional and hemispheric differentials exist with respect to warming induced by these gases. This stands in contrast to carbon dioxide and LLGHGs, which eventually become well mixed throughout the atmosphere.

From a practical perspective, these diverse properties and behaviors challenge policymakers in that it is difficult to grasp how the climate will react to changes in emissions of different gases. For example, how can one nation's commitment to reduce a GHG be compared to another nation's commitment to reduce a different gas? Having a way to equate the impacts from different gases is necessary in order to allow diverse stakeholders to work towards the common goal of climate protection, utilizing the same weighted scale.

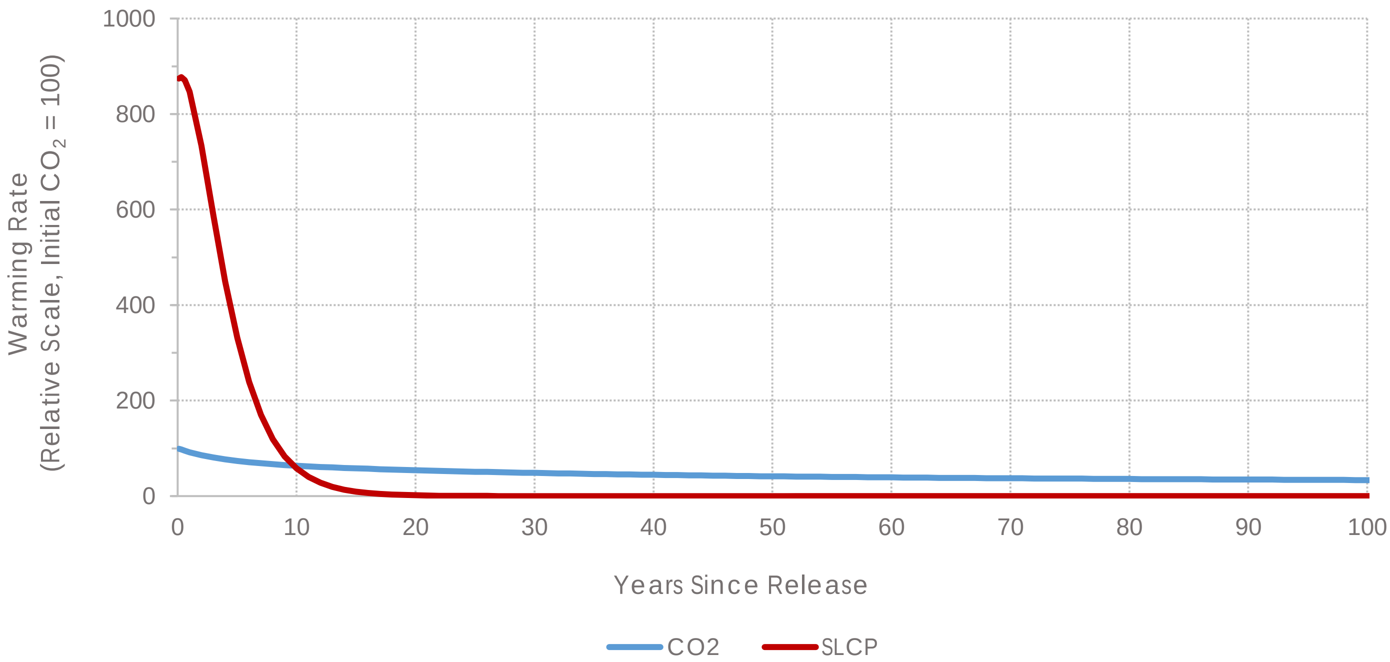
Methods for Comparing Impacts

The most widely-adopted strategies for comparing different gases do so by weighing each pollutant's impact against that of carbon dioxide. For example, the UN Framework Convention on Climate Change mandates that all participating states use the 100-year global warming potential (GWP_{100}) approach when reporting national climate goals and emissions,[105] and in accordance with the UN requirement, the USEPA[106] reports national emissions to the IPCC using GWP_{100}. US states and agencies, including the NJDEP and most private enterprises and organizations, also present emissions data in terms of GWP_{100} so that results can be easily compared with those from around the world. Emissions based on GWP_{100} are found by multiplying the mass of a gas by its GWP_{100} factor to find the equivalent amount of CO_2, or CO_2e (Figure C-2).

[105] United Nations Framework Convention on Climate Change, 2014. Report of the Conference of the Parties on its Nineteenth Session, held in Warsaw from 11 to 23 November 2013; Addendum, Part two: Action taken by the Conference of the Parties at its nineteenth session. FCCC/CP/2013/10/Add.3. http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf. Accessed 8/23/2021.

[106] USEPA, 2023, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021. U.S. Environmental Protection Agency, EPA 430-R-23-002, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021, page 1-9.

Figure C-2. Impacts from a short-lived climate pollutant (SLCP) and CO_2 using a 100-year time horizon.[107] *The areas under the lines represent the total cumulative impact from each gas. In this example, the impact from CO_2 after 100 years is the same as the impact from the SLCP (in other words, the areas under each of the two lines are the same.) The ratio of the SLCP impact to the CO_2 impact (the GWP) is therefore 1.0.*



Mathematically, the GWP is defined as[108]

$$GWP_i = \frac{\int_0^{TH} a_i \cdot [C_i(t)]\, dt}{\int_0^{TH} a_r \cdot [C_r(t)]\, dt}$$

where

GWP_i	is the global warming potential for gas i;
TH	is the time horizon, for example 100 years;
a_i	is the ability of the gas being studied to absorb radiation per unit mass (radiative efficiency);
$[C_i(t)]$	is the amount of gas present. Because the gas can decay or otherwise be removed from the atmosphere, the amount available changes over time, hence it is a function of time t;
a_r	is the radiative efficiency for the reference gas, CO_2;

[107] The SLCP lifetime is modeled here as a log-normal distribution with peak at t=0. CO_2 lifetime is from Hanson, et al., 2007. The SLCP is hypothetical and is for illustrative purposes.

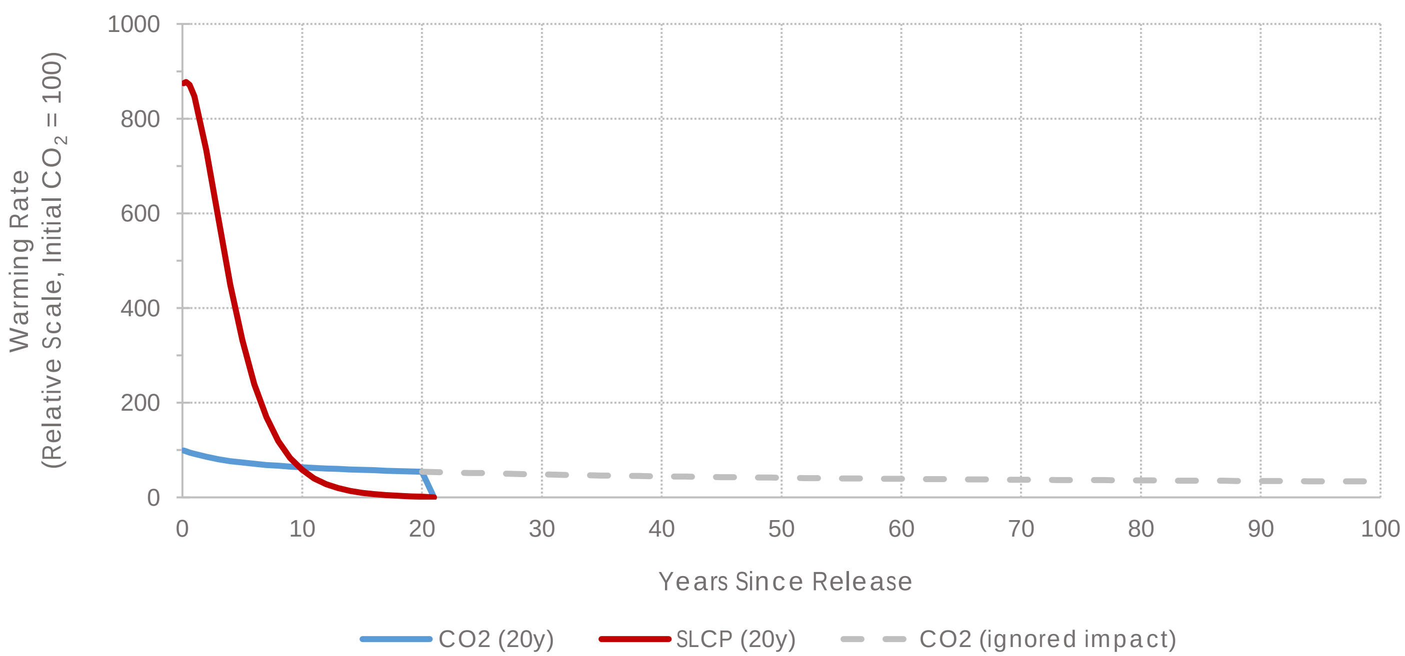
[108] IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Section 2.10.

[$C_r(t)$] is the amount of the reference gas, CO_2. Again, the amount in the atmosphere can change over time, so it is a function of time t. At the start (t=0), the amount of reference gas is the same as the amount of the gas under study.

The top of the equation first finds the amount of energy absorbed by the gas under study by multiplying the gas's ability to absorb energy by the amount of gas present. Since the amount of gas changes over time, the annual impact is calculated for each year between the time of release and the time horizon. The values are then summed up (or integrated) to find the total radiative forcing for the gas. The bottom of the GWP equation does the same for carbon dioxide. When the top and bottom are divided, it provides an estimate of how the climate impact of the gas compares to carbon dioxide over the time period under study.

Because the GWP_{100} method does not explicitly account for the fact that SLCPs are removed from the atmosphere much more quickly than CO_2, concerns have been raised that it may underestimate the benefits of reducing emissions of SLCPs.[109] One approach to address these concerns, referred to as GWP_{20}, takes the same equation but reduces the time horizon from 100 years to 20 years. However, stopping the comparison at 20 years means that only a small part of CO_2's total impact is accounted for (Figure C-3). With a smaller number on the bottom of the GWP equation, the GWP_{20} becomes substantially larger.

Figure C-3. CO_2 vs. SLCP climate impacts using 20-year GWP. By ignoring all warming from CO_2 that occurs after 20 years, the cumulative impact of the SLCP in this example (the area under the SLCP curve) appears to be 3 times greater than the impact from the CO_2. The 20-year GWP for this SLCP would therefore be 3. However, the long-term impact from the CO_2 will be greater than this suggests because of its long lifetime in the atmosphere (dashed line). In this example, both gases will cause the same amount of warming overall.



[109] IPCC, 2021: Climate Change 2021: The Physical Science Basis, Section 7.6.

While the use of GWP_{20} highlights the value of reducing SLCP emissions in the near term by making the impact appear larger, the IPCC recognizes that this approach overestimates the potential benefits of SLCP reductions. More importantly, GWP values are highly sensitive to the time horizon chosen and there is no clear agreement on what the optimal time horizon should be for evaluating their climate impacts.[110] The UNFCCC and IPCC do not establish reporting requirements for SLCPs other than those based on 100 years.

With these limitations in mind, estimated emissions based on GWP_{20} are presented in this report alongside GWP_{100} emissions to assist policymakers and the public in recognizing the disparate impacts of SLCPs compared to CO_2 and LLGHGs, pursuant to P.L. 2019 c319.

Step-Pulse Analysis of SLCP Impacts

Given the limitations of global warming potentials when assessing the consequences of SLCP emissions, climate researchers have reexamined the behavior of these gases to develop better ways to characterize their impacts. The starting point for this reassessment has been the recognition that SLCPs released in a pulse to the environment (for example as a single mass of 1 kg) decay over time, but a 1 kg pulse release of CO_2 will create a nearly constant, continuing impact that remains active over very long periods. This difference in behavior is what makes the GWP approach problematic when applied to SLCPs. If, instead of a pulse release, there is a continuous release of an SLCP (or a step increase in the rate of an existing release), the concentration of SLCP in the atmosphere will rise until reaching a point of equilibrium, referred to as steady state, where new additions of the gas are balanced by removals. Once the concentration is at steady state, the gas will exert a nearly constant climate impact in much the same way that a pulse release of CO_2 does. Under these conditions, the impacts from the continuous SLCP release and the instantaneous release of CO_2 can be compared directly. This method is referred to as the step-pulse comparison method.

One metric cited by the IPCC for creating such as comparison is the Combined Global Temperature Potential,[111] or CGTP, having units of kg/(kg/yr), or yr^{-1}

$$\textit{Cumulative equivalent } CO_2 \textit{ emissions} = \textit{CGTP x Emission Rate of SLCP}$$

For example, the 50-year CGTP for methane is 2,823 yr^{-1}. The impact of a 1 kg/yr release of methane over 50 years would therefore be equivalent to the impact of a one-time CO_2 release of 2,823 kg over that same time period. The 100-year CGTP for methane is 3,531 yr^{-1}, indicating that a 1 kg/yr release that lasts 100 years would have an impact equivalent to a one-time CO_2 release of 3,531 kg. Note that the emissions rate of the SLCP is entered as the mass of gas per unit time, not as the amount of CO_2e per unit time. To convert backwards from CO_2e, the CO_2e value is divided by the GWP factor used in the original calculation to find the mass. A second step-pulse metric, GWP*, has also been proposed and may be suitable for quantifying historical and future consequences where SLCP emissions rates decrease over time.[112] NJDEP will continue to track IPCC and UNFCCC recommendations in regards to emissions metrics and inventory accounting.

[110] IPCC, 2021: Climate Change 2021: The Physical Science Basis, Section 7.6.
IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Ch. 2.

[111] IPCC, 2021: Climate Change 2021: The Physical Science Basis, Section 7.6; Table 7.SM.7.

[112] Lynch, John; Cain, Michelle; Pierrehumbert, Raymond; and Allen, Myles. Demonstrating GWP*: a means of reporting warming-equivalent emissions that captures the contrasting impacts of short- and long-lived climate pollutants. Environmental Research Letters, Volume 15, Number 4, 044023, 2020.

APPENDIX D. COMPARISON OF NEW JERSEY EMISSIONS ESTIMATES WITH THE U.S. EPA EMISSIONS AND SINKS BY STATE REPORT

New Jersey's estimated 2021 net emissions from in-state sources, including removals due to sequestration, agree to within 2% of the value published in USEPA's state-level Emissions and Sinks Report. Specifically, New Jersey found net in-state emissions totaled 89.1 MMT CO_2e while EPA calculated a total of 91.1 MMT CO_2e.[113] New Jersey also calculates emissions due to electricity imported from out of state and from solid waste disposed of out-of-state, but these were not included in the EPA total cited above. . A side-by-side comparison is presented in Table D-1, and shown graphically in Figure D-1.

The differences that exist can largely be traced to differences in the methods used, as discussed by USEPA in Section 1.1 of their Methodology Report.[114] For example, USEPA relies on fuel sales data to estimate emissions from commercial aircraft, but flights arriving and departing from New Jersey generally spend little time in New Jersey airspace. Their approach attributes all emissions from a flight departing from New Jersey as if they all occurred within the State. New Jersey instead considers emissions associated with landing and takeoff as occurring in the State, which is an approach similar to that used by USEPA in the National Emissions Inventory.[115]

New Jersey also relies on emissions reports submitted directly to the State by electric generating facilities and solid waste incinerators in the State, while USEPA relies on federally-reported data. Even so, New Jersey and USEPA estimates for the electricity sector agree within 1%.

Methods used to evaluate hydrofluorocarbon emissions are conceptually similar but differ in their execution. USEPA uses an in-house model called the Vintaging Model while New Jersey relies on an analysis by the California Air Resource Board (CARB) based on their closely-related F-Gas model. The California model is actually derived from the USEPA model. However, the California estimates break out specific subcategories of emissions, for example those from motor vehicle air conditioning and commercial refrigeration. This insight assists New Jersey in developing policies to address climate change. New Jersey's estimates are also based on an earlier set of global warming potentials (GWP), from the IPCC Fourth Assessment Report (AR4), due to limitations in the existing data. GWP values from AR4 are slightly higher than those in the Fifth Assessment Report (AR5) used by USEPA, but the newest release of GWP values, from the Sixth Assessment Report,[116] are closer to those in AR4. Overall, the slightly lower estimate of HFC emissions published by USEPA is consistent with the use of the different GWP values.

At a more fundamental level, USEPA's goal was to apportion IPCC-reported national emissions to the individual states. In contrast, New Jersey's inventory report is crafted differently in order to provide policymakers with the data necessary to identify the most effective pathways towards carbon reduction. So, for example, New Jersey includes out-of-state emissions where state-level policies can have an impact (specifically, electricity and solid waste). In some cases, USEPA methods are very similar to what New Jersey used, as in estimating on-road transportation emissions with the MOVES3 model. In other cases, USEPA used geographic proxies such as population size and production capacity that differ from New Jersey's approach but which allowed calculation of state-level estimates that add up to the IPCC-recognized national total.

113 USEPA Inventory of U.S. Greenhouse Gas Emission and Sinks by State, 1990-2021,. August 2023, https://www.epa.gov/system/files/other-files/2023-02/State-Level-GHG-data.zip EPA estimates are based on the IPCC 5th Assessment Report, 100-year GWP values(https://www.ipcc.ch/report/ar5/wg1/). USEPA only publishes estimates based on GWP_{100} and no comparison was made using GWP_{20}.

114 Methodology Report for Inventory of U.S> Greenhouse Gas Emission and Sinks by State: 1990-2021, EPA-430-R-23-003, August 2023, https://www.epa.gov/system/files/documents/2023-09/Methodology-Report-Full.pdf.

115 https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

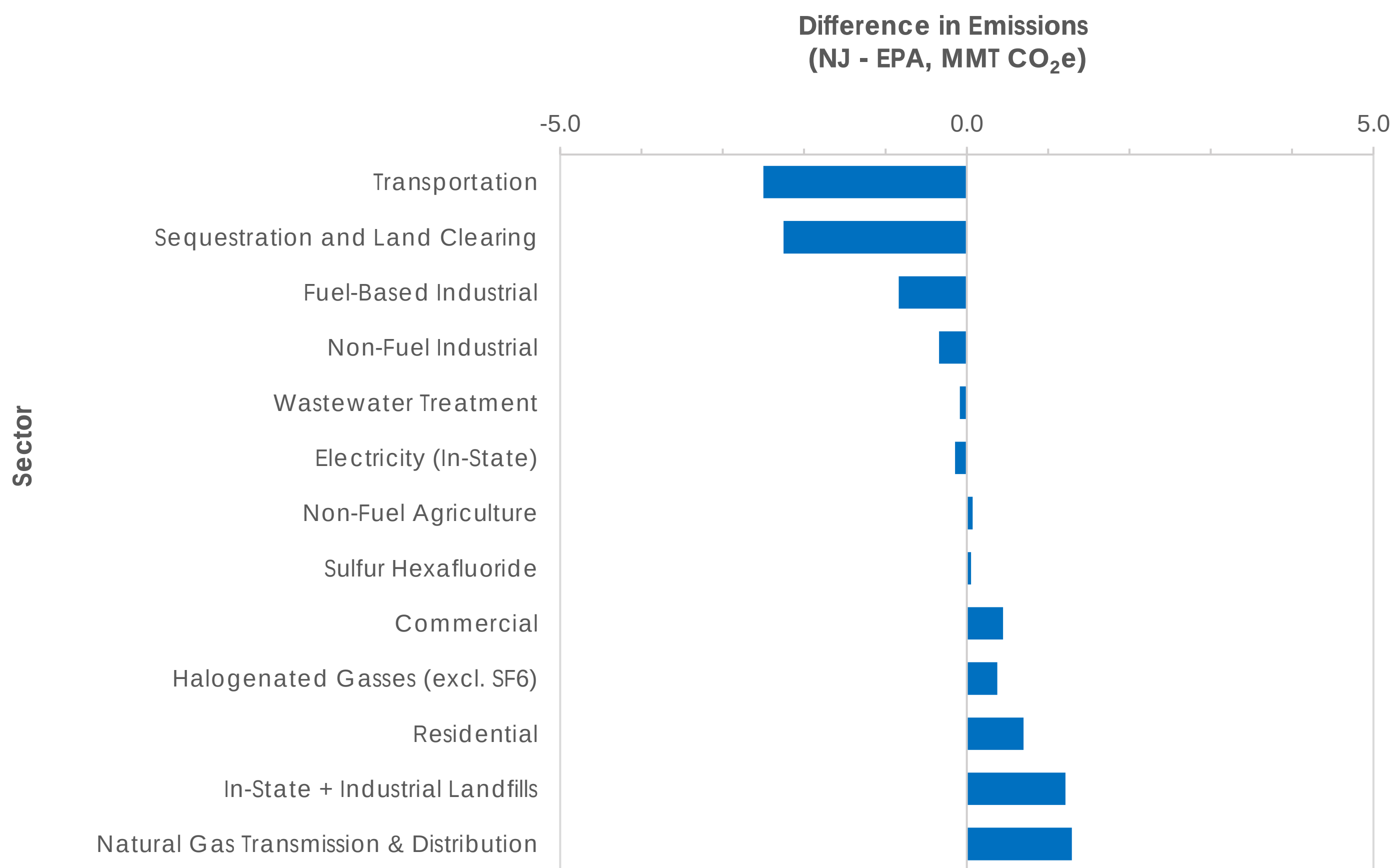
116 https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_FullReport_small.pdf

Table D-1. Comparison of USEPA and New Jersey Emissions Estimates for 2021.

Sector	GHG Emissions Estimates EPA (MMT CO_2e)	GHG Emissions Estimates NJDEP (MMT CO_2e)	Notes
Residential	14.2	14.9	Estimates agree within 5%.
Commercial	9.5	9.9	Estimates agree within 5%.
Industrial - Fuel	8.4	7.6	Estimates agree within 10%.
Industrial - Non-Fuel	0.6	0.3	Estimates agree within 53%. The small quantities involved lead to a large percentage difference.
Transportation	39.8	37.3	Estimates agree within 6%.
Electricity - EGU	13.5	13.5	Estimates agree within 1%.
Electricity - MSW	0.9	0.8	Estimates agree within 6%.
Electricity - Imported	N/A	4.8	Emissions from imported electricity were not evaluated by USEPA. New Jersey includes estimated emissions from imported electricity under statutory mandate.
Halogenated Gases	4.8	5.2	Estimates agree within 8%. New Jersey used IPCC AR4 GWP values and data derived from California F-Gas model; USEPA uses IPCC AR5 and their Vintaging model. The difference in estimates is consistent with slightly lower GWP values in AR5.
Sulfur Hexafluoride (SF6)	0.02	0.08	Estimates agree within 208%. The small quantities involved lead to a large percentage difference.
Non-Fuel Ag	0.4	0.4	Estimates agree within 19%.
Natural Gas Transmission and Distribution	1.2	2.5	Estimates agree within 19%. To develop state-level estimates for transmission and storage, USEPA apportioned the total national transmission and storage segment emissions to each state based on the fraction of national transmission pipeline mileage occurring in each state. NJ used the USEPA 2023 State Inventory Tool and pipeline data from USDOT Pipeline and Hazardous Materials Safety Administration that is specific to New Jersey.
Landfill - In-State, incl Industrial	1.7	2.9	Estimates agree within 73%. EPA took national totals and distributed them among the states to assure the individual state totals added to the national total. NJ used the USEPA 2023 State Inventory Tool and state-specific solid waste disposal records gathered by NJDEP waste management programs.
Landfill - out of state	N/A	3.7	Emissions from out-of-state solid waste disposal were not evaluated by USEPA. New Jersey includes estimated emissions from exported waste under statutory mandate.
Wastewater Treatment	1.0	0.9	Estimates agree within 9%.

Sector	GHG Emissions Estimates EPA (MMT CO_2e)	NJDEP (MMT CO_2e)	Notes
Sequestration & Land Clearing	-4.8	-7.1	Estimates agree within 47%. USEPA includes adjustments for harvested wood products and aquaculture, while NJ uses land use change data. Difference also arise from other methodological distinctions and the high levels of uncertainty when estimating land-based processes.
Total Net Emissions	91.1	97.6	Including NJ Out-of-State Estimates.
Total Net In-State Emissions	**91.1**	**89.1**	**Estimates agree within 2%.**

Figure D-1. Comparison of USEPA and New Jersey Emissions Estimates by Sector for 2021.



APPENDIX E. DETAILED BLACK CARBON EMISSIONS ESTIMATES

Appendix E tables. can be downloaded from

https://dep.nj.gov/wp-content/uploads/ghg/2024-nj-ghg-inventory-report-appendix-e-black-carbon-data.xlsx.