MAINE

CLEAN TRANSPORTATION ROADMAP FOR MEDIUM- AND HEAVY-DUTY VEHICLES

EXECUTIVE SUMMARY

GOVERNOR'S OFFICE OF
Policy Innovation and the Future

MAINE GOVERNOR'S
Energy Office

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MaineDOT

EXECUTIVE SUMMARY

This Clean Transportation Roadmap for Medium- and Heavy-Duty Vehicles (MHDV) ("roadmap") charts a path for Maine to decarbonize the trucks and buses moving people and goods within and through the state. Trucks and buses account for 27 percent of the greenhouse gas (GHG) emissions from the state's transportation system, and 10 percent of the state's total emissions.[1] These shares are projected to increase in the future as light-duty vehicles become more efficient and electrify. Decarbonizing Maine's trucks and buses will be critical to achieving the state's ambitious emissions reductions goals laid out in law—a 45 percent reduction by 2030 and 80 percent by 2050.

This roadmap supports Maine's climate action plan, *Maine Won't Wait*, adopted in 2020 and updated in 2024, which calls for accelerating Maine's transition to electric vehicles (EV).[2] The roadmap also complements the 2021 *Maine Clean Transportation Roadmap* that examines future pathways and infrastructure needs to decarbonize the state's light-duty transportation sector.[3] This *Clean Transportation Roadmap for Medium- and Heavy-Duty Vehicles* takes a deeper look at the challenges and opportunities to decarbonize Maine's medium- and heavy-duty vehicles, and establishes policy recommendations and an action plan for decarbonization.

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Maine's Medium- and Heavy-Duty Vehicles

MHDVs include trucks used to move goods and provide commercial and public services, and transit, school, intercity, and charter buses (Figure ES.1). These vehicles are currently almost exclusively powered by gasoline or diesel internal combustion engines. Decarbonization will require converting Maine's trucks and buses to zero-emission vehicle

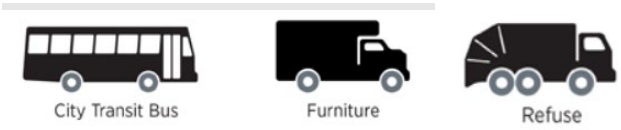
[1] Maine Department of Environmental Protection (2024). 10th Report on Progress on Greenhouse Gas Reduction Goals.

[2] Maine Climate Council (2020). Maine Won't Wait.

[3] Governor's Energy Office, Governor's Office of Policy Innovation and the Future, and Cadmus (2021). Maine Clean Transportation Roadmap.

(ZEV) technologies such as battery electric drivetrains or hydrogen fuel cells.[4] While clean fuels such as biodiesel may also play a role in reducing emissions, this roadmap focuses mainly on ZEV technologies, especially electrification.

FIGURE ES.1 COMMON TYPES OF MHDVS

Weight Class	Typical Vehicles
3–5 (10,001–19,500 lb.)	
6 (19,501–26,000 lb.)	
7 (26,001–33,000 lb.)	
8 (over 33,000 lb.)	

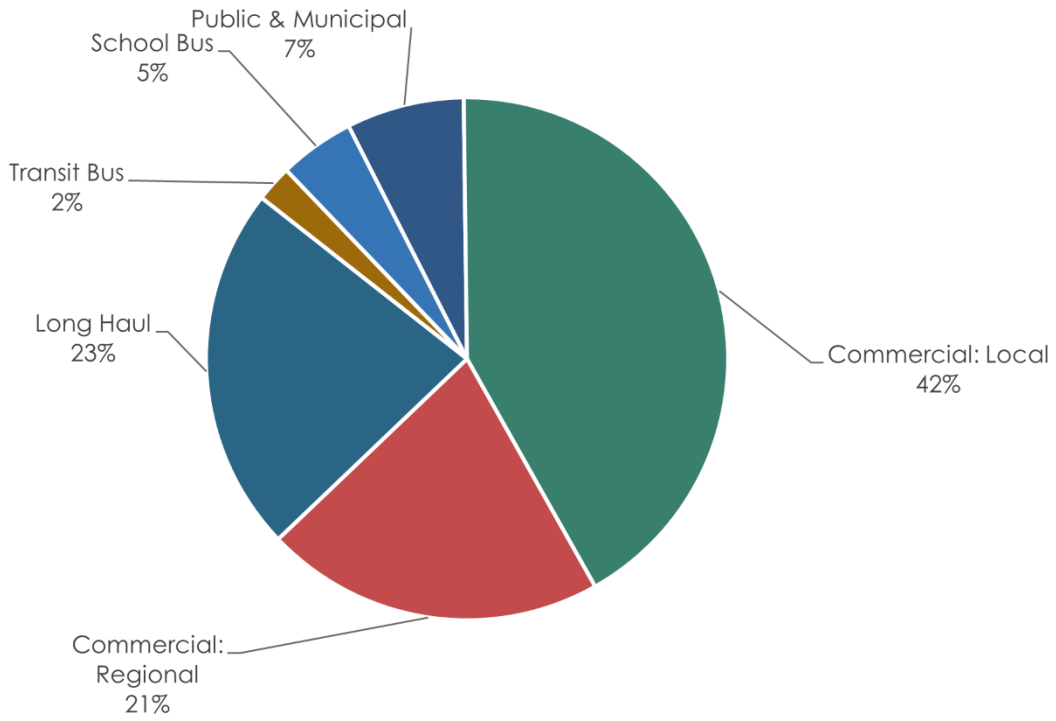
Source: Adapted from Alternative Fuels Data Center, https://afdc.energy.gov/data/10381. Weight class refers to the gross vehicle weight rating (maximum vehicle + load weight).

This roadmap characterizes Maine's trucks and buses based on available data on their weight class, industry, and vocational characteristics—key factors that affect the potential to convert to zero-emissions technology. For example, smaller vehicles driven relatively short distances and returning to a consistent home base (such as delivery trucks) have strong potential to electrify in the near future. Heavy trucks providing long-distance, interstate services will take longer to electrify or may require the use of hydrogen fuel cell technology, due to the large energy capacity required to move heavy vehicles over long distances.

[4] This roadmap uses ZEV to refer to both battery and hydrogen fuel cell vehicles, while it uses EV to refer to distinguish just battery EVs.

About 41,000 commercial medium-duty trucks (MDT) and 23,000 heavy-duty trucks (HDT) were registered in Maine as of 2023, along with 4,100 buses.[5] Based on registration data, MDTs in Maine drive an average of 53 miles per day, and HDTs drive an average of 96 miles per day. While these are distances that should easily fall within the range of most future medium- and heavy-duty ZEVs, including electric trucks, daily averages can obscure substantial differences across fleets and vehicles. Figure ES.2 illustrates how different truck and bus market segments contribute to Maine's MHDV GHG emissions of 1.33 million metric tons in 2020. About one-third of these emissions are from medium-duty vehicles with the remaining two-thirds from heavy-duty vehicles.

FIGURE ES.2 CONTRIBUTION OF MARKET SEGMENTS TO MAINE'S MHDV GHG EMISSIONS



Source: Analysis by ERG and Cambridge Systematics.

[5] MDTs are defined for this study as having a gross vehicle weight rating (GVWR, or vehicle weight plus load rating) of 10,001–26,000 lb., including Federal vehicle weight classes 3 through 6. HDTs are defined as having a GWVR of over 26,000 lb., including Federal vehicle weight classes 7 and 8. Vehicles with a weight rating less than 10,000 lb. are characterized as light-duty vehicles (passenger cars, pickups, vans, and sport utility vehicles) or light-medium trucks and are not considered in this roadmap.

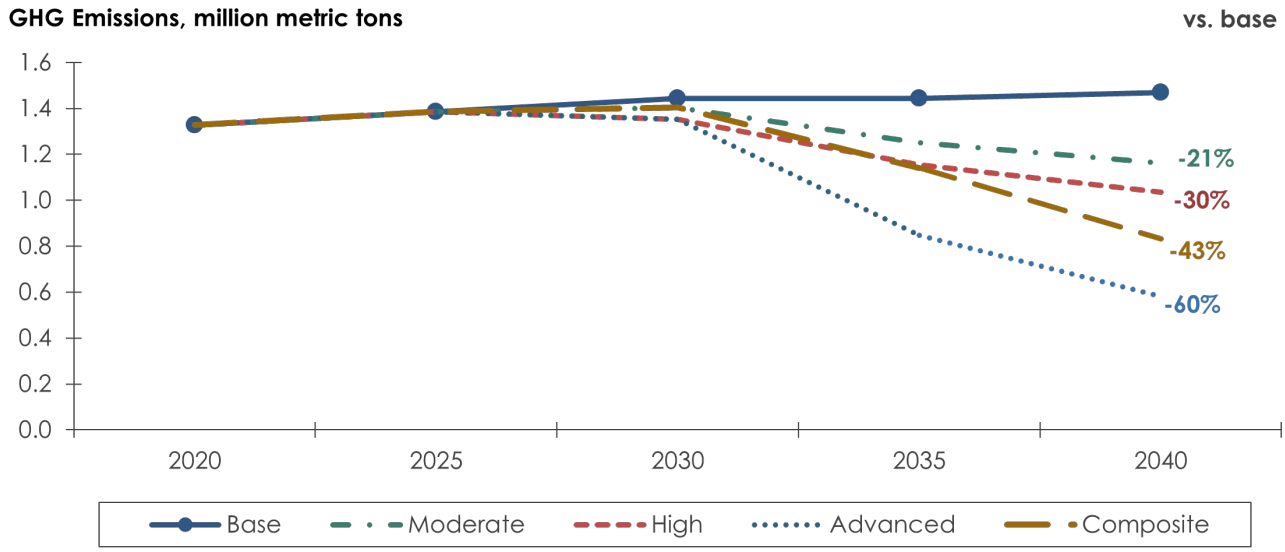
Current and Future Zero-Emission Vehicle Options

While light-duty EVs are becoming common in many parts of the country, MHD ZEV technology is just starting to come to market in many states. Nevertheless, manufacturers are already producing ZEVs across all weight classes. Over 30,000 zero-emission trucks (ZET) were already deployed nationwide by the end of 2023, with over 250 models currently offered by over 40 manufacturers. In Maine and elsewhere throughout the country, electric transit and school buses are already in use in diverse bus fleets. The range of MHD ZEVs on a single charge continues to improve, with the median range of 2023 models being 170 miles and a number of models offering ranges of 200 to 300 miles under favorable conditions. Factors such as cold or hot weather, auxiliary power uses such as refrigeration and power take-offs, and hilly terrain may reduce these ranges. As battery technology continues to improve, ZET and buses should be able to take on longer-range and higher-load capabilities. Manufacturers are also beginning to offer hydrogen fuel cell trucks with ranges of 250 to 500 miles and a 20-minute refueling time, although further coordination and investment by the public and private sector will be needed to bring the infrastructure to fuel these trucks to the northeast.

Benefits of Zero-Emission Vehicles

Three alternative MHD ZEV adoption scenarios were modeled in this roadmap, and compared to a "base" case in which most MHDVs (over 90 percent) remain fueled by gasoline or diesel. These "moderate," "high," and "advanced" scenarios represent increasing levels of policy implementation and market action to achieve higher rates of ZEV market penetration through 2040. The 2040 ZEV share, representing the percentage of all MHDVs registered in Maine which are zero-emissions, increases from 18 percent under the "moderate" scenario to as much as 47 percent under the "advanced" scenario. A "composite" scenario was also developed to represent the potentially feasible market penetration levels in Maine specific to different market segments. These scenarios would reduce MHD GHG emissions by 300,000 to 900,000 metric tons per year, or about 20 to 60 percent, compared to projected emissions with no further action by the state (Figure ES.3).

FIGURE ES.3 MHDV GHG EMISSIONS BY SCENARIO



Source: Analysis by ERG and Cambridge Systematics.

Costs and Savings for Zero-Emission Vehicles

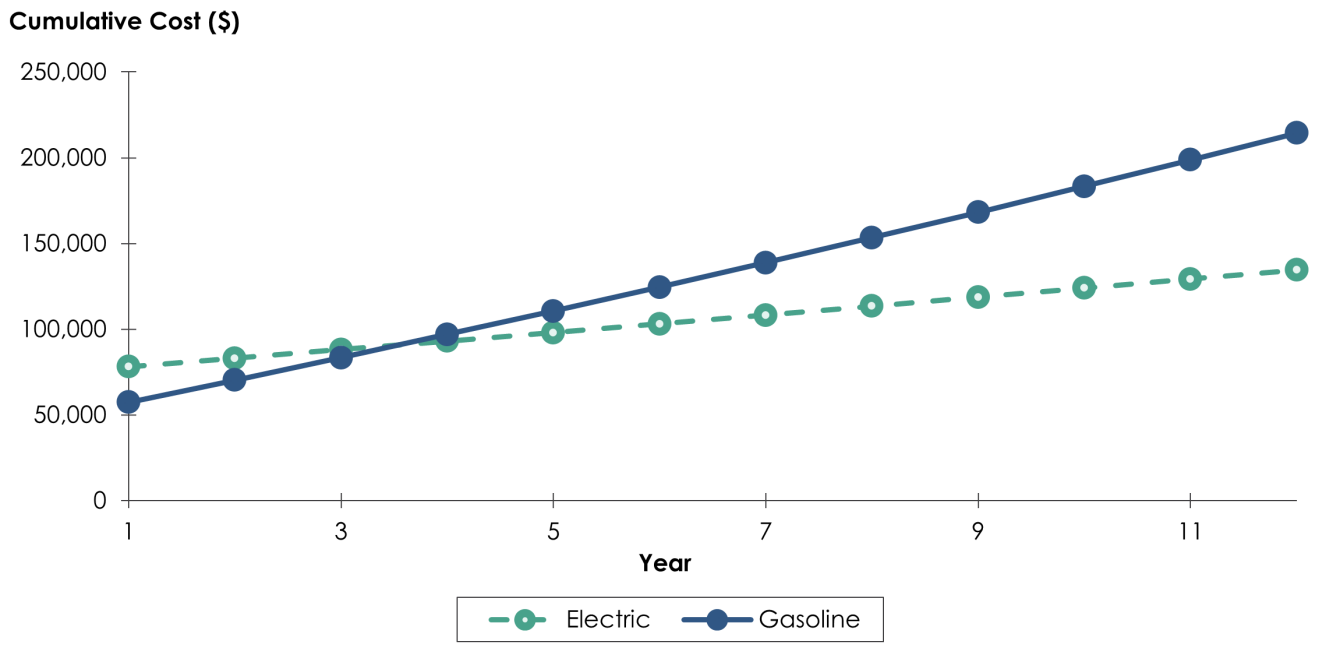
Up-front costs of MHD ZEVs remain higher than gasoline or diesel alternatives, often requiring incentives to "bridge the gap" and contribute to lower overall costs across the lifetime of the vehicle. Investments in charging or refueling infrastructure are also needed to support ZEVs, including charging stations as well as, in many cases, electrical infrastructure upgrades to support higher power demand at the site of charging. Over time, however, MHD ZEVs deliver fuel and maintenance cost savings, which increase with higher vehicle utilization. Federal and state incentives, such as the Federal Clean Commercial Vehicle Tax Credit and Efficiency Maine Trust's (EMT) state vehicle and charging incentives, are currently available to help offset costs; other financial arrangements such as leasing or "trucking as a service" can annualize capital costs, minimizing the need for cash-on-hand at the time of vehicle purchase.

Declining battery costs are expected to dramatically reduce or eliminate the up-front price differential, with some market segments achieving purchase price cost parity between electric and conventional vehicles as soon as 2030.[6] As illustrated in Figure ES.4, smaller and

[6] Bloomberg New Energy Finance with the Smart Freight Centre (2024). Zero-Emission Commercial Vehicles The Time Is Now: A Factbook for Investors.

shorter-range vehicles, such as Class 3 trucks and vans, can already provide rapid payback, with savings exceeding costs within two to three years of purchase in some cases.

FIGURE ES.4 ILLUSTRATIVE CUMULATIVE COST OVER TIME FOR GASOLINE VERSUS BATTERY TRANSIT VAN



Source: CALSTART, based on Maine case study of a Class 3 gasoline transit van driven 25,000 miles a year. Includes costs of charging infrastructure, but does not include any available incentives, which could further reduce the cost of the EV.

While the majority of MHD ZEV charging is expected to be done at private depot and distribution locations, public charging infrastructure will also be necessary to serve some percentage of MHD ZEV charging and refueling. Statewide, across both public and private depot charging, the additional charging demand in 2040 from MHD ZEVs could range from 0.6 to 1.3 million megawatt-hours (mWh), or 5 to 11 percent of 2022 statewide electricity demand, depending upon the ZEV scenario. About 15 to 20 percent of this demand is expected to be met at publicly accessible fast charging sites, requiring an estimated $4 to $16 million per year through 2040 for charging infrastructure and grid upgrades at these sites, depending upon the ZEV scenario and considering a range of potential costs. Additional revenue generated by host sites from vehicle charging—estimated to average between $7 and $17 million annually through 2040—can partially offset these capital costs as well as covering the cost of electricity provided by the charging station and ongoing maintenance costs.

"Smart charging" at depots that minimizes charging during periods of peak demand will help to minimize the need for investments in new generation and grid capacity to meet this increased electricity demand. Challenges related to grid capacity and charging infrastructure are currently being addressed through planning efforts by the Governor's Energy Office (GEO), Maine Department of Transportation (DOT), Maine Public Utilities Commission (PUC), EMT, and the state's two investor-owned utilities, and will require continued attention in the future.

Opportunities and Challenges for Zero-Emission Vehicle Adoption

To better understand the opportunities and challenges for transitioning Maine's trucks and buses to ZEVs, outreach was conducted to stakeholders including fleet owners and operators, vehicle manufacturers, truck and bus dealers, and providers of charging and fueling infrastructure. Some of the key opportunities include:

- **Sustainability goals—**Some companies and municipalities have adopted their own net-zero or low-emissions goals and transitioning to ZEVs will help them achieve emission reductions.
- **Potential long-term cost savings—**Many fleet operators describe themselves as "fuel-agnostic" and are open to ZEV adoption if it makes financial sense.
- **Funding—**Several Federal and state funding sources already exist to support purchases of ZEVs and charging infrastructure.
- **Low-hanging fruit—**Vehicles with relatively short and well-defined routes, which return "home" to a depot at regular intervals, and which have commercially available ZEV alternatives are the best market-segment candidates for early electrification. Examples include buses, short-range delivery and service trucks operating in more densely populated areas, and yard and drayage trucks. While these vehicle types and use cycles may be most suitable for early electrification, individual fleet operational characteristics, and the availability of models meeting performance requirements at a reasonable price point, will determine where electrification is both operationally and financially viable.

The primary barriers that stakeholders perceive to ZEV adoption include:

- Concerns about **limited range** and impacts of cold weather.

- Lack of **maintenance providers** and long lead times for procurement and repair.
- High **upfront costs**, operating cost uncertainty, and uncertain resale potential.
- Lack of **charging infrastructure**, inconsistent electricity pricing, and concerns about grid reliability.

Existing state and Federal programs such as the EMT commercial vehicle incentive, Federal Clean Commercial Vehicle tax credit, federally funded and state-administered EV infrastructure programs, and the state's workforce development initiatives already begin to leverage these opportunities and address barriers. However, additional actions are needed to demonstrate and prove emerging technology, overcome financial barriers, develop a robust public and private network of charging infrastructure, develop a local workforce to service vehicles, and educate vehicle owners about the best approaches for their unique needs.

Policy Recommendations

Accelerating the transition from gasoline- and diesel-powered trucks and buses to zero-emission alternatives requires a suite of supportive policies. While both carrots (incentives) and sticks (regulations/fees) have proven effective in other markets, a coordinated array of policy actions can facilitate a faster, more cost-effective transition to MHD ZEVs in Maine.

Table ES.1 identifies and describes seven types of policies, identifies current or completed Maine policies in that category, and provides recommended additional policies for Maine to consider for adoption and implementation. Maine can build on successful implementation of these recommendations by other states, while tailoring them to the state's unique needs.

TABLE ES.1 CURRENT AND RECOMMENDED MAINE POLICIES AND PROGRAMS TO SUPPORT MHD ZEVS

Policy Type	Justification	Current	Recommended
Target Setting	» Target setting establishes clear vision and sends signal to industry that Maine is open for ZEV business.	» Multi-state NESCAUM-led MHD ZEV memorandum of understanding.[1] » Statutory clean school bus sales target.[2]	» Establish "lead by example" MHD ZEV targets for the state-owned fleet. » Complete a MHD state fleet transition plan.
Planning	» Provides a baseline of knowledge to support cost-effective policies and investments.	» Clean transportation roadmaps, National Electric Vehicle Infrastructure (NEVI) Plan[3], Public Utilities Commission (PUC)-led integrated grid planning.	» Continue stakeholder engagement after this roadmap is published. » Update and expand NEVI Plan guidance for MHD infrastructure. » Monitor and participate in planning for regional hydrogen infrastructure development.

Policy Type	Justification	Current	Recommended
Vehicle Incentives	» Helps to mitigate up-front cost differential for ZEV versus conventional vehicle.	» EMT work van incentives and MHDV pilot. » Federal tax credits.	» Develop a MHD ZEV voucher incentive program. » Assess opportunities for state tax credits.
Infrastructure Support	» Infrastructure costs pose an up-front cost barrier for fleets. » Coordinated planning between utilities, industry, and Government is critical.	» Central Maine Power "make-ready" pilot. » Electric utility EV alternative charging rates.	» Convene MHD ZEV infrastructure stakeholder forum. » Develop MHD ZEV charging and fueling voucher incentive program. » Explore development of utility-run MHD infrastructure incentives. » Build on PUC proceedings requiring EV charging rates.
Fleet Advisory Support	» Fleet electrification can be challenging; support programs make transition more widely accessible.	» Central Maine Power electric school bus support.	» Launch no-cost MHD ZEV fleet advisory program.
Regulations	» Complement incentives to drive faster adoption of MHD ZEVs; may be necessary to meet emissions targets.	» None.	» Track MHD ZEV deployment in states Maine and other states with clean truck regulations and their impact on MHDVs traveling to Maine.
Economic Development	» Train a new generation of workers and transition existing workers to service ZEVs and infrastructure.	» Workforce initiatives through community colleges, Maine Won't Wait, Clean Energy Partnership, Federal grants.	» Explore offering manufacturing tax credit for green investments. » Expand EV job training programs. » Expand Clean Energy Partnership clearinghouse to increase focus on the ZEV industry.
Innovative Policies	» Expand beyond what might be achieved through other actions.	» Regional Greenhouse Gas Initiative (RGGI). » Weight exemption for auxiliary power units (400 lb.).	» Evaluate potential allocation of RGGI funds to support strategic investment in MHD ZEV programs. » Plan for heavier MHD ZEVs on the road.

[1] Northeast States for Coordinated Air Use Management (NESCAUM) Multi-State Medium- and Heavy-Duty Zero-Emission Vehicle Memorandum of Understanding.

[2] Maine Revised Statutes Title 20-A S5401.

[3] Maine DOT (2023). Maine's Updated Plan for Electric Vehicle (EV) Infrastructure Deployment (Maine's NEVI Plan).

Table ES.2 proposes responsibilities and timeframes for implementing each recommended policy.

TABLE ES.2 ACTION PLAN

Policy Recommendation	Responsibility	Timeframe
1. Lead by example MHD ZEV targets for public fleet	Lead By Example Initiative	July 1, 2025
2. MHD state fleet transition plan	Governor's Office of Policy Innovation and the Future (GOPIF); Department of Administrative and Financial Services; and Maine DOT	December 31, 2026
3. Continue MHDV stakeholder engagement	GOPIF and Maine DOT	Ongoing
4. Update and expand NEVI Plan guidance for MHD infrastructure	Maine DOT	2025 NEVI planning cycle and ongoing
5. Develop MHD ZEV voucher incentive program	EMT	July 1, 2025; launch as soon as funding is available
6. Assess state tax credit options	GOPIF and Bureau of Tax and Finance	December 31, 2025
7. Develop MHD ZEV charging and fueling voucher incentive program	EMT, Maine DOT	July 1, 2025; launch as soon as funding is available
8. Explore development of utility-run MHD infrastructure incentives	PUC, GEO	2025
9. Build on regulatory proceedings requiring EV charging rates	PUC, GEO	Ongoing, in rate cases
10. Launch no-cost fleet advisory program	Various	By 2026
11. Track MHD ZEV deployment in Maine and other states with clean truck regulations	GOPIF, Maine Department of Environmental Protection (DEP)	Ongoing
12. Explore offering manufacturing tax credit	GOPIF, Maine Department of Economic and Community Development	2025
13. Expand EV job training programs	GEO, through the Maine Clean Energy Partnership	Ongoing to meet demand
14. Expand Clean Energy Partnership clearinghouse to increase focus on the ZEV industry	GEO	July 1, 2026
15. Evaluate use of RGGI funds to support ZEVs	GOPIF, Maine DEP, GEO, EMT	December 31, 2025
16. Plan for heavier MHD ZEVs on the road	Maine DOT	December 31, 2026

Implementation of many of the above recommendations will require varying degrees of funding. Existing programs offered through the U.S. Department of Transportation, U.S. Environmental Protection Agency, and U.S. Department of Energy could support many of these recommended initiatives. Maine program budgets may be able to support activities that require modest costs, such as planning and regulatory proceedings.