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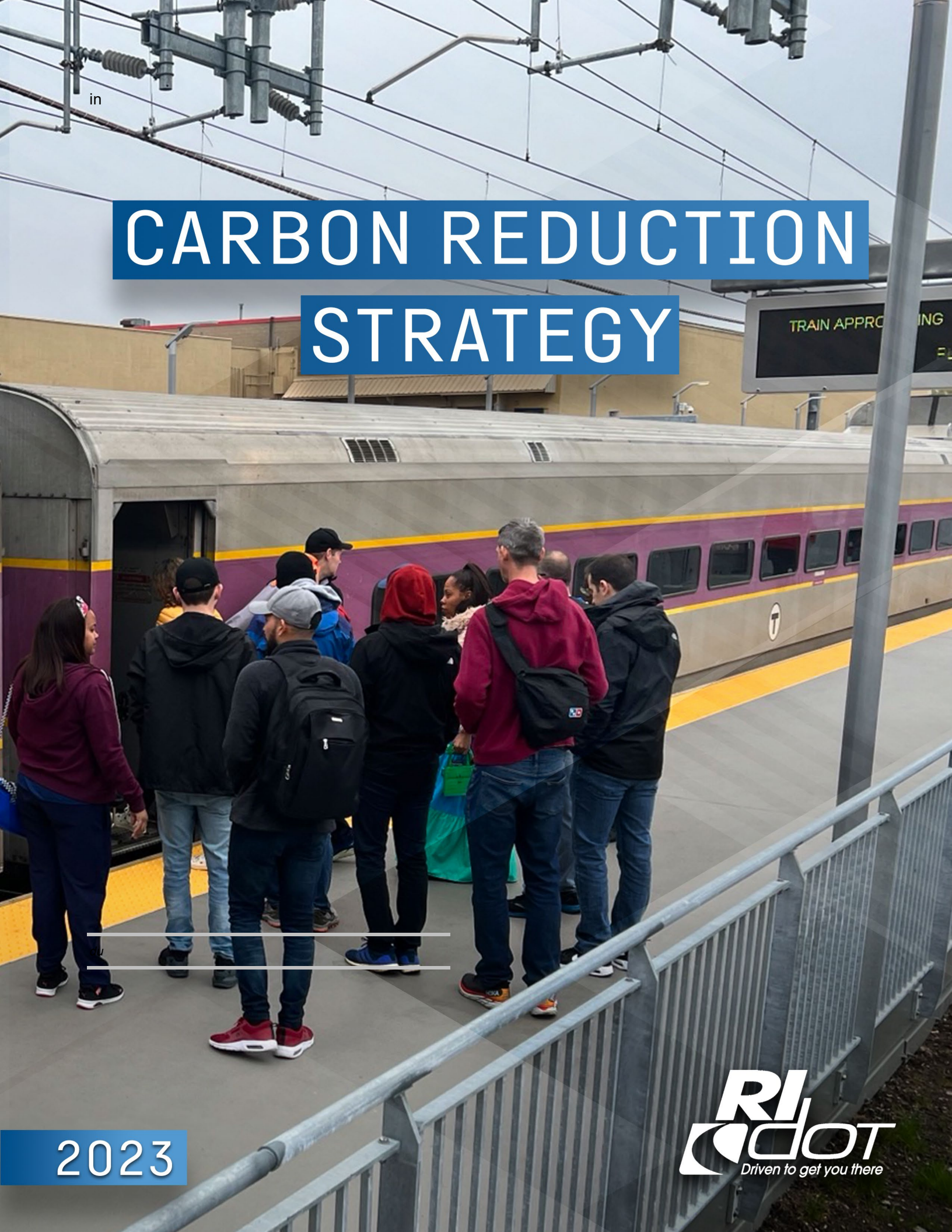
CARBON REDUCTION STRATEGY



2023

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Driven to get you there

Carbon Reduction Strategy

Rhode Island Department of Transportation

date

September 2023

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1.0 EXECUTIVE SUMMARY

1.1 Objectives

The Rhode Island Department of Transportation (RIDOT) created this Carbon Reduction Strategy (CRS) with the following objectives:

- To support **implementation of the 2021 Act on Climate** requiring the state to achieve net zero greenhouse gas (GHG) emissions by 2050.[1]
- To complete a **baseline assessment and forecast** of the carbon impacts of the transportation sector in Rhode Island.
- To identify **funding priorities** for U.S. Department of Transportation (U.S. DOT) Carbon Reduction Program funds.
- To establish a **framework for the future of carbon reduction planning at RIDOT** and identify additional strategies that RIDOT and its partners should engage in to reduce emissions.

1.2 Development Process

The CRS' development process consisted of:

- A baseline inventory and forecast of transportation GHG emissions, including a sensitivity test for alternative electrification futures.
- A review of existing RIDOT and other State of Rhode Island plans supporting emissions reductions.
- Collecting and summarizing information on the effectiveness of transportation GHG reduction strategies.
- A review of quantified GHG emissions reductions from projects included in the Statewide Transportation Improvement Program (STIP).
- Identification and prioritization of projects to be funded through the Carbon Reduction Program.
- Identification of additional strategies and actions to reduce Rhode Island's transportation GHG emissions.

The process included consultation with key stakeholders, including the State's Metropolitan Planning Organization (MPO), as well as other state agencies, advocacy groups, and the general public. Engagement

[1] *State of Rhode Island. (2022, June 21). Act on Climate. Act on Climate | Climate Change. Retrieved May 1, 2023, from https://climatechange.ri.gov/act-climate.*

opportunities included: 1) direct consultation with other agencies; 2) a stakeholder workshop in September 2023 to identify and prioritize additional strategies; 3) presentations for the Transportation Advisory Committee (TAC) and State Planning Council (SPC), at meetings open to the public; and 4) a 30-day public comment period. Stakeholder input was especially considered in the formulation of additional recommendations as well as priorities for CRP program funding.

1.3 Baseline Transportation GHG Inventory and Alternative Forecast Scenarios

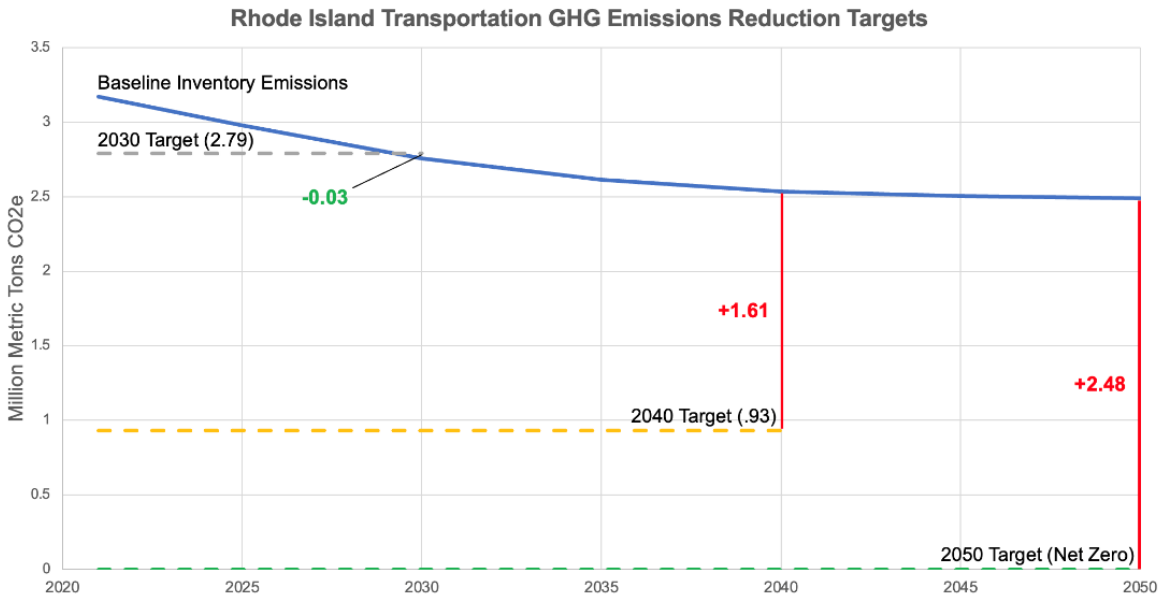
Base year emissions were estimated for four transportation categories: on-road private mobile sources, on-road public transit, rail transit, and construction and maintenance activities. Emissions were then forecasted at five-year intervals through 2050, at which time the State of Rhode Island is statutorily required reach net zero greenhouse gas emissions Under the 2021 Act on Climate. These estimates were informed by recent trends and current policies. An alternative forecast also was developed considering the potential for accelerated adoption of zero-emission vehicles.

In 2021, it was estimated that on-road sources, rail transportation, and roadway construction and maintenance activities were responsible for a total of 3.2 million metric tons (MMT) of carbon dioxide-equivalent (CO_2e) emissions. The vast majority (nearly 99 percent) of emissions are from on-road cars and trucks, with 1.4 percent from buses, rail vehicles, and construction and maintenance activities.

Even with the adoption of advanced clean cars and trucks rules, Rhode Island is expected to fall well short of the transportation emission reductions needed to achieve state requirements. A principal objective of this Plan is to identify policies and investments that will facilitate the pursuit of net-zero targets.

Under current adopted policies, emissions are projected to decline to 2.8 MMT in 2030 an about 2.5 MMT in 2040 in 2050—leaving a very significant gap compared to the State's goal of net-zero emissions (Figure 1). With high rates of zero-emission vehicle adoption as proposed under Advanced Clean Cars 2 and Advanced Clean Cars Trucks rules, emissions would decline to about 1.1 MMT in 2040 and 0.5 MMT in 2050—an 80 percent reduction from the baseline projection in 2050, but still well short of the net-zero requirement. A principal objective of this Plan is to identify strategies for policymaking and investment that will facilitate the pursuit of the net-zero targets codified in state law and recent action plans.

Figure 1.1 Rhode Island Transportation GHG Baseline Emissions Projections and Targets



1.4 Current Plans Supporting Transportation GHG Emissions Reduction

The State's 2021 Act on Climate set GHG targets of 45 percent below 1990 levels by 2030, 90 percent below 1990 levels by 2040, and net zero by 2050. The 2016 *Greenhouse Gas Emissions Reduction Plan*, and a 2022 update of this plan, provide a strategy for reducing the State's emissions, including transportation sector recommendations. The State's 2021 *Clean Transportation and Mobility Innovation Report* outlined a strategic plan aimed toward fostering clean transportation and mobility in the State.

RIDOT and the Division of Statewide Planning have developed a variety of plans that support carbon reduction. One of five goal areas in the Long Range Transportation Plan, *Moving Forward RI-2040*, is to "promote environmental sustainability;" the plan identifies the need to reduce vehicle-miles of travel. The 2020 *Congestion Management Plan* recommends congestion management strategies and solutions that can reduce carbon emissions by reducing inefficient driving in low-speed and stop-and-go traffic. The Transit Master Plan, *Transit Forward RI-2040*, presents a program to better meet the transportation needs of the State's residents, workers, and visitors, reducing emissions by encouraging mode shift away from driving. Similarly, the 2020 *Statewide Bicycle Mobility Plan* identifies bicycle infrastructure and policy that can encourage mode shift. A policy guide for electrifying transportation and the *State Plan for Electric Vehicle Infrastructure Deployment* chart a path towards building out public infrastructure to support statewide electrification.

1.5 Benefits and Cost-Effectiveness of GHG Reduction Strategies

The 2021 *Clean Transportation and Mobility Innovation Report* provided information on other benefits of GHG reduction strategies as well as the relative cost-effectiveness of these strategies, or how much benefit can be obtained per dollar invested. Strategies were rated according to cost-effectiveness for reducing GHG emissions, as shown in Table 1.1.

Table 1.1 Transportation GHG Reduction Strategies by Cost-Effectiveness

Moderate	Strong	Very Strong
• Transit and rail service expansion • Shared ride incentives • Pedestrian investment	• Micromobility (electric bicycles) • Bicycle infrastructure • Bus service efficiency improvements • Travel demand and mobility management	• Electrification and alternative fuels • Traffic flow improvements • Land use (compact, walkable development near transit)

The strategies were also identified as having varying degrees of other important benefits, including mobility, equity, air quality, and health benefits.

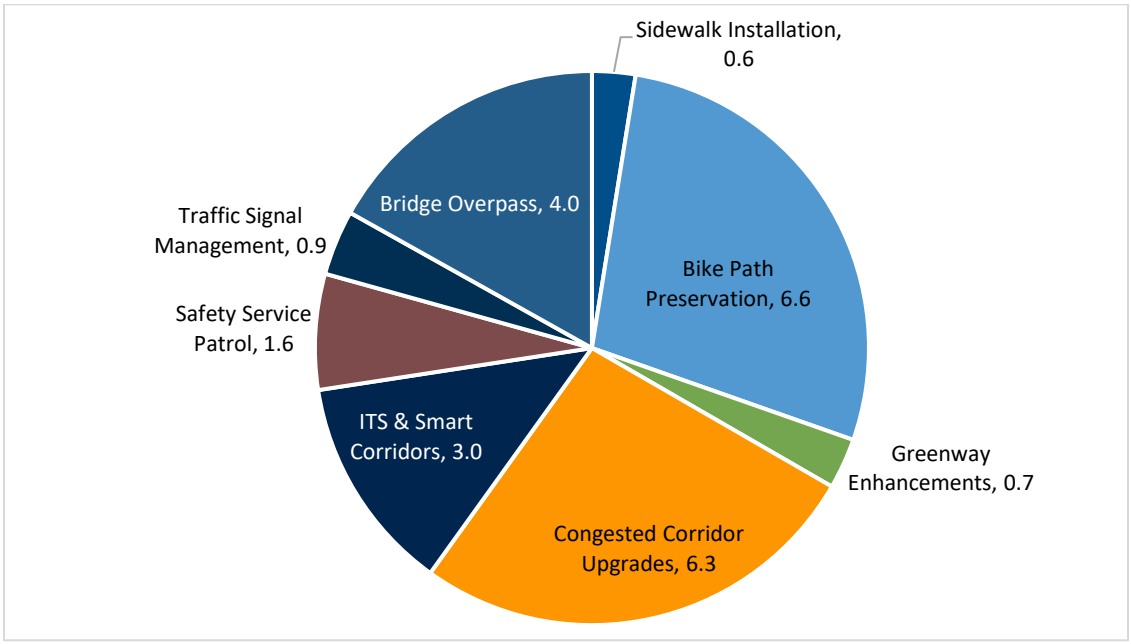
1.6 Evaluation of RIDOT's Capital Program

RIDOT's State Transportation Improvement Plan contains a range of projects that are likely to impact carbon emissions. Three projects of regional significance—the Opening of the Cranston Canyon, Route 146 Reconstruction, and Completion of the I-95 Missing Move and Quonset Connector Ramps—were subject to quantification of GHG emissions in their planning and design stages. These projects were estimated to collectively reduce approximately 10,000 metric tons of GHGs per year. The scale of emission reduction is relatively small compared to total transportation emissions and projects in Rhode Island's construction program will not substantially "move the needle" when it comes to carbon reduction. Nevertheless, these projects are also providing critical mobility and safety benefits for Rhode Island's residents, visitors, and freight industry.

1.7 Carbon Reduction Program Funding

The Carbon Reduction Program will provide an estimated $35.7 million to the State between Federal Fiscal Years 2022 and 2025. Around $23.7 million has been preliminarily assigned to existing projects in the Statewide Transportation Improvement Program, with about two-thirds for congestion management and one-third for bicycle and pedestrian infrastructure to encourage mode shift (Figure 1.2). The remaining third will be allocated primarily towards projects that support mode shift, with some funding also directed towards efficient freight movement and electrification.

Figure 1.2 Preliminary Assignment of Years 1-3 Carbon Reduction Program Funding ($millions)



1.8 Additional Strategies to Reduce Emissions

Carbon Reduction Program funding represents an important step in helping decarbonize Rhode Island's transportation sector and support the state's greenhouse gas reduction goals. However, much more will need to be done in order to move the state on a trajectory to reach net zero emissions by 2050. Considering the strategies identified in existing state planning documents, as well as the outcomes of the stakeholder workshop and other involvement conducted in support of this Strategy, RIDOT will work with its partners to undertake the following actions:

1. Continue to support statewide **electrification/zero-emission vehicle transition** by developing public charging infrastructure and supporting fleet transition efforts.
2. Within constraints of available funding, prioritize **mode shift projects** in programming, including transit service enhancements consistent with the Transit Master Plan, pedestrian and bicycle infrastructure, and micromobility, rideshare, and carshare services.
3. Undertake research, development, and demonstration needed to reduce **emissions from RIDOT's activities**, including clean fleets, low carbon materials, and green infrastructure.
4. Update and expand **plans, policies, and analysis methods** to support carbon reduction, including a Complete Streets plan and guidelines, improved data and modeling systems, revised project selection criteria, and support for smart land use practices.
5. Work with the legislature and partner agencies to explore potential **alternative funding sources** to support additional carbon reduction project and strategy implementation.

2.0 OVERVIEW AND OBJECTIVES

***Key Takeaways**:*

- *This Carbon Reduction Strategy guides RIDOT's use of Federal Carbon Reduction Program funds, while also identifying broader strategies to reduce emissions from the transportation sector and help the state meet its greenhouse gas emission reduction requirements.*

2.1 Rhode Island's Carbon Reduction Strategy Objectives

The Rhode Island Transportation Carbon Reduction Strategy was created with the following objectives:

- To support **implementation of the 2021 Act on Climate**, which requires the state to reduce GHG emissions 45 percent below 1990 levels by 2030 and 90 percent below 1990 levels by 2040, and achieve net zero emissions by 2050.[2]
- To complete a **baseline assessment and forecast** of the carbon impacts of the transportation sector in Rhode Island.
- To identify **funding priorities** for U.S. Department of Transportation (U.S. DOT) Carbon Reduction Program funds provided to Rhode Island for fiscal years 2022 through 2026.
- To establish a **framework for the future of carbon reduction planning at RIDOT** and identify additional strategies that RIDOT and its partners should engage in beyond the projects funded by the Carbon Reduction Program.

Given the transportation sector is responsible for nearly 40 percent of the State's GHG emissions, a focus on reducing transportation carbon emissions is essential to ensuring that Rhode Island stays on track with its climate goals.[3]

2.2 Federal Carbon Reduction Program Requirements

This Strategy is developed in accordance with the U.S. DOT requirement to develop and submit a Carbon Reduction Strategy by November 15, 2023,[4] pursuant to the Infrastructure Investment and Jobs Act of 2021.

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[2] *State of Rhode Island. (2022, June 21). Act on Climate. Act on Climate | Climate Change. Retrieved May 1, 2023, from https://climatechange.ri.gov/act-climate.*

[3] *Rhode Island Department of Environmental Management. Greenhouse Gas Emissions Inventory. https://dem.ri.gov/environmental-protection-bureau/air-resources/greenhouse-gas-emissions-inventory.*

[4] *U.S. Department of Transportation. (2022, April 20). Bipartisan Infrastructure Law—Carbon Reduction Program (CRP) fact sheet: Federal Highway Administration. Bipartisan Infrastructure Law—Carbon Reduction Program (CRP) Fact Sheet | Federal Highway Administration. https://www.fhwa.dot.gov/bipartisan-infrastructure-law/crp_fact_sheet.cfm.*

States are required to develop a Carbon Reduction Strategy in consultation with any Metropolitan Planning Organization (MPO) designated within the State (23 U.S.C. 175(d)(1)).

According to U.S. DOT program guidance,[5] each State's Carbon Reduction Strategy should:

- Support efforts to reduce transportation emissions.
- Identify projects and strategies to reduce transportation emissions.
- At the discretion of the State, quantify the total carbon emissions from the production, transport, and use of materials used in the construction of transportation facilities within the State.
- Be appropriate to the population density and context of the State.

The Carbon Reduction Strategy must be updated at least once every four years. States and MPOs are encouraged to obligate program funding for projects that support implementation of the State's Carbon Reduction Strategy. Program funding may be used on a wide range of projects that support the reduction of transportation emissions.

2.3 Contents of the Strategy

The remainder of this document is organized as follows:

- Section 3.0 of this document describes the process by which it was developed, including stakeholder consultation.
- Section 4.0 presents a baseline inventory and forecast of transportation GHG emissions for the state through 2050.
- Section 5.0 presents an alternative forecast assuming the state adopts advanced clean vehicle standards.
- Section 6.0 describes existing plans and policies in the state supporting transportation emissions reduction.
- Section 7.0 presents information on the cost-effectiveness and co-benefits of carbon reduction strategies.
- Section 8.0 discusses the State Transportation Improvement Program and its potential effects on emissions.
- Section 9.0 discusses priorities for the use of CRP funds.
- Section 10.0 identifies additional strategies that RIDOT and partner agencies can undertake to reduce transportation emissions.
- Appendix A provides more detail on the baseline inventory and forecast.

[5] *Federal Highway Administration. Carbon Reduction Program (CRP) Implementation Guidance (Memorandum), April 1, 2022.*

3.0 STRATEGY DEVELOPMENT PROCESS AND STAKEHOLDER COORDINATION

***Key Takeaways**:*

- *RIDOT engaged other state agencies and advocacy groups in the development of carbon reduction strategies and priorities through an in-person workshop, in addition to providing the opportunity for public comment on the draft strategy.*
- *Presentations were made to councils of the state's MPO, ensuring MPO coordination in CRS development; as well as to a broader group of state agencies charged with reducing GHG emissions.*

3.1 Summary of CRS Development Process

The Carbon Reduction Strategy's development process consisted of three phases:

- Phase 1: Background research, analysis, and preliminary drafting.
- Phase 2: Stakeholder outreach, identification of priority projects and strategies, and development of the final Strategy document.

During Phase 1, RIDOT's Planning Division, supported by its consultant Cambridge Systematics, advised a team of Brown University Master of Public Affairs (MPA) students in conducting a set of background research and analytical tasks. These included: reviewing existing plans and policies; developing a baseline inventory with alternative forecasts; researching information on the cost-effectiveness and co-benefits of carbon reduction strategies; and developing a preliminary draft strategy. During Phase 2, the Planning Division and consultant team conducted additional stakeholder engagement to identify priorities for the use of program funds as well as additional emission reduction strategies; fully developed the draft document and provided it for public comment; and made final revisions to the strategy document.

3.2 Stakeholder Engagement and MPO Consultation

Stakeholder engagement in the development of the Carbon Reduction Strategy included the following methods:

- **Presentations** to the Transportation Advisory Committee (TAC), State Planning Council (SPC), and Rhode Island Rhode Island Executive Climate Change Coordination Council (RI-EC4). The presentations

included 1) the development of the Carbon Reduction Strategy and 2) the draft strategy findings and recommendations. The TAC and SPC are councils of the Rhode Island Division of Statewide Planning, Rhode Island's sole MPO, thereby ensuring MPO consultation during the process. These presentations also gave multiple state agencies, as well as any public members attending the meetings, the opportunity to provide feedback. See the sidebar for the membership of these groups.[6,7,8]

- A **stakeholder workshop** to brainstorm and prioritize carbon reduction strategies. This workshop included staff from various state agencies, including the MPO, as well as representatives of advocacy groups. More information on the workshop process and outcomes is provided in Section 3.3.
- **Consultation** with other internal and external partners, including members of RIDOT's construction and maintenance team, representatives of RIPTA, and the port manager at ProvPort,[9] regarding baseline assumptions (for transit services and technology) and potential uses of funding.
- A 30-day **public comment** period on the draft Carbon Reduction Strategy.

Councils and Committees Engaged in Carbon Reduction Strategy Development

The **Transportation Advisory Committee** meets monthly and includes representatives from RIDOT, the Department of Health (RIDOH), Division of Statewide Planning, Public Transit Authority (RIPTA), Turnpike and Bridge Authority (RITBA), Department of Environmental Management (RIDEM), and the Governor's Commission on Disabilities (RIGCD). The committee also includes 12 private organizations, three municipal representatives, a representative from a Native American tribe, and a member of the public.

The **State Planning Council** is made up of state and municipal agencies, other organizations, and individuals that represent overall stakeholders in state planning. The State Planning Council includes two members of the public, seven representatives from local municipalities, 14 representatives of State level agencies, and two members representing non-profit housing and small businesses, respectively.

The **Rhode Island Executive Climate Change Coordination Council** was established to coordinate efforts between state agencies to reduce GHG emissions. The council includes representatives from the Department of Administration (RIDOA), RIDEM, RIDOH, RIDOT, RIPTA, Coastal Resources Management Council (RICRMC), the Division of Statewide Planning, Emergency Management Agency (RIEMA), Executive Office of Health and Human Services (RIOHHS), Infrastructure Bank (RIIB), Office of Energy Resources (RIOER), Division of Public Utilities and Carriers (RIDPUC), and the Commerce Corporation (CommerceRI). EC4 meetings are open to the public, accessible both online and in-person.

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6 *EC4 Summary | Climate Change (ri.gov).*

7 *Transportation Advisory Committee | Rhode Island Division of Statewide Planning (ri.gov).*

8 *State Planning Council | Rhode Island Division of Statewide Planning (ri.gov).*

9 *Christopher Waterson, Port of Providence / Waterson Terminal Services.*

3.3 Stakeholder Workshop

A 2.5-hour, in-person stakeholder workshop was held in September 2023 to identify and begin to prioritize additional strategies that RIDOT could implement, either on its own or in partnership with other agencies. A total of 21 participants from state agencies and advocacy groups were present at the workshop. The agencies and organizations represented included RIDOT, RIPTA, the Division of Statewide Planning, Department of Environmental Management, Office of Energy Resources, Quonset Development Corporation, Grow Smart Rhode Island, and the Acadia Center.

Participants were divided into breakout groups and asked to identify strategies in three categories:

- **RIDOT actions** – Actions that RIDOT could take on its own.
- **Partnerships** – Actions where RIDOT would need to work together with another agency or organization.
- **"Big Swings"** – More ambitious longer-term actions that would move the needle on emissions reduction but also would be challenging to implement and may require further study and planning work.

Participants then applied a three-tier prioritization scheme:

- 1 – Top priority for short-term action.
- 2 – Other priorities to advance.
- 3 – Strategies needing more study or not having consensus.

The resulting strategies by category and priority are shown in Table 3.1.

Table 3.1 Transportation Carbon Reduction Strategies Proposed in Workshop

Category	1 – Top near-term priority	2 – Other priorities	3 – More study/ development
RIDOT actions	• Multimodal infrastructure • EV share/rideshare/ bikeshare programs • RIDOT clean fleets	• Remote work • Low-carbon materials • STIP project prioritization criteria • Solar at DOT & RIPTA facilities • EV charging infrastructure	• Green infrastructure
Partnerships	• Fully fund/implement Transit Master Plan & Statewide Bicycle Plan • Increase MBTA service	• Mobility as a Service / multimodal ticketing • Microtransit partnerships • Free/reduced fares	• Transportation demand management & land use
Big Swings		• Statewide parking study • Statewide pedestrian plan	• Car-free/zero emission zones • RI-based passenger rail • Congestion pricing • High occupancy vehicle / managed lanes • Gas guzzler tax

4.0 BASELINE INVENTORY AND FORECAST

Key Takeaways:

- *Rhode Island's transportation emissions were estimated to be about 3.2 million metric tons of carbon dioxide (MMT CO_2e) in 2021. Under current policies, emissions are forecasted to decrease to around 2.5 MMT CO_2e in 2050, with a much greater decrease to 0.5 MMT in 2050 if the state adopts advanced clean vehicle rules.*
- *Even with aggressive adoption of clean vehicles, the state's transportation sector will fall well short of its proportionate share of GHG reduction goals in 2040 and 2050, and further actions by RIDOT and other agencies will be needed to achieve these goals.*

4.1 Emissions Sources Included

The Rhode Island Department of Environmental Management develops and updates a statewide GHG emissions inventory covering all sectors. The 2019 inventory estimated that a total of 4.29 million metric tons (MMT) of emissions were produced by the transportation sector, representing 39.7 percent of the state's emissions. Of these, 3.61 MMT were from highway vehicles, with aviation and nonroad sources accounting for the remainder.[10] RIDOT developed a new emissions inventory for the purposes of this Carbon Reduction Strategy to provide a more detailed and current look at specific transportation sector sources, as well to develop forecast year projections (through 2050) using sources and methods consistent with a base year inventory. The inventory results may differ somewhat due to differences in data sources and methods between the two inventories, in addition to having a different base year.

The baseline emissions inventory and forecast included the following sources: on-road private mobile sources, on-road public mobile sources, passenger and freight rail, and construction and maintenance activities. Within the on-road mobile sources group, emissions are further categorized by vehicle class and technology type. Public transportation's primary sources include demand response vehicles, motor buses, and vanpool services. Rail transit is comprised of both passenger and freight rail. Construction and maintenance activities refer to the building and repair plans included in the STIP.

[10] *https://dem.ri.gov/environmental-protection-bureau/air-resources/greenhouse-gas-emissions-inventory*

4.2 Emissions Estimates and Projections

The year 2021 serves as the baseline year in the emissions inventory analysis, since that was the latest year for which most data sources were available at the time of the analysis. The baseline emissions estimates and forecasts were calculated using a set of “business-as-usual" assumptions that reflect national vehicle fuel efficiency standards and state projections of vehicle-travel. Each transportation source’s baseline inventory was forecasted through the year 2050 using a range of assumptions specific to each source (see Section A.1 for detailed methodologies). To enable cross-reference with the State’s intermediate goals toward net-zero emissions by 2050, the baseline forecast is presented in five-year intervals after the year 2025. Table 4.1 and Figure 4.1 below display the resulting estimates.

Table 4.1 Rhode Island Transportation Emissions Forecast

Units: Metric Tons CO_2e	2021	2025	2030	2035	2040	2045	2050
On-Road Mobile Sources	3,131,761	2,929,579	2,716,803	2,580,246	2,502,362	2,472,454	2,455,581
On-Road Public Transportation	19,845	18,106	18,207	17,429	17,301	17,301	17,301
Rail Transit	15,992	12,441	8,884	1,842	1,798	1,744	1,746
Construction and Maintenance	10,203	10,905	7,909	7,329	7,521	7,344	7,421
Grand Total	**3,177,801**	**2,971,031**	**2,751,803**	**2,606,845**	**2,528,983**	**2,498,843**	**2,482,049**

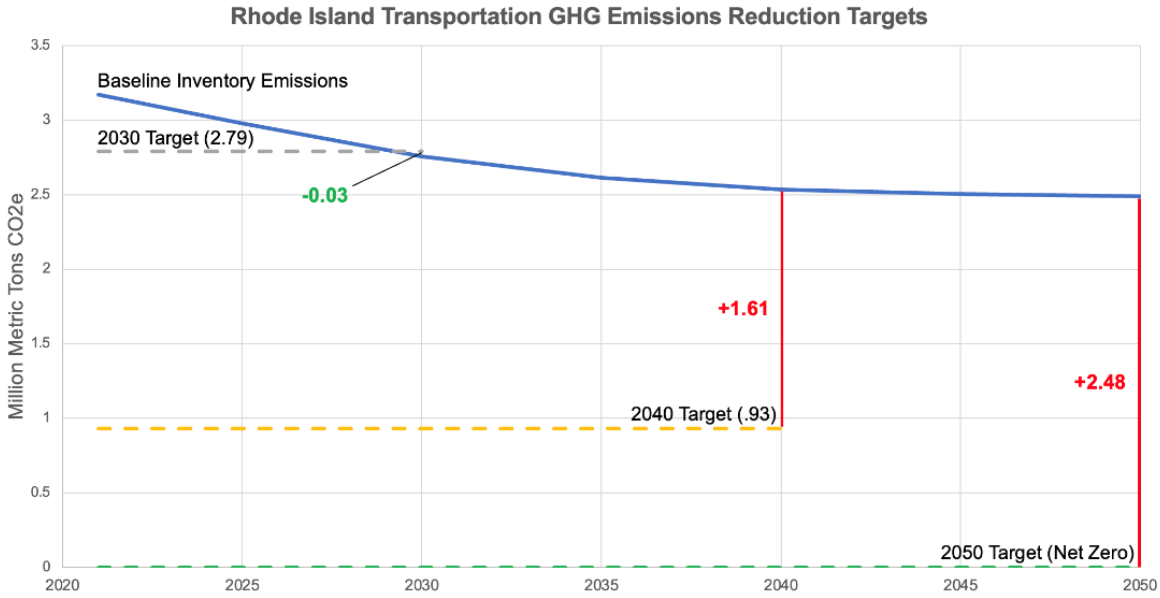
The vast majority of 2021 emissions (over 98 percent) are from on-road cars and trucks. On-road public transportation (buses), passenger and freight rail, and construction and maintenance of the state’s transportation network each contribute less than 1 percent.

Under the baseline forecast, transportation emissions are projected to decrease from about 3.2 million metric tons of carbon dioxide equivalent in 2021 to around 2.5 MMT CO_2e in 2050. Despite projected increases in vehicle miles traveled (VMT), the forecasted reductions in emissions can be primarily attributable to fuel economy improvements as well as modest increases in vehicle electrification for light duty passenger vehicles. On a much smaller scale, on-road public transportation emissions are projected to slightly decrease as RIPTA transitions its motorbus fleet toward electric and diesel-electric hybrid technologies.[11] A significant emissions reduction is projected for rail transit in accordance with Amtrak and Massachusetts Bay Transportation Authority (MBTA) plans to decarbonize rail transportation. Finally, the Federal Highway Administration’s Infrastructure Carbon Estimator (ICE) tool predicts a low-to-moderate reduction in construction and maintenance activity emissions through 2050. Figure 4.1 shows baseline projections compared to targets, and a series of tables in Appendix A detail the projected patterns of emissions sources within each transportation category. While RIDOT’s 2030 target is projected to be achieved, the projected emissions leave a gap of 1.6 MMT in 2040 and nearly 2.5 MMT in 2050 compared to the net zero target. This suggests that a much more

[11] *Under the baseline scenario, RIPTA will integrate nearly 40 new battery-electric buses by 2026, representing just over 10 percent of the fleet, while the remainder of the diesel buses are to be replaced with diesel-hybrid buses at the end of their useful life.*

aggressive shift to clean vehicles and fuels, and/or efforts to reduce vehicle-travel, will be needed to come close to or achieve the 2040 and 2050 targets.

Figure 4.1 Rhode Island Transportation GHG Reduction Baseline Projections and Targets



5.0 SCENARIO ANALYSIS OF HIGH ZERO EMISSION VEHICLE FUTURE

5.1 Alternative Vehicle Technology Scenarios and Policy Assumptions

Key Takeaways:

- *The adoption of zero emission vehicle (ZEV) policies, specifically the proposed Advanced Clean Cars II and Advanced Clean Truck rules, is estimated to have a substantial impact on emissions reductions.*
- *Compared to baseline forecasts, adoption of ZEV policies could reduce emissions 50 percent below the baseline forecast in 2030, and 80 percent below the baseline forecast in 2050, to as low as 0.5 MMT CO_2e – still short of the net-zero target.*

The baseline forecast assumes modest levels of electrification. This section estimates the additional emissions reductions possible through the adoption of Advanced Clean Cars II (ACCII) and Advanced Clean Trucks (ACT) rules that have recently been adopted by the State of California as well as neighboring states, including Massachusetts and New York, and proposed in Connecticut. In May 2023, RIDEM proposed a draft rule to adopt these standards in Rhode Island as well and the rule is likely to be adopted in early 2024.[12]

These rules would place zero-emissions vehicle sales requirements upon manufacturers selling vehicles in Rhode Island. Zero-emissions vehicle sales must constitute an increasingly large fraction of car and truck sales from 2024 to 2035, then remain at constant, high levels beyond 2035 (100 percent for light-duty passenger vehicles, 55 percent for light-medium trucks, 75 percent for medium and heavy-duty trucks).[13,14] California's Air Resources Board has modeled the vehicle technology shares that they anticipate will accompany the implementation of their clean transportation regulations. These technology shares have been slightly modified for translation onto the RI vehicle fleet, yielding the emissions pattern observed below in Figure 5.1 and Figure A.1 in Appendix A.

The proposed rule would help to implement previously proposed strategies to incentivize electric vehicle expansion throughout the State. The Clean Transportation and Mobility Innovation Report outlines RI's goal to

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12 *250-RICR-120-05-37: Rhode Island's Low-Emission and Zero-Emission Vehicle Programs.* https://dem.ri.gov/sites/g/files/xkgbur861/files/2023-05/250-RICR-120-05-37-redline-d0523.pdf.

13 *State of California. (2023). California Air Resources Board. Advanced Clean Cars Program | California Air Resources Board.* https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program.

14 *State of California. (2023). California Air Resources Board. Advanced Clean Trucks | California Air Resources Board.* https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks.

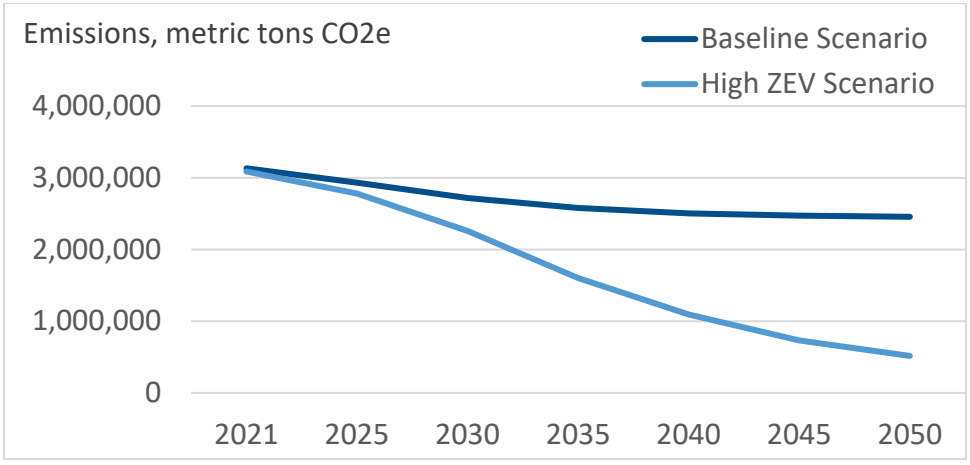
deploy 400,000 EVs on the road by 2030, with an interim goal of 50,000 EVs by 2025.[15] The State's EV goals roughly align with the ZEV magnitudes that would be seen under the advanced clean cars and trucks rules.

Zero-emission vehicles are currently more costly than conventional vehicles and require new charging or refueling infrastructure. The availability of vehicles meeting consumer and business performance requirements is also limited, but improving. It is likely that significant state investment and incentives will still be needed to achieve the levels of ZEV sales and use required under the proposed rules. The Rhode Island 2021 Act on Climate proposes supporting policies, including rebates for EV purchases and construction of EV charging stations.[16] The DRIVE^{EV} program provides rebates of up to $2,000 for the purchase or lease of new battery electric vehicles and fuel-cell electric vehicles and up to $1,500 for new plug-in hybrid electric vehicles, with additional rebates for income-qualified consumers. RIDOT and OER are using Federal and state funding, including the National Electric Vehicle Infrastructure (NEVI) Program and Volkswagen settlement funds, to support the development of public charging infrastructure, and have applied for additional federal funding through the U.S. DOT Charging and Fueling Infrastructure (CFI) Program.

5.2 Projections and Comparison with Baseline Forecasts

In the vehicle electrification scenario described above, annual emissions from private on-road mobile sources are substantially reduced in comparison to the baseline forecast. Annual emissions in the ZEV scenario are about 50 percent lower than the baseline level in 2030, 1.5 MMT CO_2e lower in 2040, and 2 MMT CO_2e lower in 2050 or 80 percent below the baseline. These annual reductions culminate in about 30 MMT fewer total CO_2e emissions during the period from 2021 through 2050, relative to baseline conditions. Even with the high levels of electrification, a gap of 0.5 MMT would still remain in 2050 compared to the net-zero requirement.

Figure 5.1 ZEV Scenario Emissions



[15] *State of Rhode Island. (2021). Clean Transportation and Mobility Innovation Report. Climatechange.ri.gov. https://climatechange.ri.gov/sites/g/files/xkgbur481/files/documents/ec4-0304-mwg-final-report-pres.pdf.*

[16] *State of Rhode Island. (2022). Act on Climate | Climate Change. https://climatechange.ri.gov/act-climate.*

6.0 CURRENT POLICIES AND PLANS SUPPORTING TRANSPORTATION GHG EMISSIONS REDUCTION

Key Takeaways:

- *Statewide emissions reduction targets outlined in the 2021 Act on Climate provide the legal foundation for collective planning and action.*
- *Existing plans include strategies to promote electric vehicles, improve public transit, encourage alternative fuels, support innovation, and encourage collaboration in the implementation of emissions reduction measures.*

6.1 Summary

The 2021 Act on Climate establishes enforceable emissions reduction mandates for the State of Rhode Island. The state's Greenhouse Gas Emissions Reduction Plan provides a strategy for reducing the State's emissions. In addition, existing transportation plans for Rhode Island developed by RIDOT, the Department of Statewide Planning, and the Office of Energy Resources support emissions reductions in various ways. Table 6.1 summarizes the various carbon reduction strategies referenced in existing plans.

Table 6.1 Summary of Existing Strategies to Reduce Carbon Emissions

Promoting Electric Vehicles	1. Increasing the availability of electric vehicle charging infrastructure. 2. Incentivizing the purchase of electric vehicles. 3. Expanding public awareness and education about the benefits of electric vehicles.
Improving Public Transit	1. Expanding public transit options and improving the efficiency and effectiveness of public transit to encourage their use over personal vehicles. 2. Improving walking and cycling infrastructure to encourage transport mode shifts.
Encouraging Alternative Fuels	1. Emphasizing the take-up of alternative fuels (such as hydrogen, biodiesel and renewable natural gas) for various transportation applications to reduce total emissions attributed to fossil fuels.
Supporting Innovation	1. Development and adoption of new clean transportation technologies, such as micromobility and connected infrastructure, to improve transportation efficiency and reduce emissions. 2. Improvement of overall traffic efficiency and improved land use policies.

Encouraging Collaboration	1. Building partnerships and collaboration among stakeholders (Government agencies, private businesses, and community organizations) to support the implementation of clean transportation solutions. 2. Co-existence of efforts in reducing transportation emissions with other efforts outlined in the Act on Climate (e.g., improving building efficiency and enhancing the State's climate resilience). This requires interagency coordination. 3. Collaboration as a part of key interventions: in the promotion of and investment in a multimodal transportation system (public transport, biking, walking infrastructure, efficient freight and logistics operations), engagement with transit riders, community organizations, and local officials, ensures that interventions align with community needs.

6.2 State Emission Reduction Policies, Plans, and Strategies

6.2.1 Rhode Island 2021 Act on Climate[17]

The 2021 Act on Climate establishes enforceable emissions reduction mandates for the State of Rhode Island alongside several sector-specific supportive requirements. The emissions reduction mandates—45 percent below 1990 levels by 2030, 80 percent below 1990 levels by 2040, and net-zero by 2050—were signed into law by Governor Dan McKee, thus legitimizing their enforcement on behalf of the RI General Assembly. As the State's transportation sector contributes approximately 40 percent of the State's GHG emissions, RIDOT's carbon reduction efforts are an essential component to help reach the Act's requirements. Additionally, the Act's formalization of plans to decarbonize the electricity grid by 2030 bolsters the high emissions reduction potential of electric vehicles.

6.2.2 Rhode Island Greenhouse Gas Emissions Reduction Plan[18]

The 2016 Rhode Island Greenhouse Gas Emissions Reduction Plan provides a strategy for reducing the State's greenhouse gas emissions. Developed by the Rhode Island Executive Climate Change Coordinating Council and its cross-divisional members (Office of Energy Resources, Department of Environmental Management, Division of Statewide Planning, RIDOT), the study identifies major GHG emissions sources and mitigation strategies that engage actors across a range of sectors. The study notably recognizes the transportation sector's disproportionately large share of total statewide emissions and recommends expansion of electric vehicle use and public transportation capacity.

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17 *State of Rhode Island. (2021). 2021 Act on Climate.* https://climatechange.ri.gov/act-climate.

18 *State of Rhode Island. (2016). Rhode Island Greenhouse Gas Emissions Reduction Plan. climatechange.ri.gov.* https://climatechange.ri.gov/sites/g/files/xkgbur481/files/documents/ec4-ghg-emissions-reduction-plan-final-draft-2016-12-29-clean.pdf.

An update to the 2016 study was published in 2022.[19] Key recommendations of the update are shown in the sidebar.

Summary of Transportation Recommendations in the Rhode Island 2022 Climate Update

- Target 10 percent EV penetration by 2030 by adopting ACCII and with ZEV-focused programs such as DRIVE EV.
- Adopt the Advanced Clean Trucks Rule.
- Incentivize electric mobility.
- Decarbonize Rhode Island's transit fleet.
- Look to the Transit Master Plan and Bicycle Mobility Plan for next steps (as resources are available).
- Develop a 'Complete Streets' State Plan and Design Guidelines.
- Model climate impacts of transportation demand, including CRP analysis and other GHG modeling improvements and performance measures.

6.2.3 Energy 2035[20]

Energy 2035, a report released in 2016 by the Office of Energy Resources, develops a long-term vision for the State's future regarding energy use. The report outlines a plan for meeting the State's energy needs while reducing greenhouse gas emissions and promoting energy efficiency. RIDOT's planning leverage is implicated in the report's recommendation to increase the use of electric vehicles and promote alternative transportation modes, such as biking and walking.

6.2.4 Clean Transportation and Mobility Innovation Report[21]

The Clean Transportation and Mobility Innovation Report, released by the Governor's Office in 2021, outlines a strategic plan aimed toward fostering clean transportation and mobility in the State. This plan's development was collaborative, with key input from stakeholders in the public sector (including RIDOT, DSP, and RIPTA),

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19 *RIEC4 (2022). Rhode Island 2022 Climate Update. https://dem.ri.gov/press-releases/state-climate-panel-votes-accept-updated-greenhouse-gas-emissions-reduction-plan*

20 *State of Rhode Island. (2015). Energy 2035 Rhode Island State Energy Plan. Planning.ri.gov. https://planning.ri.gov/sites/g/files/xkgbur826/files/documents/LU/energy/energy15.pdf.*

21 *State of Rhode Island. (2021). Clean Transportation and Mobility Innovation Report: Rhode Island's Roadmap to a Clean Transportation Future. Climatechange.ri.gov. https://climatechange.ri.gov/sites/g/files/xkgbur481/files/documents/ec4-0304-mwg-final-report-pres.pdf.*

industry, and academia. A major objective of this plan was to support the direction of new investment anticipated from implementation of a multi-state Transportation and Climate Initiative Program. Although this program was not successfully adopted, the report still provides valuable ideas and information about emission reduction strategies.

The report compares illustrative portfolios of strategies based on cost-effectiveness at achieving emissions reductions and other benefits (see Section 7). Strategies are categorized as 1) electrification and alternative fuels, 2) vehicle travel reduction, 3) transit and rail, and 4) traffic efficiency. Benefit metrics include GHG emissions, air quality, mobility, health, and job creation. The report places a strong emphasis on identifying and designing strategies in a way that supports equitable outcomes and ensures that benefits of investments accrue to overburdened and underserved communities. The report also includes strategies to support economic development. The report includes 24 recommendations, summarized in the sidebar, as well as initial action steps. Some of these recommendations, such as adoption of requirements for zero-emission vehicle sales and development of an EV roadmap, have already been implemented.

Summary of Recommendations in the Clean Transportation and Mobility Innovation Report

- Implement measures to ensure equity in transportation investments.
- Consider setting a transportation GHG reduction goal.
- Focus on implementation of Transit Forward RI, especially focusing on mobility for urban and rural underserved populations.
- Create Next Generation Transit Districts with rapid, high-capacity, high-interval electrified transit to spur transit-oriented development.
- Consider establishing a Task Force to review and revise existing land use statutes.
- Promote active mobility by implementing a new statewide bike and scooter share program.
- Enhance the Complete Streets program.
- Consider establishing goals for zero-emission vehicle sales and truck fleets.
- Electrify the rail system to support faster and more frequent service.
- Develop an EV roadmap.
- Establish/expand Intelligent Transportation Systems, telecommunications infrastructure, and deployment of connected and autonomous vehicles.
- Explore development of a Statewide Mobility Services Program to support transit access and short trips.
- Develop initiatives, policies, and incentives for workforce development and training to support new transportation vehicles and services.

6.3 Transportation Plans Supporting Emissions Reductions

6.3.1 Long Range Transportation Plan—Moving Forward RI-2040[22]

Rhode Island's Long Range Transportation Plan, Moving Forward RI-2040, establishes a long-range outline for investing in the State's transportation system that will help ensure Rhode Island remains a great place to live, work, and do business. One of five goal areas in the plan is to "promote environmental sustainability." The plan identifies the need to reduce VMT and that the EC4 has set targets to reduce VMT 2 percent by 2035 and 10 percent by 2050, relative to 2014.

6.3.2 Congestion Management Plan[23]

The Congestion Management Plan, developed by the Division of Statewide Planning in 2020, is a systematic process for identifying the causes and locations of roadway traffic congestion, developing monitoring processes to measure transportation system performance and reliability, and developing congestion management strategies and solutions. The Plan includes an action plan with implementation steps that support mode shift as well as efficient traffic operations. Congestion management can help to reduce carbon emissions by reducing inefficient driving in low-speed and stop-and-go traffic.

6.3.3 Rhode Island Transit Master Plan 2040[24]

Published in 2020, the Transit Master Plan "Transit Forward RI-2040" presents a program to enhance and develop Rhode Island's passenger transportation network to better meet near, and long-term, mobility needs of the State's residents, workers, and visitors. The plan includes an assessment of funding sources that could be used to implement the plan's recommendations. Transit Forward RI-2040 is a collaboration among RIDOT, RIPTA, and the Division of Statewide Planning. Transit services can help to reduce carbon emissions by encouraging mode shift away from driving. RIPTA has estimated that full implementation of the plan could reduce emissions by over 230,000 metric tons, or the equivalent of taking 50,000 cars off the road.

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22 *Rhode Island Division of Statewide Planning. (2020). Long Range Transportation Plan—Moving Forward RI-2040.* https://planning.ri.gov/planning-areas/transportation/long-range-transportation-plan.

23 *Rhode Island Division of Statewide Planning. (2020). Congestion Management Plan.* https://planning.ri.gov/planning-areas/transportation/congestion-management.

24 *Rhode Island Public Transit Authority. (2020). Rhode Island Transit Master Plan 2040: Transit Forward RI-2040.* https://transitforwardri.com/.

6.3.4 Rhode Island Statewide Bicycle Mobility Plan[25]

The Rhode Island Statewide Bicycle Mobility Plan, developed in 2020 by the Division of Statewide Planning, identifies a wide range of bicycle enhanced corridors, programs, and policies recommended to achieve the vision for cycling across Rhode Island. Improved bicycle facilities can help to reduce carbon emissions by encouraging mode shift away from driving.

6.3.5 Electrifying Transportation: A Strategic Policy Guide for Improving Public Access to Electric Vehicle Charging Infrastructure in Rhode Island[26]

This document is a plan for a statewide electric vehicle charging station infrastructure designed to make EV charging stations more accessible to the public. The plan was developed in 2021 by RIDOT, OER, and the Department of Motor Vehicles, with support from DEM and the Rhode Island Department of Public Health. The plan reviews the current status of electrification; makes recommendations based on public and stakeholder input; and provides a working document to support priorities and coordinated action. Priorities include: vehicle and infrastructure incentive programs; alignment of programs to center equity for underserved and overburdened communities; electrify transit and school buses; understanding revenue impacts and developing sustainable funding options; supporting a 100 percent renewable energy standard; developing a dashboard to track progress; and demonstrating action through commitments and accountability.

6.3.6 State Plan for Electric Vehicle Infrastructure Deployment[27]

The State Plan for Electric Vehicle Infrastructure Deployment (2022) describes how Rhode Island will use funding from the National Electric Vehicle Infrastructure (NEVI) Program to help plan and strategize the build-out of a fast EV charging station network. The plan was developed by RIDOT in collaboration with the OER and DEM. The plan documents that RIDOT and OER had already implemented an EV charging pilot program starting in 2020. The plan sets a goal to fully build out charging along Interstate 95 and build two additional stations. The plan describes a competitive grant program to implement this infrastructure using federal and state matching funds. Deployment of fast-charge networks is important to support consumers with purchasing and using EVs and thereby reducing emissions.

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[25] *Rhode Island Division of Statewide Planning. (2020). Rhode Island Statewide Bicycle Mobility Plan. https://planning.ri.gov/sites/g/files/xkgbur826/files/documents/LRTP/Bicycle-Mobility-Plan.pdf.*

[26] *RIDOT, RI OER, and Department of Motor Vehicles (2021). Electrifying Transportation: A Strategic Policy Guide for Improving Public Access to Electric Vehicle Charging Infrastructure in Rhode Island. https://energy.ri.gov/transportation/electrifying-transportation*

[27] *Rhode Island Department of Transportation. (2022). State Plan for Electric Vehicle Infrastructure Deployment. https://www.dot.ri.gov/projects/EVCharging/docs/Rhode%20Island%20Electric%20Vehicle%20Infrastructure%20Deployment%20State%20Plan_Draft%20for%20Review-Rev%2003.pdf.*

6.3.7 Additional RIDOT Actions

In 2023, RIDOT adopted internal changes to its project prioritize process to better ensure that selected projects would align with state plans and goals. The agency updated its pre-scoping template to require the engineering team to consult existing state plans, including the Transit Master Plan, Bicycle Master Plan, Long-Range Transportation Plan, and Statewide Freight Plan), to identify opportunities to include elements of these plans in the implementation of capital projects.

In addition to working to deploy NEVI funds consistent with the State Plan for Electric Vehicle Infrastructure Deployment, RIDOT has collaborated with the OER to write a grant proposal for the federal Charging and Fueling Infrastructure Program which would further support EV charging infrastructure deployment.

RIDOT has also submitted a grant application for a major highway/bridge reconstruction project along Northeast Corridor. As mitigation for construction disruptions, the project would include a “Rhody Express” pilot project to increase MBTA commuter rail service between Providence, T.F. Green International Airport, and Wickford Junction from 10 to 25 runs per day.

7.0 GHG REDUCTION BENEFITS, COST-EFFECTIVENESS, AND CO-BENEFITS BY PROJECT TYPE

Key Takeaways:

- *The 2021 Clean Transportation and Mobility Innovation Report identifies three categories of clean transportation projects—VMT Reduction and Mode Shift, Transportation System Efficiency, and Vehicle Fuel Technology—and evaluates the cost-effectiveness of projects within each category.*
- *Projects that promote alternative fuel technologies, decrease traffic congestion, or encourage smarter land use are identified as highly cost-effective for reducing emissions.*

As detailed in Section 9.0 of this report, RIDOT must consider a range of project selection criteria in its CRP funding allocation decisions to maximize the benefits and feasibility of project implementation. The expected GHG reduction benefits, co-benefits, and corresponding cost-effectiveness of each prospective project serve as important considerations to help guide the selection of projects identified for CRP funding. To evaluate project types based on these considerations, RIDOT has referred to the State's 2021 Clean Transportation and Mobility Innovation Report, which evaluates and compares various emissions reduction strategies by project category. Table 7.1 defines the types of emissions reduction strategies considered in the report, and Table 7.2 summarizes the study's key cost-effectiveness findings.

Table 7.1 Transportation Strategies with Emissions Reduction Potential[28]

VMT Reduction and Mode Shift Strategies	
Shared Ride Incentives	Shared ride incentives refer to monetary rewards offered to encourage passengers to choose shared-ride options instead of solo-ride options when using ride-hailing services like Uber or taxi services.
Micromobility	Micromobility projects involve the use of shared electric scooter/bicycle programs. Subsidies for shared electric scooter/bicycle programs provide financial support for the startup and operating costs of such shared mobility programs. These subsidies also can include user-side incentives such as discounted rates.
Micromobility—E-bike Ownership Subsidies	Subsidies for e-bike ownership are financial incentives granted to persons who purchase electric bicycles for personal use.
Land Use/Smart Growth	Land use/smart growth refers to planning and development strategies that foster compact, mixed-use communities to accommodate various alternative modes of transportation.

[28] *State of Rhode Island. (2021). Clean Transportation and Mobility Innovation Report. Climatechange.ri.gov.* https://climatechange.ri.gov/sites/g/files/xkgbur481/files/documents/ec4-0304-mwg-final-report-pres.pdf.

VMT Reduction and Mode Shift Strategies	
Bicycle Investment	Financial investments can be made to improve the infrastructure that accommodates bicycling—including bike lanes, bike parking and other amenities.
Pedestrian Investment	Financial investments that improve pedestrian infrastructure—such as sidewalks, crosswalks, and pedestrian bridges—can encourage citizens to choose walking over other modes of transportation.
Travel Demand and Mobility Management	Travel demand and mobility management refers to a set of strategies that aim to influence travel behavior. These strategies can leverage information provisions, economic incentives, and infrastructural design to promote energy-efficient practices like public transit, ridesharing and telework.
Transportation System Efficiency Projects	
Bus Rapid Transit	Bus rapid transit (BRT) projects involve the construction and operation of new BRT services. BRT's use of dedicated roadways and stations offer these services greater reliability than conventional bus services.
Commuter/Intercity Rail	Commuter and intercity rail projects refer to the construction and operation of new and/or enhanced rail services.
Bus Service—Expansion	Bus service expansion entails adding more vehicle trips and increasing frequency or time-of-day coverage on existing routes.
Bus Service—Efficiency	Bus service efficiency improvements can be achieved through measures that help reduce run times, such as transit signal priority and queue jump lanes.
Electric Microtransit	Microtransit refers to app-enabled, flexible-route services using smaller vehicles than standard buses.
Traffic Flow Improvements	Traffic flow improvements can be achieved through various traffic management strategies, ranging from signal coordination to roadway reconfiguration.
Vehicle and Fuel Technology Projects	
Light-duty Electric Vehicles	Financial incentives alongside accelerated development of public charging infrastructure and grid improvements can make EVs more accessible and convenient to the public. The State can expand its own public light-duty electric vehicle fleet by purchasing these vehicles directly.
Electric Transit Buses	Public agencies can make direct purchases of electric transit buses and/or charging infrastructure to promote their adoption.
Electric School Buses	Public agencies can promote electric school buses through direct purchase or reimbursements to school districts for their purchase of these buses and/or charging infrastructure.
Electric Trucks	Public agencies can offer incentives to medium-duty truck fleet operators for the purchase of new battery-electric trucks and/or charging infrastructure. Direct purchases also can be made for public fleets.
Hydrogen Trucks	Public agencies can invest in hydrogen refueling infrastructure and/or offer incentives for the purchase of hydrogen fuel cell trucks.

Table 7.2 Transportation Strategy Cost-Effectiveness[29]

Transportation Strategy	GHG	$PM_{2.5}$	Jobs	Health Benefits
VMT Reduction and Mode Shift Projects				
Shared ride incentives	+	+	+	+
Micromobility	+	+	+	++
Micromobility—E-bike ownership subsidies	++	++	+	++
Land use/smart growth	+++	++	++	++
Bicycle investment	++	++	++	+++
Pedestrian investment	+	+	++	+++
Travel demand and mobility management	++	++	++	++
Transportation System Efficiency Projects				
Bus rapid transit	+	+	++	+
Commuter/intercity rail	+	+	++	+
Bus service—Expansion	+	-	+++	+
Bus service—Efficiency	++	+	+++	++
Electric microtransit	+	+	++	+
Traffic flow improvements	+++	-	+++	-
Vehicle and Fuel Technology Projects				
Light-duty electric vehicles	+++	+++	+	++
Electric transit buses	+++	+++	+	+++
Electric school buses	+++	+++	+	++
Electric trucks	+++	+++	++	++
Hydrogen trucks	+++	+++	++	++

Source: Clean Transportation and Mobility Innovation Report
Legend: + Moderate; ++ Strong; +++ Very Strong; - NA

[29] *State of Rhode Island (Ibid).*

8.0 GHG EMISSIONS AND REDUCTIONS ASSOCIATED WITH THE STIP

Key Takeaways:

- *RIDOT's Long-Range Transportation Plan sets the policy framework for considering environmental impact, including GHG emissions, as a criterion for STIP development and project selection.*
- *RIDOT evaluates prospective projects' impact on GHG emissions as a determinant of their selection for implementation.*
- *Although many projects have the potential to reduce emissions, only three projects of regional significance featured a project-level analysis of emissions impacts, all of which reduced emissions through congestion mitigation.*

8.1 Overview of the STIP

In accordance with Federal law, each state must develop a Statewide Transportation Improvement Program that identifies at least four years of funded projects. Transportation projects must be included within a state's STIP to secure eligibility for Federal funding. Rhode Island's STIP includes a wide range of current and prospective projects that vary in scope.

8.2 How GHG Emissions are Considered in STIP Development

Transportation projects can influence carbon emissions through a variety of channels—including mode shifts, traffic flow improvements, induced demand effects, clean technology transitions, transit vehicle operations, and construction and maintenance activities.

Proposed STIP projects are evaluated based on various criteria before being included in the STIP by the MPO. The TAC and RI-EC4 evaluate many projects that are candidates for inclusion, with GHG emissions and other environmental factors being considerations. Consistent with the LRTP, one of the key goals of the State's STIP is to "promote environmental sustainability," with associated objectives to reduce vehicle miles traveled, reduce transportation greenhouse gas emissions, and create a network of open space, trails, and paths.[30]

[30] Section_1_STIPFinal MTP 5-23-23_0.pdf (ri.gov).

8.3 Emissions Reductions Associated with STIP Projects

Quantifying emissions reductions associated with every project programmed in the STIP was beyond the scope of this effort and is subject to a great deal of uncertainty given the limited data available for most projects at the programming stage. However, three projects in the RIDOT STIP, which have secured funding for current or imminent implementation and constitute projects of regional significance for the State, underwent project-specific studies and emissions analyses. These projects are 1) Opening of Cranston Canyon, 2) Route 146 Reconstruction, and 3) Completion of the I-95 Missing Move and Quonset Connector Ramps. These projects are expected to reduce emissions by increasing roadway travel efficiency through traffic flow improvements. Collectively, these three projects are projected to reduce emissions by 10,530 tons CO_2e per year upon their completion. These projects are described below.

8.3.1 Opening of Cranston Canyon[31]

Primary Actions: Rebuild six structures in Bridge Group 51B; create and reorient lanes at I-295 North.

Project Type(s): Traffic operation and flow improvements; roadway state of good repair.

Total Projected Cost: $85 million.

Emissions Reduction: Expected to reduce annual emissions by approximately 4,095 tons CO_2e/year upon completion.

8.3.2 Route 146 Reconstruction[32]

Primary Actions: Bridge replacements; roadway repaving; traffic signal removal.

Project Type(s): Traffic operation and flow improvements.

Total Projected Cost: $196 million.

Emissions Reduction: Expected to reduce annual emissions by approximately 5,922 tons CO_2e/year upon completion.

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31 *Rhode Island Rhode Island Department of Transportation. (2023). Opening the Cranston Canyon: Safety and Congestion Improvements to Route 37 and I-295. Cranston Canyon—Rhode Island Rhode Island Department of Transportation. http://www.dot.ri.gov/projects/CranstonCanyon/.*

32 *Rhode Island Department of Transportation. (2023). Route 146 Reconstruction Project. Route 146—Rhode Island Rhode Island Department of Transportation. http://www.dot.ri.gov/projects/Route146/index.php#:~:text=Work%20will%20begin%20in%202022%20on%20a%20%24196,Route%2014 6%20between%20Providence%20and%20Worcester%20each%20day.*

8.3.3 Completion of the I-95 Missing Move and Quonset Connector Ramps[33]

Primary Actions: Construct two new highway ramps to complete the interchange of I-95 and Route 4.

Project Type(s): Traffic operation and flow improvements; capacity expansion.

Total Projected Cost: $135 million.

Emissions Reduction: Expected to reduce annual emissions by approximately 513 tons CO_2e/year upon completion.

A high level of effort, relative to emissions reductions and other anticipated benefits, would be needed to estimate emissions associated with each of the many smaller-scale projects also included in the STIP. These three projects are therefore taken as representative of the order of magnitude of emissions reductions that might be achieved through STIP investments.

8.4 GHG Considerations for Future STIP Development

The STIP is developed in accordance with the State's Long-Range Transportation Plan—Moving Forward RI-2040, with projects required to be pulled directly from the LRTP to be included in the STIP. The LRTP reflects the values of the State as well as national transportation goals. A national goal for all LRTP projects is to "protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and state and municipal-planned growth and economic development patterns." The State of Rhode Island reinforces this commitment by outlining challenges and opportunities being addressed through LRTP projects and in STIP development, including addressing traffic congestion, active transportation, smart growth, and climate impacts and resiliency.[34]

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33 *Rhode Island Department of Transportation. (2023). I-95 'Missing Move' and Quonset Ramps Construction. Missing Move—Rhode Island Rhode Island Department of Transportation. http://www.dot.ri.gov/projects/missingMove/.*

34 *Final-LRTP-December-2020.pdf (ri.gov).*

9.0 CARBON REDUCTION PROGRAM FUNDING

Key Takeaways:

- *RIDOT considered cost-effectiveness and other internal priorities in its identification of CRP priority projects.*
- *About $23.7 million of the estimated $35.7 million available CRP funds have been preliminarily assigned to a set of existing STIP projects that reduce emissions through congestion management and mode shift.*
- *The remaining $12.2 million funds will be allocated toward projects that promote mode shift, efficient freight movement, and electrification of assets.*
- *Federal requirements mandate that 65 percent CRP funds be allocated to urbanized areas according to population, while 35 percent can be used anywhere within the state.*

In its selection of projects that would receive CRP funds, RIDOT considered project eligibility requirements as outlined in the Federal guidelines, in conjunction with other internally prioritized criteria throughout the strategy selection process, including:

- Project alignment with the cost-effectiveness table in the Clean Transportation Mobility Report.
- Project consistency with RIDOT's internal goals and operations to ensure execution within the department's logistical constraints.
- Project alignment with external stakeholder operations and community needs.
- Project scale (reasonably within the scope of available CRP funding).

9.1 STIP Projects Assigned for CRP Funding

Of the $35.7 million prospective Federal funding available to RIDOT through the CRP, around $23.7 million has been preliminarily assigned to existing projects in the STIP. RIDOT's internal priorities and logistical capacities show many readily available STIP projects associated with congestion management. Accordingly, around two-thirds of the initial funding allocation has been directed toward projects that aim to abate carbon emissions by means of congestion reduction. The remaining one-third of RIDOT's initial $23.5 million allocation has been assigned to projects that encourage mode shift among residents, specifically through improvements to bicycle and pedestrian infrastructure. Table 9.1 details the STIP projects currently identified for funding alongside their primary project categories and corresponding funding magnitudes.

Table 9.1 STIP Projects Assigned for CRP Funding

STIP Project	Primary Category	Amount ($M)
Sidewalk Installation	Mode Shift	0.6
Bike Path Preservation	Mode Shift	6.6
Greenway Enhancements	Mode Shift	0.7
Statewide Congested Corridor Upgrades	Congestion	6.3
ITS Additions for Congestion Management	Congestion	2.8
Safety Service Patrol	Congestion	1.6
Traffic Signal Management	Congestion	0.9
Smart Corridors Initiatives	Congestion	0.2
Bridge Overpass	Congestion	4.0
Total Assigned Allocation		**23.7**

9.2 Remaining Funding Allocation

Given the large share of CRP funds preliminarily attached to congestion management STIP projects, RIDOT's allocation proposals for the remaining $12.2 million funds aim to diversify the department's range of carbon reduction strategies. RIDOT has identified various additional projects that would encourage residents' mode shift away from single or low-occupancy private vehicles in favor of alternative, lower-emissions sources. The set of proposed mode shift strategies, if executed, would expand and maintain the State's infrastructural capacity to accommodate bicycle travel and public transportation.

Beyond mode shift and congestion management strategies, RIDOT has proposed allocating a portion of remaining CRP funds toward freight management in Providence Port, and another portion toward electrifying RIDOT's construction and maintenance assets. The particular set of projects for these allocations will be informed by continued engagement with Providence Port's management staff and attention to the continually evolving maintenance vehicle technologies. Finally, RIDOT is proposing to use some funds to support state oversampling of the next National Household Travel Survey. Given that most trips in Rhode Island are taken by personal vehicle, this oversampling will provide critical additional data on transit and non-motorized trips to help plan for and model mode shift strategies that support carbon reduction. Table 9.2 details the list of projects that currently are proposed for CRP funding, alongside their project categories and corresponding funding magnitudes:

Table 9.2 Additional Projects Proposed for CRP Funding

STIP Project	Primary Category	Amount ($M)
Statewide Striping Contracts: Bike Lane Design and Construction	Mode Shift	1.0
Lending Library for Bicycle Infrastructure	Mode Shift	1.3
Bicycle Mobility Plan Implementation	Mode Shift	1.5
Electrification of RIDOT Assets	Alternative Fuel Vehicles	0.5
National Travel Survey	Mode Shift	0.6
Providence Ferry Landing	Mode Shift	1.5
Port: Oversized/Overweight Permitting Software	Freight	1.6
Bridge Group 4R (Transit Operating Support)	Mode Shift	4.1
Total Proposed Allocation	**-**	**12.0**

9.3 Funding Suballocation

Per Federal regulation, 65 percent of the State's CRP apportionment must be obligated based on the population shares within different urbanized area thresholds, with the remaining 35 percent allowed to be expended in any area of the State. As such, Table 9.3 outlines the allowable funding allocations across the State of Rhode Island based on the latest available census data. As CRP funds are disseminated, RIDOT will track and monitor these allocations to ensure they are in compliance with Federal regulation.

Table 9.3 Funding Suballocation

	Urbanized Area (UZA) Population Threshold	Rhode Island UZA(s)	Percent of Population	Total Funding ($)
65%	Greater than 200,000	Providence	90.5%	21,041,818
	50,000 to 200,000	*None*	0%	0
	5,000 to 50,000	Charlestown, Westerly	0.3%	65,019
	Less than 5,000	*Not applicable*	9%	2,155,320
35%	Anywhere in State			12,525,777
	Statewide Total			**35,787,935**

9.4 Expected Carbon Reduction Benefits

The projects outlined in this section are expected to yield carbon reduction benefits consistent with those detailed in the Section 7.0 cost-effectiveness summary. The 2021 Clean Transportation and Mobility Innovation Report ranks congestion management, electrification, and certain mode shift strategies among the more cost-

effective project types in terms of their capacity to reduce GHG emissions. Following a 2021 U.S. Environmental Protection Agency report that examined freight emissions at Rhode Island's Providence Port, the State is especially interested in monitoring and maximizing the carbon reduction benefits for this port.[35] The proposed queuing and routing software installations, if properly executed, would improve air quality and reduce noise in a historically underserved community, in addition to reducing carbon emissions, by reducing truck idling.

Quantification of GHG reduction benefits from individual projects can require information that may not be readily available (such as forecasts of bicycle or pedestrian traffic volumes on a new facility) or may require a level of effort for analysis disproportionate to the scale of the project. With that said, RIDOT is currently working to improve its data and modeling systems, including the statewide travel demand model, to provide better data to support analysis and forecasting of project benefits, including emission reduction benefits.

35 *RI.gov. (2022). Port of Providence Truck Count and Assessment Study. Port Of Providence Truck Count And Assessment Study | Rhode Island Division of Statewide Planning. https://planning.ri.gov/planning-areas/transportation/freight-planning/port-providence-truck-count-and-assessment-study#:~:text=As%20part%20of%20this%20process%2C%20one%20of%20the,into%20and%20out%20of%20the%20Port%20of%20Providence.*

10.0 ADDITIONAL CARBON REDUCTION STRATEGIES

Key Takeaways:

- *The Carbon Reduction Program represents just one step in moving the state on a trajectory to reach net zero emissions by 2050; much more will need to be done.*
- *RIDOT must support and prioritize electrification, mode shift, and other carbon reducing activities.*
- *RIDOT cannot decarbonize the transportation sector on its own. Full implementation of carbon reduction strategies will require additional funding as well as partnerships with other agencies.*

Carbon Reduction Program funding represents an important step in helping decarbonize Rhode Island's transportation sector and support the state's greenhouse gas reduction goals. However, much more will need to be done in order to move the state on a trajectory to reach net zero emissions by 2050. Reaching net zero emissions will require complete decarbonization of transportation fuels, Including electricity generated by other renewable energy and/or other zero-emission fuels such as renewables-based hydrogen. In interim years, reductions in vehicle travel and improvements in travel efficiency can work alongside low- and zero-emission vehicles to reduce emissions and help achieve targets.

Considering the strategies identified in state planning documents identified in Section 6 of this plan, as well as the outcomes of the stakeholder workshop and other involvement conducted in support of this Strategy, RIDOT will work with its partners to undertake the following actions:

6. Continue to support statewide **electrification/zero-emission vehicle transition** by:
    a. Pursuing funding opportunities for **public charging infrastructure** and working with OER to build out this infrastructure on a timeline supporting the state's zero-emission vehicle sales requirements.
    b. Supporting sister agency **fleet transition** efforts, including RIPTA and other state agencies, through formula and grant funding and technical support.
7. Within constraints of available funding, prioritize **mode shift projects** in programming, including:
    a. **Transit service enhancements** consistent with the Transit Master Plan. These may include MBTA as well as RIPTA service enhancement, further piloting and implementation of microtransit where traditional services are less effective, and exploration of mobility-as-a-service and integrated ticketing to make it as easy as possible to travel without a car.
    b. **Pedestrian and bicycle** infrastructure, including Complete Streets as well as shared-use paths.
    c. Electric **micromobility**, **rideshare, and carshare** services, especially targeting underserved populations to improve mobility while also reducing emissions.

8. Undertake research, development, and demonstration needed to reduce **emissions from RIDOT's activities**, including:
    a. Transitioning agency and contractor fleets to low- or zero-emission vehicles, as vehicles with the required performance specifications become available. This will require planning for charging and fueling infrastructure as well as financial and technical support for fleet transition.
    b. Developing and implementing specifications for low-carbon materials.
    c. Developing green infrastructure practices, guidelines, and projects (e.g., carbon-sequestering vegetation, solar in rights-of-way).
9. Update and expand **plans, policies, and analysis methods** to support carbon reduction:
    a. Develop a **'Complete Streets'** State Plan and Design Guidelines to support mode shift on state and municipal roads.
    b. Work to improve **data and modeling systems** to better evaluate the GHG effects of investment plans and projects.
    c. Revisit STIP **project selection criteria** to ensure GHG emissions are considered and given appropriate weight.
    d. Support efforts by other agencies, including DSP and the Office of Housing and Community Development, to implement **travel-efficient land use and transit-oriented development**, through project prioritization and planning activities that consider land use.
10. Work with the legislature and partner agencies to explore potential **alternative funding sources** to supplement existing funding for carbon reduction project and strategy implementation.
    a. Some programs, such as a "cap-and-invest" program that sets a declining cap on carbon emissions, could potentially generate revenue while at the same time providing incentives to reduce emissions. Cap-and-invest programs have already been implemented by west coast states and New York State is in the process of designing a cap-and-invest program. Rhode Island could potentially join with other states' efforts on these programs.
    b. The Rhode Island Transit Master Plan includes a section, "Potential Funding Sources," that identifies funding sources already in use in other states to fund transit, and that could be added or expanded to support implementation of the master plan. Some of these sources could potentially be used for other clean transportation purposes as well.

It is critical to note that most decarbonization strategies require funding to implement. While some opportunities may exist to redirect funding with RIDOT's existing transportation budget, the state's capital program mainly funds activities that are needed simply to keep the existing system in a state of good repair. The federal government has provided additional funding in recent years for decarbonization, through the Infrastructure Investment and Jobs Act of 2021 and the Inflation Reduction Act of 2023, but these sources are not guaranteed to be sustained in the future. RIDOT will need to work with partner agencies and State government to explore additional funding sources if the state's full carbon reduction potential is to be realized and targets met.

APPENDIX A. GREENHOUSE GAS INVENTORY AND FORECASTS

A.1 Methods

On-road Private Mobile Sources

- A baseline forecast of emissions associated with on-road vehicle transportation required the following data inputs: statewide vehicle miles traveled, categorized by four vehicle classes (light-duty passenger, light-duty truck, medium-duty and heavy-duty); fuel technology fractions that constitute each vehicle class (e.g., gasoline, diesel, electric); fuel conversion factors; and fuel emissions factors.
- The total annual fuel consumption of each technology type within each vehicle class was calculated by multiplying the vehicle miles traveled within each class-technology combination by the corresponding combination's appropriately converted fuel economy. Projected fuel consumption for each class-technology category were then multiplied by each category's respective emissions factors. For several emissions factors that provided emissions per mile rather than per unit of fuel, the total CO_2e contribution was calculated by multiplying the factor by the total miles traveled, rather than the fuel consumption.
- The transportation emissions reduction targets displayed in Figure 4.1 (Rhode Island Transportation GHG Reduction Targets) were derived by multiplying the State's 1990 transportation emissions level by the percentage reduction targets established in the 2021 Act on Climate, adjusting the 2030 target downward from 45 percent to 40 percent.

On-road Public Transportation

- The baseline emissions calculations associated with on-road public transportation required the following data inputs: statewide vehicle miles traveled, categorized by three transportation services (Demand Response, Motorbus and Vanpool); fuel economy by vehicle-fuel type, a fuel conversion factor for diesel; fuel emissions factors.
- For each mode, the vehicle miles traveled were multiplied by the vehicle emissions rate, which was calculated using the fuel economy reported through the National Transit Database. For vanpool, all vehicles were assumed to be gasoline powered and for demand response, all vehicles were assumed to be diesel-powered, based on fuel reports to the NTD. For fixed-route bus service, buses were assumed to be converted from diesel to diesel-hybrid, with a small number of electric buses entering service in the near term based on inventory projections provided by correspondence with RIPTA.
- For all modes, no increases in service were assumed in future years.

Rail Transit

- A copy of the November 2022 Rhode Island Community Flows and Forecast Interim Update was obtained from the Rhode Island Department of Statewide Planning. This document includes calculated compound annual growth rates for inbound, outbound, and through bound freight. The Department of Statewide Planning clearly documents the types of freight and origins/destinations of each type, rendering these calculations robust and suitable for extrapolations. The Division of Statewide Planning Interim Freight Plan Update provides lengths of different officially delineated sections of track, in miles. These data inputs allow for rough rail freight ton-mileage to be derived by multiplying ton flows by the total length of rail trackage that freight would move on into, out of, or through Rhode Island.
- For passenger rail, passenger count data was obtained for the MBTA Providence/Stoughton line for January 2023. Using mileage information calculated from track schematics, it was then possible to add the total length of track between the Massachusetts-Rhode Island border and each of the three in-state MBTA stations (Providence, T.F. Green Airport, and Wickford Junction) for which counts were made. Once done, passenger rail-mileage was calculated by multiplying average weekly passengers to each of these stops by the appropriate length of track, summing these values, and multiplying to calculate the full year's worth of passenger-mileage. Amtrak rail passenger-mileage for the entirety of the State of Rhode Island was available for the year 2016, but more recent years were not accessible, and it was not possible to calculate more recent years given freely available data. As such, there was no basis for extrapolations for either MBTA or Amtrak passenger counts, so the assumption was made that rail passenger-mileage will remain roughly at pre-pandemic levels until 2050.

Construction and Maintenance Activities

- A copy of the RIDOT capital program (STIP) was obtained, then cleaned and coded to align with the input values for the FHWA ICE tool. Cleaning and coding involved the following steps:
  - Filtering out projects that already are completed.
  - Filtering out projects that are not relevant to categories in the FHWA ICE tool.
  - Categorizing projects using relevant capital attributes.
- Cleaned and coded data from the STIP was entered into the FHWA ICE tool to obtain annual GHG emissions associated with construction and maintenance activities from 2022 through 2031.
- Emissions projections beyond the year 2031 were calculated using a trailing 10-year average number.

On-Road Private Mobile Sources Scenario Analysis

To forecast emissions associated with the proposed Advanced Clean Cars 2 and Advanced Clean Trucks rules, a new technology share forecast was projected as an alternative to the shares used in the baseline inventory analysis. All other variables and underlying assumptions remained consistent with the baseline

analysis. Because the cars and trucks electrification rules involve different vehicle parameters and data sets, slightly different methodologies were used to obtain new technology share forecasts for light-duty vehicles and medium- and heavy-duty vehicles. Analyses for each of the vehicle class subgroups were performed as follows:

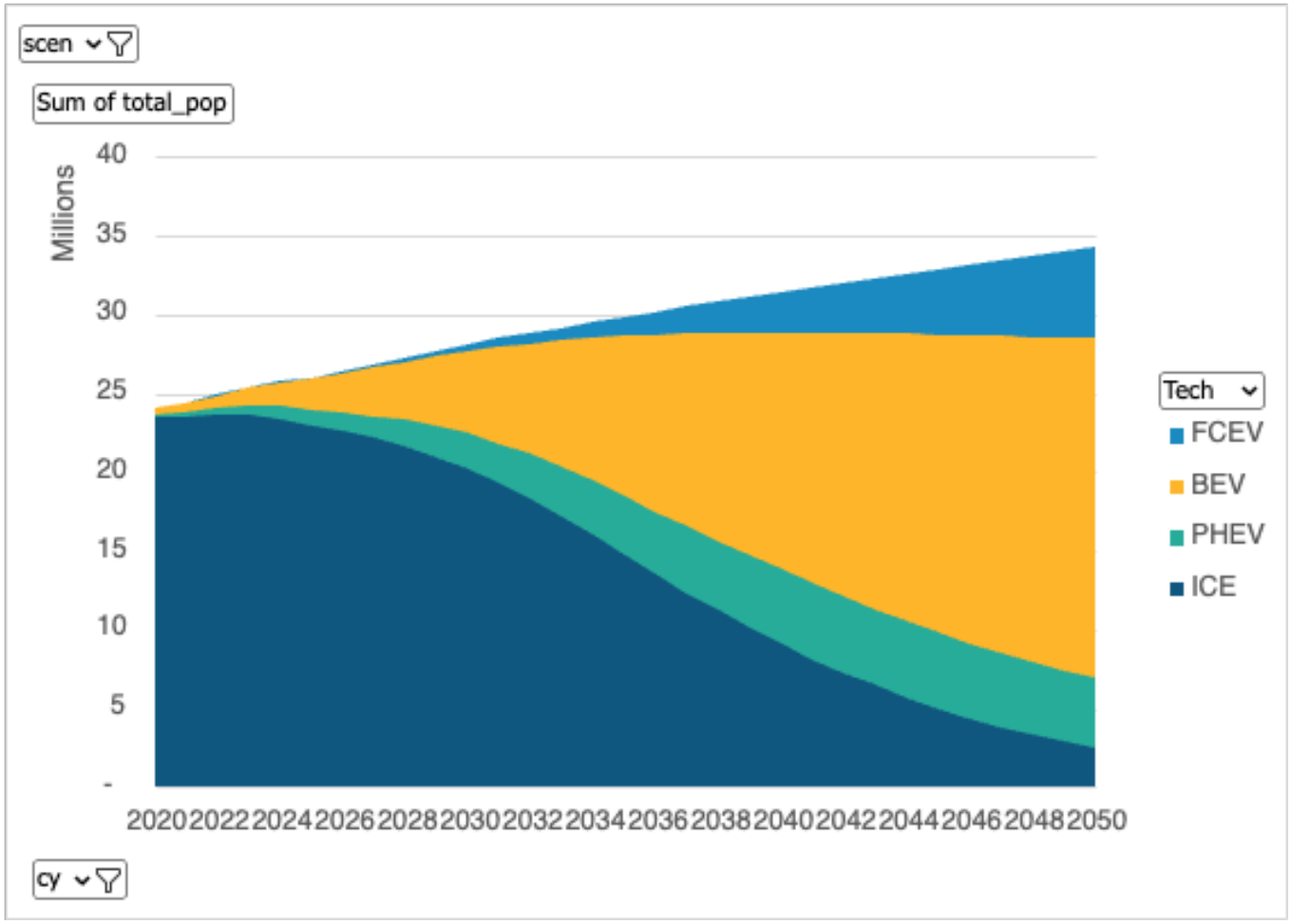
- **Light-duty Passenger Cars and Light-Duty Trucks**

  A spreadsheet was obtained from the California Air Resources Board, which forecasted vehicle technology shares for vehicle classes 1–4 from 2020 through 2050. The CARB data was used to recalibrate RI's technology shares for both light duty cars and light duty trucks.

  The CARB spreadsheet divided vehicle technologies into four broad categories—internal combustion engine (ICE), plug-in hybrid electric vehicle (PHEV), battery-electric vehicle (BEV), and hydrogen fuel cell (HFC). Figure A.1 provides a graphical representation of the spreadsheet data. For the purpose of this analysis, the HFC category—which constituted a small share of overall vehicles—was incorporated into the BEV category. The ICE category was interpreted to include gas, diesel, biofuel, compressed natural gas and gas-electric hybrid technology types. The PHEV share forecast was applied to the plug-in hybrid category.

  For both the PHEV and BEV categories, the CARB technology share forecasts were directly applied to the RI forecast without any quantitative translation. The ICE category total share aligned with the CARB data, but the subcategories within the ICE group reflected the ICE-group shares exhibited in the baseline inventory analysis.

Figure 10.1 California's Technology Share Forecast for Light-Duty Vehicles Following ACC II Implementation



- **Medium-duty and Heavy-duty Vehicles**

  CARB provided a technology share forecast graph with different categories for vehicle classes subject to the Advanced Clean Trucks regulation. The different categories were interpreted in the following manner in their projection upon RI data:

  All model years (MY) except MY2024+—all vehicles of every technology type purchased prior to the program's commencement 2024.

  MY 2024+: Non-ZEV—all non-electric vehicles except plug-in hybrid purchased after 2023.

  MY 2024+: Others—all plug-in hybrid vehicles purchased after 2023.

  MY2024+: ZEV—all "electric" vehicles purchased after 2023.

Discrete vehicle stock values were derived from the graph provided by CARB and applied to the state's private mobile sources vehicle stock. A linear regression was performed on these fractions to extrapolate data for the years 2045 and 2050. For both the electric and plug-in electric vehicle categories, the graph's corresponding vehicle shares were applied directly to the RI technology forecast; zero of these technology types existed in the RI medium and heavy-duty vehicle stock prior to the regulation. For all other vehicle categories (gasoline, compressed natural gas, diesel, and ethanol flex fuel), forecasts were calculated using a combination of baseline scenario technology share data, "All MY Except MY2024+" CA shares, and "MY2024+: Non-ZEV" CA shares. Because the program's sales requirements begin in 2023, the baseline scenario's 2023 technology shares served as the share fractions used in the remaining pre-2024 vehicle values. These pre-2024 shares were combined with post-2024 non-ZEV projections to determine overall non-ZEV and non-plug-in vehicle shares from 2024 through 2050.

A.2 Data Sources

On-road Private Mobile Sources

- **Rhode Island's Travel Demand Model:** growth rates and vehicle class shares for VMT data.[36]
- **FHWA Highway Performance Monitoring System:** baseline VMT in 2021.
- **U.S. Energy Administration's Annual Energy Outlook tables:** vehicle technology share forecast (2021–2050).[37]
- **VISION model AEO data tables:** vehicle fuel economies for each class-technology combination.[38]
- **U.S. Department of Energy:** fuel conversion factors.[39]
- **U.S. Environmental Protection Agency:** fuel emissions factors.[40]
- **Rhode Island Department of Environmental Management 2019 Greenhouse Gas Emissions Inventory:** 1990 transportation emissions.[41]

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36 *RI.gov. (2023). Travel demand model. Travel Demand Model | Rhode Island Division of Statewide Planning. https://planning.ri.gov/planning-areas/transportation/travel-demand-model.*

37 *U.S. Energy Information Administration. (2023). Annual Energy Outlook—U.S. Energy Information Administration (EIA). Annual Energy Outlook 2023—U.S. Energy Information Administration (EIA). https://www.eia.gov/outlooks/aeo/tables_ref.php.*

38 *Argonne National Laboratory (2023). VISION Model. https://www.anl.gov/esia/vision-model.*

39 *U.S. Department of Energy. (2023). Fuel conversion factors to gasoline gallon equivalents. State & Alternative Fuel Provider Fleets: Fuel Conversion Factors to Gasoline Gallon Equivalents. https://epact.energy.gov/fuel-conversion-factors.*

40 *Environmental Protection Agency. (2022, April 1). Emission factors for greenhouse gas inventories. Epa.gov. https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf.*

41 *Rhode Island Department of Environmental Management. (2019). 2019 Rhode Island Greenhouse Gas Emissions Inventory. dem.ri.gov. https://dem.ri.gov/sites/g/files/xkgbur861/files/2022-12/ridem-ghg-inventory-2019.pdf.*

On-road Public Mobile Sources

- **National Transit Database (2019):** VMT, vehicle technology shares and fuel consumption data.
- **U.S. Department of Energy**: Consumption and conversion factors.[42]
- Environmental Protection Agency: Emissions factors.[43]
- Rhode Island Public Transit Authority staff: Fleet composition changes.

Rail Transit

- **Oak Ridge National Laboratory Transportation Energy Data Book (TEDB) Table 7.1 and 10.8:** BTU calculations and BTU/ton-mile data.[44]
- **U.S. Energy Information Administration:** Diesel CO2 emissions levels.[45]
- **Rhode Island Commodity Flows and Forecast Report Addendum, November 7, 2022:** Freight tonnage calculations.[46]
- **State of Rhode Island 2022 Freight and Goods Movement Plan—Interim Update**: Freight mileage and compound annual growth rate calculations.[47]
- **RIDOT Passenger Count Surveys:** Bus passenger trips.
- **Amtrak:** Amtrak passenger rail miles.[48]
- **Bureau of Transportation Statistics:** Amtrak energy intensity data (BTU per passenger-mile).[49]

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42 *U.S. Department of Energy. (2023). Fuel conversion factors to gasoline gallon equivalents. State & Alternative Fuel Provider Fleets: Fuel Conversion Factors to Gasoline Gallon Equivalents. https://epact.energy.gov/fuel-conversion-factors.*

43 *Environmental Protection Agency. (2022, April 1). Emission factors for greenhouse gas inventories. Epa.gov. https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf.*

44 *Davis, S. C., & Boundy, R. G. (2022, June). Home—Transportation Energy Data Book Transportation Energy Data Book. tedb.ornl.gov. https://tedb.ornl.gov/wp-content/uploads/2022/03/TEDB_Ed_40.pdf.*

45 *U.S. Energy Information Administration. (2022, October 5). U.S. Energy Information Administration—EIA—independent statistics and analysis. EIA. https://www.eia.gov/environment/emissions/co2_vol_mass.php.*

46 *State of Rhode Island. (2018, July 20). Addendum #3. Purchasing.ri.gov. https://purchasing.ri.gov/rivip/stateagencybids/7612803.pdf.*

47 *RI.gov. (2022). Freight and Goods Movement Plan Interim Update, 2022. Freight and Goods Movement Plan Interim Update, 2022 | Rhode Island Division of Statewide Planning. https://planning.ri.gov/planning-areas/transportation/freight-planning/2016-freight-and-goods-movement-plan#:~:text=The%20Statewide%20Freight%20%26%20Goods%20Movement,the%20efficient%20movement%20of%20goods.*

48 *Amtrak. (2016). Rhode Island 2016—Amtrak.com. Amtrak.com. https://www.amtrak.com/content/dam/projects/dotcom/english/public/documents/corporate/stateeconomicimpactbrochures/Rhode-Island-fy16.pdf.*

49 *U.S. Department of Transportation. (n.d.). Energy intensity of Amtrak services. Energy Intensity of Amtrak Services | Bureau of Transportation Statistics. https://www.bts.gov/content/energy-intensity-amtrak-services.*

- Passenger growth rates projections are not publicly available, so passenger numbers are assumed to remain constant.

Construction and Maintenance Activities

- **Rhode Island Statewide Transportation Improvement Plan:** STIP project data used as inputs for the Federal Highway Administration's Infrastructure Carbon Estimator tool.
- **Federal Highway Administration Infrastructure Carbon Estimator Tool:** emissions calculation methodology/source.[50]

On-Road Private Mobile Sources Scenario Analysis

- **California Air Resources Board:** vehicle technology share projection for light, medium and heavy-duty vehicles.
- *All sources listed for On-Road Private Mobile Sources.

A.3 Key Assumptions

On-road Private Mobile Sources

- RI fulfills the State's final and intermediate electricity-grid improvements (net-zero by 2030), and these improvements occur linearly.
- Gasoline-electric hybrid vehicles only yield gasoline-induced emissions.
- Plug-in hybrid vehicles only yield electricity-induced emissions.
- Fuel economies of electric and vehicles are weighted averages of this vehicle type's various subsets.
- Light-duty vehicles include vehicle classes 1–2.
- Medium-duty vehicles include vehicles classes 3–6.
- Heavy-duty vehicles included vehicle classes 7–8.
- Vehicle types with very small overall technology shares are omitted from analysis.
- Fuel economies are "on-road" rather than "new vehicle."

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50 *Minnesota Department of Transportation. (2023). Sustainability and Public Health. Greenhouse Gas Emissions Analysis Tool—Sustainability and Public Health—MnDOT. https://www.dot.state.mn.us/sustainability/ghg-analysis.html#:~:text=The%20FHWA%20Infrastructure%20Carbon%20Estimator,for%20materials%20and%20construction%20activities.*

On-road Public Mobile Sources

- RI on-road public transportation will exhibit no capacity changes from 2022 through 2050; vehicle miles remain constant.
- RI on-road public transportation's motorbus fleet will exhibit vehicle technology changes from 2022 through 2050 that are consistent with RIPTA's diesel-electric hybrid plan and anticipated electric bus additions. Vanpool and demand response vehicles will exhibit zero technological changes.
- 2022 public transportation figures approximate pre-pandemic magnitudes and provide an appropriate baseline estimate to extrapolate through 2050.
- Fuel economy estimates were sourced from RIPTA's reporting to the National Transit Database. For electric buses, fuel economy estimates were sourced from the National Renewable Energy Laboratory (NREL) Electrification Futures Study.

Rail Transit

- Rail passenger-mileage will remain at pre-2020 levels through 2050.
- The States of Rhode Island and Massachusetts will succeed in achieving their net-zero emissions goals, including both electricity and rail transportation, and these declines are roughly linear.
- Compound annual growth rates in freight tonnage calculated by the Rhode Island Department of Statewide Planning are borne out in practice.
- Estimates of total trackage mileage traversed by inbound, outbound, and throughbound freight are accurate and sufficient to estimate total rail freight-mileage for each type of freight transit.
- No additional passenger or freight lines will be constructed in the State in the next 27 years.
- The calculated annual growth rate for throughbound freight en route to Connecticut is -0.9 percent.
- The calculated annual growth rate for throughbound freight en route to Massachusetts is 2.4 percent.
- The calculated annual growth rate for outbound freight is 1.8 percent.
- The calculated annual growth rate for inbound freight is 1.8 percent.

Construction and Maintenance Activities

- According to the Census Bureau, an urbanized area is a continuously built-up area with a population of 50,000 or more. Also from the Census Bureau, there is no county in Rhode Island that has a population less than 50,000. It is therefore assumed that all areas in Rhode Island are urbanized.
- The lifetime of all constructions are 30 years.

- All sidewalks are off-street.
- Signages are included in all road constructions.
- 0 percent of roadways are constructed on rocky and mountain terrain.
- Construction of Specialty Buildings is not included in the calculations.
- Projects that are in a “proposed” condition are not counted.
- Statewide improvement programs with no specific locations are not included in the calculation.
- Intersections, crosswalks, and roundabouts are not included in the calculation.
- All future projections are calculated by using a trailing 10-year average number.

On-Road Private Mobile Sources Scenario Analysis

- Rhode Island’s private on-road mobile vehicle stock would exhibit approximately the same shifts in vehicle technology composition in response to the Advanced Clean Cars and Trucks regulations as those projected for California.
- When translating data from CARB’s technology projection spreadsheets to RI’s vehicle stock, technology categories are interpreted or combined in the manner previously outlined in the methodology section.

A.4 Key Uncertainties

On-road Private Mobile Sources

Several of the aforementioned data sources offered data forecasts as inputs for various components of this section’s analysis. Uncertainty in this section’s emissions forecasts therefore compound with each of the separate data forecasts that were used as inputs. Changes in Federal policy, technological capabilities, or driving culture and behaviors may alter projections of vehicle technology shares, fuel economies and travel demand, respectively. Changes in any of these external factors could influence the emissions forecast in positive or negative directions.

On-road Public Mobile Sources

As discussed in the previous sections, the public transportation baseline inventory projects vehicle miles traveled from the year 2022 upon each year through 2050. This assumption carries several uncertainties, including the assumption that 2022 miles traveled data appropriately reflect the magnitude and trajectory of pre-pandemic levels. This uncertainty is diminished by the similarity between VMT data for 2022 and the few years preceding 2020. Still, it is uncertain how future changes in policy, state projects, technology, or demand for public transportation may cause vehicle miles traveled and fleet technology composition to deviate from the 2022 baseline estimate.

Rail Transit

Amtrak does not appear to have Rhode Island-specific rail passenger-mileage for years after 2016, and publicly reported data do not make it possible to create rail passenger-mileage for more recent years. Given that the Covid-19 pandemic seriously impacted rail travel, it is likely that overall rail passenger mileage for the baseline is lower than reported. However, this cannot be verified. Emissions from rail passenger travel also may decarbonize faster, or more slowly, than expected due to technology uptake. Additionally, freight flow projections, and thus rail freight ton-mileage, may vary depending on larger economic shifts, potential industrial development, deployment of low- or zero-carbon freight railroad equipment, or other unidentified trends.

Construction and Maintenance Activities

Although the Rhode Island STIP lists the major construction and maintenance activities for the next 10 years, the STIP mostly includes standardized activities such as road and sidewalk rehabilitation. There are many unstandardized activities left unaccounted for by the ICE tool, such as the construction of EV charging infrastructure. Additionally, changes in the public's use of RI's transportation infrastructure could necessitate additional projects, such as rehabilitation work.

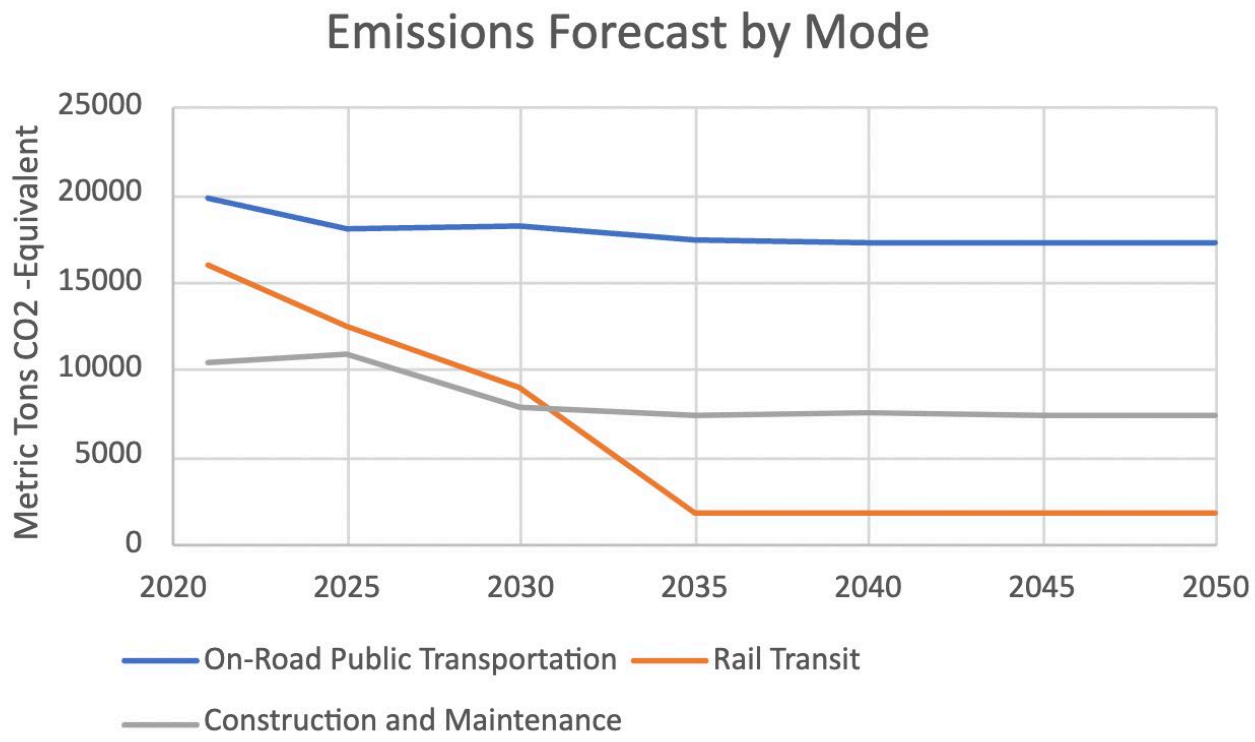
On-Road Private Mobile Sources Scenario Analysis

The scenario analysis makes key assumptions that are susceptible to error and uncertainty. It is unlikely that changes in Rhode Island's private vehicle stock will precisely correspond to the projected changes in California's vehicle stock, even under the same policy conditions. This uncertain interstate translation is compounded by uncertainty that California's future changes in vehicle stock are consistent with the changes anticipated by CARB.

A.5 Additional Tables and Figures

Aggregate Emissions

Figure 10.2 Emissions Forecast by Mode



On-Road Private Mobile Sources

Table 10.1 On-Road Private Mobile Sources Baseline Inventory Forecast

Units: MT CO_2e	2021	2025	2030	2035	2040	2045	2050
Light-Duty Cars	900,853	802,974	694,076	594,930	531,433	502,399	485,813
Light-Duty Trucks	1,082,343	1,058,526	1,046,436	1,025,026	1,006,850	999,040	993,709
Medium-Duty Vehicles	486,662	456,908	424,061	420,242	422,382	426,114	427,285
Heavy-Duty Vehicles	661,903	611,171	552,230	540,048	541,697	544,901	548,774
Total	3,131,761	2,929,579	2,716,803	2,580,246	2,502,362	2,472,454	2,455,581

Figure 10.3 On-Road Mobile Baseline Inventory Total Emissions Graph

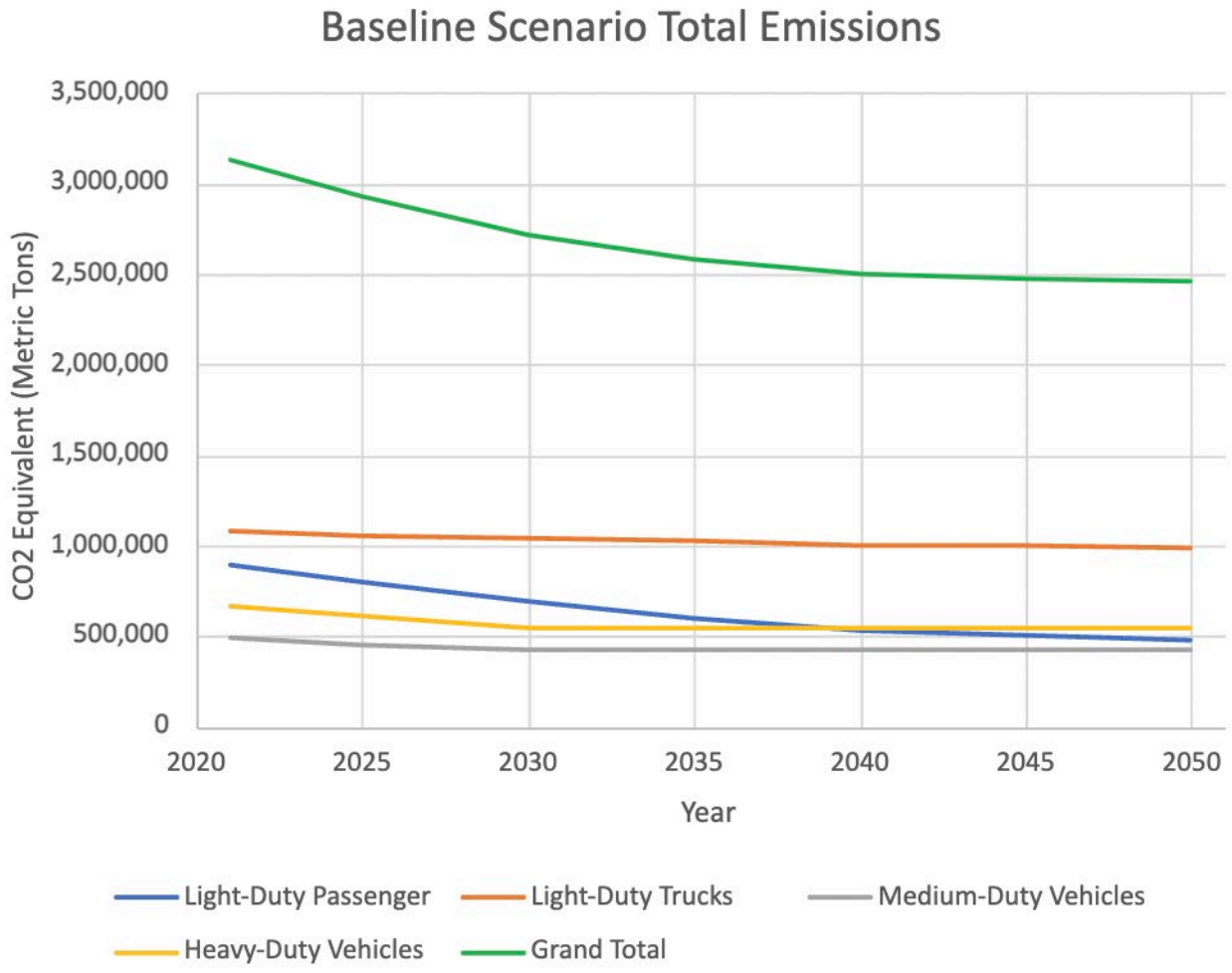
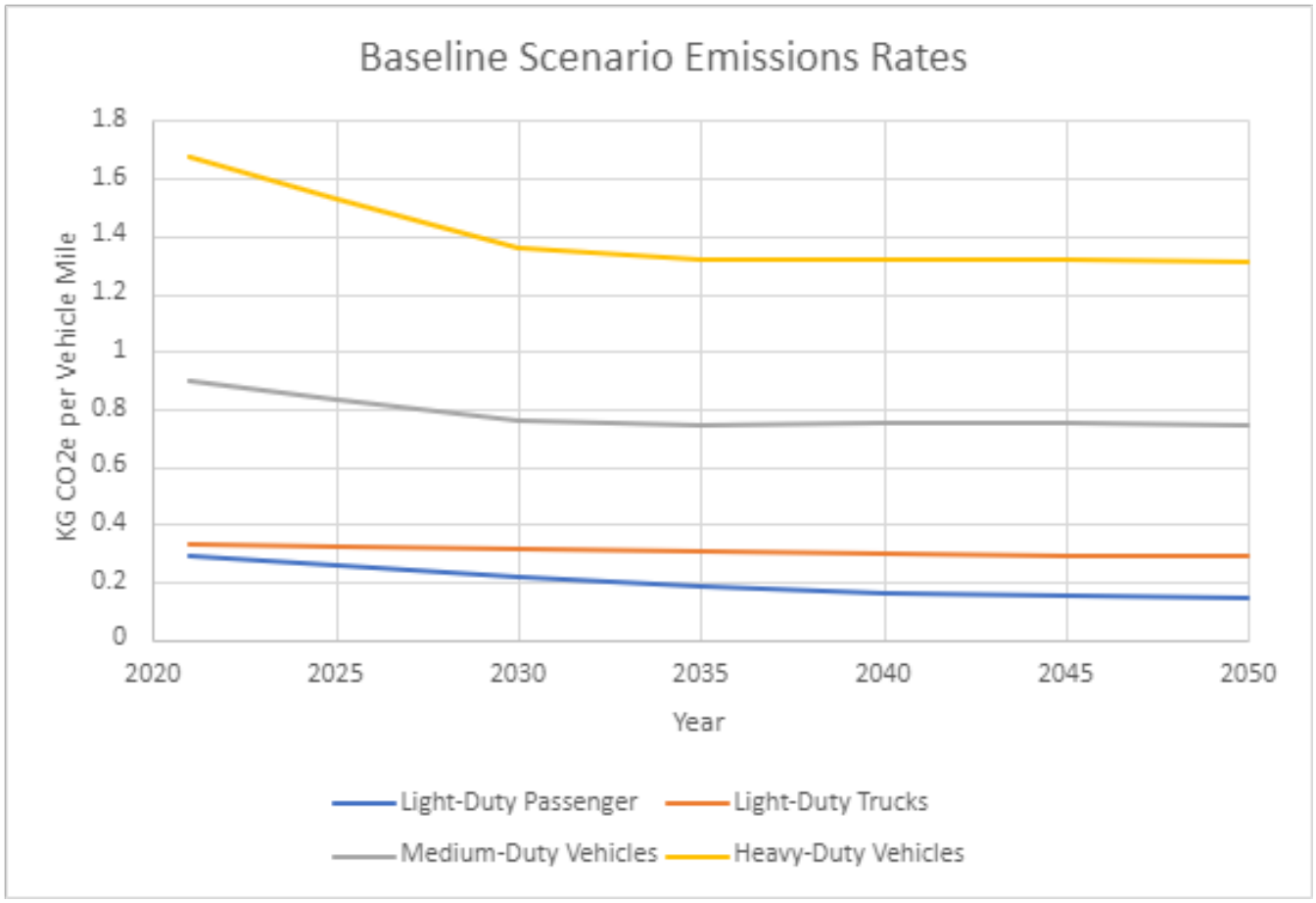


Table 10.2 On-Road Private Mobile Sources Baseline Inventory Emissions Rates

Units: kg $C0_2e$/mile	2021	2025	2030	2035	2040	2045	2050
Light-Duty Cars	0.289	0.254	0.217	0.184	0.164	0.154	0.148
Light-Duty Trucks	0.331	0.320	0.312	0.303	0.296	0.292	0.288
Medium-Duty Vehicles	0.895	0.829	0.760	0.746	0.747	0.748	0.743
Heavy-Duty Vehicles	1.672	1.525	1.360	1.319	1.318	1.314	1.131

Figure 10.4 On-Road Private Mobile Sources Baseline Inventory Emissions Rate Graph



On-road Public Mobile Sources

Table 10.3 On-Road Public Transportation Baseline Inventory Forecast

Units: MT CO_2e	2021	2022	2025	2030	2035	2040	2045	2050
Demand Response	2,195	2,584	2,584	2,584	2,584	2,584	2,584	2,584
Motorbus	17,117	17,489	15,013	15,114	14,336	14,207	14,207	14,207
Vanpool	532	509	509	509	509	509	509	509
Total	**19,845**	**20,582**	**18,106**	**18,207**	**17,429**	**17,301**	**17,301**	**17,301**

Rail Transit

Table 10.4 Passenger and Freight Rail Baseline Inventory Forecast

Units: MT CO_2e	2021	2025	2030	2035	2040	2045	2050
Passenger Rail	14,903	11,281	7,627	479	319	138	0
Freight Rail	1,089	1,160	1,257	1,363	1,479	1,606	1,746
Total	**15,992**	**12,441**	**8,884**	**1,842**	**1,798**	**1,744**	**1,746**

Construction and Maintenance Activities

Table 10.5 Construction and Maintenance Baseline Inventory Forecast

Units: MT CO_2e	2022	2025	2030	2035	2040	2045	2050
Road Rehabilitation	9,125	8,496	5,528	5,447	5,484	5,409	5,469
Sidewalk Rehabilitation	392	625	275	502	561	532	544
New Sidewalk/Bike Lane	283	211	207	366	450	417	427
New Roadway	0	624	1,679	627	725	662	661
Bridge Replace/Repair	578	949	221	386	302	325	321
Total	**10,378**	**10,905**	**7,909**	**7,329**	**7,522**	**7,344**	**7,421**

On-Road Private Mobile Sources Scenario Analysis

Table 10.6 CO_2e Total Emissions Forecast Under ZEV Scenario

Units: MT CO_2e	2021	2025	2030	2035	2040	2045	2050
Light-Duty Cars	883,641	750,706	566,399	351,479	198,387	103,639	49,618
Light-Duty Trucks	1,054,717	967,528	811,546	540,681	319,397	169,310	81,423
Medium-Duty Vehicles	486,666	456,499	385,338	312,399	254,272	202,490	170,108
Heavy-Duty Vehicles	661,906	605,016	495,954	396,200	321,161	254,968	214,907
Grand Total	3,086,929	2,779,748	2,259,237	1,600,759	1,093,217	730,407	516,054
Baseline Difference	-44,832	-149,830	-457,566	-979,487	-1,409,145	-1,742,047	-1,939,527

Table 10.7 CO_2e Emissions Rates Forecast Under ZEV Scenario

Units: KG CO_2e	2021	2025	2030	2035	2040	2045	2050
Light-Duty Cars	0.283	0.238	0.177	0.109	0.061	0.032	0.015
Light-Duty Trucks	0.323	0.292	0.242	0.160	0.094	0.049	0.024
Medium-Duty Vehicles	0.895	0.829	0.690	0.555	0.450	0.355	0.296
Heavy-Duty Vehicles	1.672	1.509	1.221	0.967	0.781	0.615	0.514

Figure 10.5 ZEV Scenario Emissions Rate per Vehicle-Mile

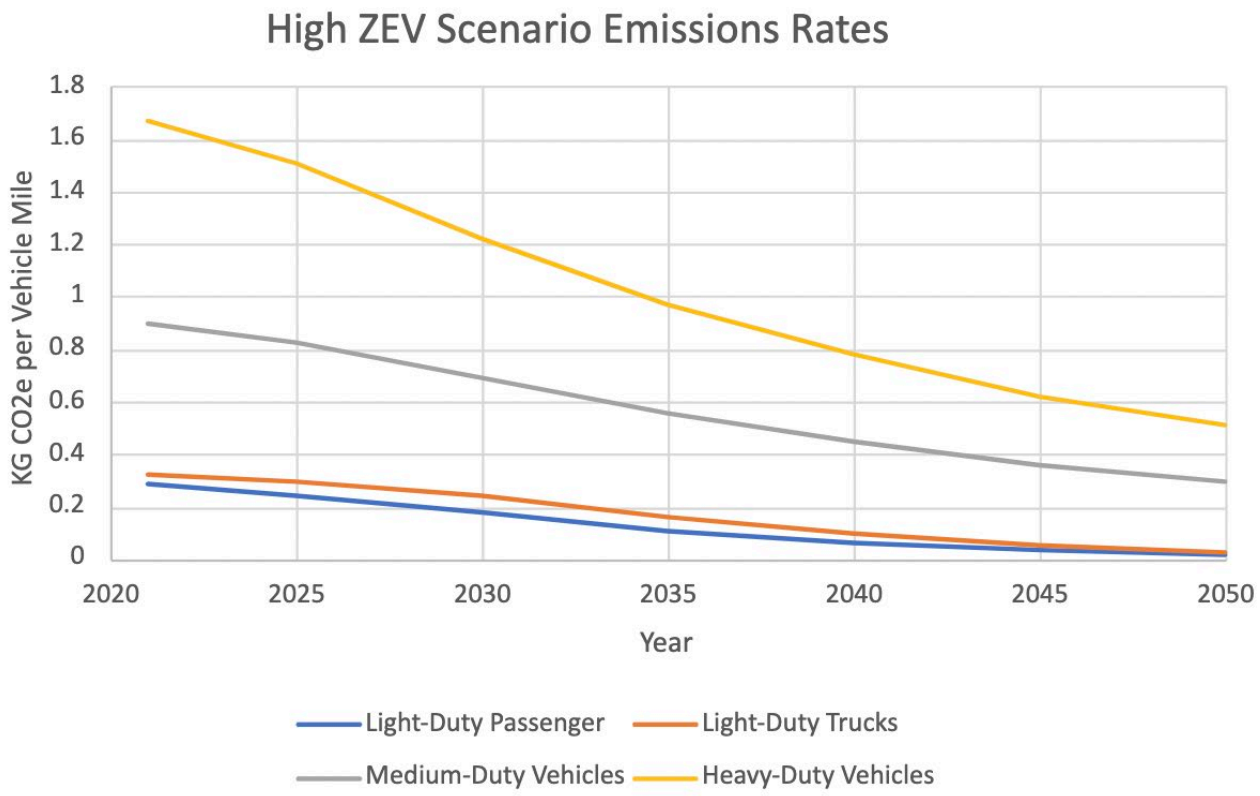


Table 10.8 Advanced Clean Cars II Sales Requirements for LDVs[51]

Model Year	Percentage Requirement
2026	35%
2027	43%
2028	51%
2029	59%
2030	68%
2031	76%
2032	82%
2033	88%
2034	94%
2035 and subsequent	100%

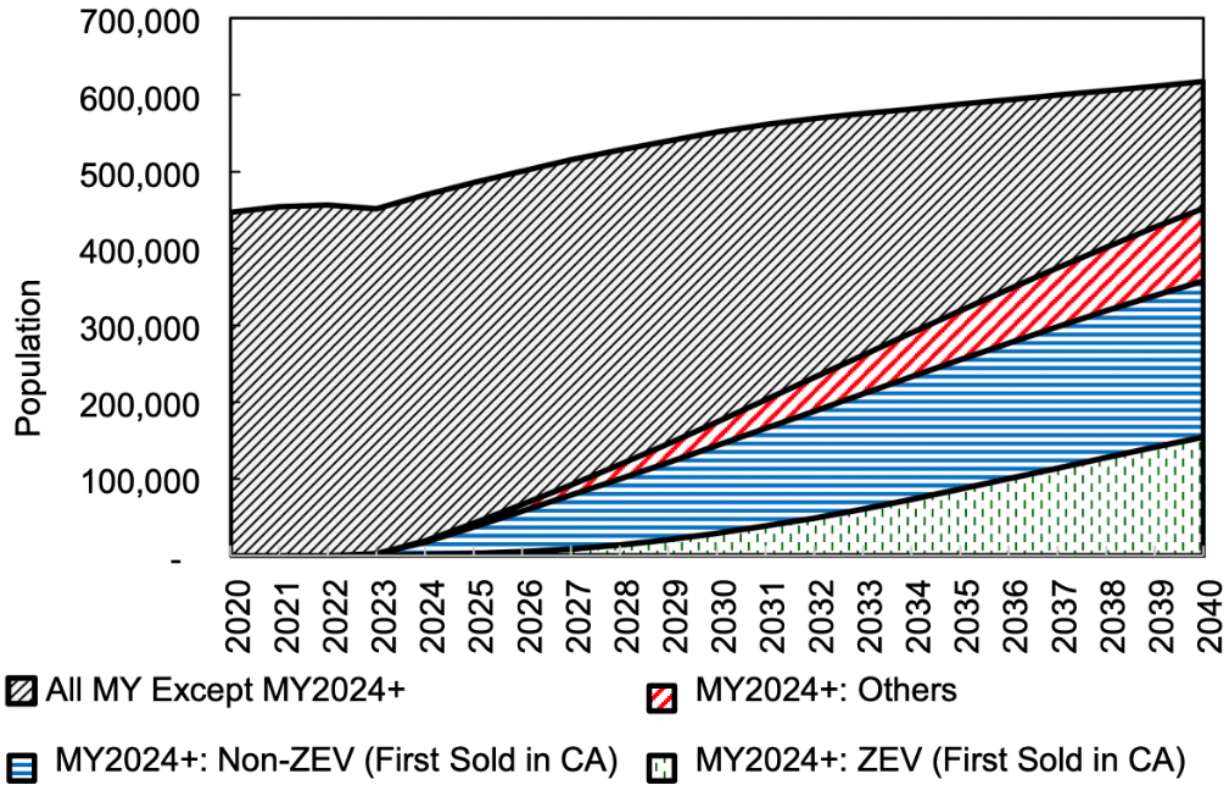
Table 10.9 Advanced Clean Trucks ZEV Sales Percentage Schedule[52]

Model Year	Class 2b–3 Group	Class 4–8 Group	Class 7–8 Tractors
2024	5%	9%	5%
2025	7%	11%	7%
2026	10%	13%	10%
2027	15%	20%	15%
2028	20%	30%	20%
2029	25%	50%	25%
2030	30%	55%	35%
2031	35%	55%	40%
2032	40%	60%	40%
2033	45%	65%	40%
2034	50%	70%	40%
2035	55%	75%	40%

[51] *State of California. (2023). California Air Resources Board. Advanced Clean Cars Program | California Air Resources Board. Retrieved May 1, 2023, from https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program*

[52] *State of California. (2023). California Air Resources Board. Advanced Clean Trucks | California Air Resources Board. Retrieved May 1, 2023, from https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks.*

Figure 10.6 California's Technology Share Forecast for Medium- and Heavy-Duty Vehicles Following ACC II Implementation[53]



53 *California Air Resources Board. (2021). Attachment D Emissions Inventory Methods and Results for the Proposed Advanced Clean Trucks Regulation Proposed Modifications. arb.ca.gov.* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/30dayattd.pdf.