GOVERNOR'S Energy Office | GOVERNOR'S OFFICE OF Policy Innovation and the Future | CADMUS

Executive Summary:

Maine Clean Transportation Roadmap

December 2021

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Executive Summary

The State of Maine is leading on climate action among peer states. In its 2020 *Maine Won't Wait* Climate Action Plan, the state lays out a bold set of strategies to reduce greenhouse gas (GHG) emissions by 45% by 2030 and 80% by 2050 and achieve carbon neutrality by 2045, and its progress toward achieving these goals is real. For example, since 2019 the number of battery electric and plug-in hybrid electric vehicles **increased by 90% to 5,577 vehicles** and the number of public charging stations **increased by 62% to 265 stations.** [1] The electricity that powers these vehicles continues to be cleaner as the state makes progress toward achieving its requirement of 80% renewable energy by 2030.[2] Further, the state and regional partners continue to explore new approaches for providing public transportation efficiently and effectively, including innovative solutions in rural Maine, and in 2021 spent **$11.55 per capita on public transit.**

This **Clean Transportation Roadmap**—a specific action of *Maine Won't Wait*—identifies the policies, programs, and regulatory changes needed to continue decarbonizing Maine's transportation sector in coming years. The work was conducted in 2021 by researchers at Cadmus and E2Tech, with oversight from a steering committee composed of state agency staff. An external advisory group provided technical input for the modeling, analysis, and recommendations.

Maine's transportation sector produced **54% of statewide, fossil-fuel GHG emissions** in 2017, or approximately 8 million metric tons of carbon dioxide equivalent ($MMTCO_2e$). Decarbonizing the transportation sector is a challenge with over 1 million vehicles on the road and thousands of off-road vehicles, aircraft, and marine vessels. Light-duty cars and trucks are the source of **approximately 60% of total sector GHG emissions**. Given the cost and scarcity of low-carbon fuels, the light-duty vehicle (LDV) fleet must achieve near-zero emissions in the aggregate by 2050 for Maine to achieve its 2050 GHG goal. Medium- and heavy-duty surface vehicles produce the next largest segment of sector emissions—**approximately 27% in 2017**—and must similarly be decarbonized but with a greater variety of fuels and at a pace sensitive to the needs of the business community in Maine.

Although multiple strategies could reduce emissions to near-zero levels, deployment of electric vehicles (EVs) appears to be the most important, technologically ready strategy for almost all modes, due to comparatively low fuel cost, high drive-train efficiency, and sustained falling costs of batteries. As a result, EVs represent the largest focus of this Clean Transportation Roadmap. Yet, increasing the adoption of EVs faces several constraints. In the near-term (probably the next two years), EV adoption will be constrained due to global supply chain issues, insufficient diversity of makes and models, higher upfront costs of EVs relative to comparable vehicles, and low inventory of used vehicles. By the mid-2020s, these constraints are expected to ease.

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1 Maine Climate Council (2021) https://www.maine.gov/future/sites/maine.gov.future/files/inline-files/MaineWontWait_OneYearProgressReport_SinglePgs.pdf

2 State of Maine (2021) https://www.maine.gov/energy/initiatives/renewable-energy/renewable-portfolio-standards

This roadmap also highlights strategies to reduce vehicle miles traveled (VMT) and shift travel away from personal automobiles. These strategies include pricing strategies, infill development, transit expansion, telecommuting, and bicycle and pedestrian infrastructure.

Because of the long planning horizon necessary for the design and construction of infrastructure projects, the Maine Department of Transportation (MaineDOT) advanced several new initiatives prior to the publication of this roadmap. These include rewriting the state's Complete Streets Policy, hiring a consultant to prepare transit bus electrification plans for select Maine transit agencies, updating the Statewide Strategic Transit Plan, and relaunching the Go Maine initiative in partnership with the Turnpike Authority. Maine's efforts to increase the availability of high-speed broadband internet service through the establishment of the new Maine Connectivity Authority will also yield transportation emissions reduction dividends as will the new Legislative Commission to Increase Housing Opportunities by Studying Zoning and Land Use Restrictions and the significant inclusion of federal resources via the American Recovery Plan Act (ARPA) and the Infrastructure Investment and Jobs Act (IIJA).

Additional policy interventions are necessary to accelerate a transition toward a decarbonized transportation sector while minimizing unintended consequences, stranded investments, and socioeconomic inequities. This roadmap, a first attempt at a plan for this transition, focuses on the strategies needed before 2025, although longer-term considerations are also discussed.

Policy Recommendations

Through its analysis, Cadmus developed a set of recommended new programs for state government, local governments, utilities and their regulator, and Efficiency Maine Trust, as listed in Table 1. This work was aided by E2Tech, which facilitated a statewide stakeholder engagement process. These recommendations will help direct consumers, businesses, and government agencies toward cleaner transportation options. Each recommended policy is associated with a goal and a rationale.

Table 1. Cadmus Recommendations for New Programs

	Program	Goal	Rationale
State-or Efficiency Maine Run Programs	**Advanced Clean Cars II**	Increase EV Adoption	• If implemented, programs will have profound impact on GHG emissions from the transportation sector. • Sends clear, long-term signal to automakers to increase deliveries of EVs. • Historically, EV market share has been roughly twice as high in states that follow California emission regulations (Section 177 states), illustrating effectiveness of vehicle sales requirements.[3]
	Advanced Clean Trucks		
	Public DCFC Incentive and/or Ownership	Expand Charging Network	• Cadmus analysis using MA3T model suggests expanding public fast chargers by 15% in 2030 boosts EV sales by 7% in 2030 relative to business-as-usual. • Academic literature clearly demonstrates positive relationship between DCFC access and EV sales.[4]

[3] Center for American Progress (CAP; Cattaneo, Lia). June 2018. "*Plug-In Electric Vehicles: Evaluating the Effectiveness of State Policies for Increasing Deployment".* https://cdn.americanprogress.org/content/uploads/2018/06/06140002/EVreport-5.pdf

[4] For example, see review by Hardman, Scott. 2019. "Understanding the impact of reoccurring and non-financial incentives on plug-in electric vehicle adoption – A review." *Transp. Res. A Policy Pract.* 119, 1-14. https://phev.ucdavis.edu/wp-content/uploads/reoccurring-incentives-literature-review.pdf

	Program	Goal	Rationale
	Multi-Unit Dwelling (MUD) L2 Charger Incentive Program	Expand Charging Network	• Availability of charging in MUDs unlocks latent demand for EVs.[5] • 21% of Maine households are in MUDs (buildings with 2+ households).[6] • MUD households have approximately 50% lower household income in Maine than households in single-family homes.[7] • Cadmus analysis in MA3T model shows that enabling access to charging at MUDs is more impactful on EV sales than providing charging for single-family homes.
	Expanded Low-Income EV Incentive Program with L2 Charger	Incentivize Clean Vehicles	• EV rebate programs with a low-income component reduce free-riders and potentially increase cost-effectiveness.[8] • Low-income households have the largest transportation-related health burden of any group.
	Cash for Clunkers Program	Incentivize Clean Vehicles	• Removes high polluting vehicles, creating potential benefit to low-income households, which are most burdened by transportation emissions. • One of few programs capable of increasing turnover of vehicle stock. • Program requires equitable design—for example, in the 2009 federal CARS program participants were higher income than average used car buyers,[9] though lower income than average new car buyers, and only 1% of subsidies went to individuals in the bottom 50% of income.[10]
	Medium- and Heavy-Duty EV Incentive	Incentivize Clean Vehicles	• Incentives will help reduce the cost differential of ZEV MHDVs for fleet owners • Electrifying MHDVs is critical for meeting Maine's 2030 and 2050 GHG goals.[11]
	Marketing and Awareness Campaign	Education & Awareness	• Ensures public has concise, accurate information on clean transportation modes, incentives, and technologies. • Provides technical assistance to stakeholders in need.

5 DeShazo, J.R. 2019. "Overcoming Barriers to Electric Vehicle Charging in Multi-unit Dwellings: A Westside Cities Case Study" https://innovation.luskin.ucla.edu/wp-content/uploads/2019/03/Overcoming_Barriers_to_EV_Charging_in_MUDs-A_Westside_Cities_Case_Study.pdf

6 Only 19% when including Group Quarters. Data from US Census (2019) American Community Survey, 5-year Survey. https://data.census.gov/

7 Data from US Census (2019) American Community Survey, 5-year Survey. https://data.census.gov/

8 DeShazo, J. R., T. L. Sheldon, and R. T. Carson. 2017. "Designing Policy Incentives for Cleaner Technologies: Lessons from California's Plug-In Electric Vehicle Rebate Program." *Journal of Environmental Economics and Management* (84): 18–43. https://doi.org/10.1016/j.jeem.2017.01.002

9 Parker, T. & Gayer, E. Cash for Clunkers: An Evaluation of the Car Allowance Rebate System. Tech. Rep. (2013). https://www.brookings.edu/research/cash-for-clunkers-an-evaluation-of-the-car-allowance-rebate-system/

10 Miller, K. S., Wilson, W. W. & Wood, N. G. Environmentalism, Stimulus, and Inequality Reduction Through Industrial Policy: Did Cash for Clunkers Achieve the Trifecta? *Economic Inquiry* **58**, 1109–1128 (2020). https://doi.org/10.1111/ecin.12889

11 State of Maine (2020) Maine Won't Wait, Climate Action Plan. https://www.maine.gov/future/sites/maine.gov.future/files/inline-files/MaineWontWait_December2020.pdf

	Program	Goal	Rationale
Local Programs	**EV-Ready Building Codes**	Expand Charging Network	• EV-ready and EV-capable building codes are critical for reducing the cost of future charging installation on the customer side. • Estimates show that electric vehicle supply equipment (EVSE) installation costs increase by two[12] to six[13] times if a parking space is made EV-ready after construction compared to during construction.
	Transit Village to Encourage Transit Oriented Development (TOD)	VMT Reduction & Mode Shift	• Reduces VMT, boosts transit ridership, and reduces need for traditional road infrastructure.
	Bicycle & Pedestrian Investment	VMT Reduction & Mode Shift	• Ensures prioritization of nonmotorized modes. • Facilitates support of emerging micro-mobility technologies, such as e-bikes and e-scooters.
	Marketing and Awareness Campaign	Education & Awareness	• Ensures public has concise, accurate information on clean transportation modes, incentives, and technologies.
Utility or Efficiency Maine Programs	**Demand Charge Relief**	Expand Charging Network	• Cadmus analysis of CMP rates suggests demand charges account for between 34% and 70% of total costs for a 50 kW DCFC station and between 24% and 62% of total costs for a 350 kW DCFC station. • Critical for corridor charging, certain fleets, and sites with many plugs. • In a tariff analysis, Rocky Mountain Institute shows that reducing or eliminating demand charges can promote a more conducive business environment for the public DCFC market.[14]
	Utility-Side Make-Ready Infrastructure	Expand Charging Network	• Removes key barrier to expanding charging infrastructure, following California and New York programs.[15,16]
	Time Of Use (TOU) Rates	Incentivize Clean Vehicles	• Supports demand response and efficiency of grid. • Lowers operating cost of EVs.
	Marketing and Awareness Campaign	Education & Awareness	• Ensures public has concise, accurate information on clean transportation modes, incentives, and technologies.

Funding Recommendations

The roadmap also explores the magnitude and timing of investment needed between 2022 and 2025 for charging infrastructure and for an expanded low- and moderate-income (LMI) EV rebate. As shown in Table 2, the estimated investment for these programs increases over time as EV adoption grows. Note that the investments in Table 2 are typically shared between government, the business community, homeowners, and other entities. DCFC charging and LMI EV rebates are the two most critical programs

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12 Great Plains Institute (GPI; McFarlane, B. D., M. Prorok, and T. Kemabonta). 2019a. "Analytical White Paper: Overcoming Barriers to Expanding Fast Charging Infrastructure in the Midcontinent Region." https://scripts.betterenergy.org/reports/GPI_DCFC_Analysis_July_2019.pdf

13 California Electric Transportation Coalition (CalETC; DoVale K., E. Kamei, C. Kido, and E. Pike). 2019. *Plug-In Electric Vehicle Infrastructure Cost Analysis Report for CALGreen Nonresidential Update.* https://caletc.com/assets/files/CALGreen-2019-Supplement-Cost-Analysis-Final-1.pdf

14 Rocky Mountain Institute (RMI) (2019). https://rmi.org/wp-content/uploads/2017/04/eLab_EVgo_Fleet_and_Tariff_Analysis_2017.pd

15 NRDC (2021) https://www.nrdc.org/experts/miles-muller/ca-approves-new-rules-support-ev-charging-infrastructure

16 NY (2021) https://jointutilitiesofny.org/ev/make-ready

for the State of Maine to fund, based on experience in other states. See notes below the table for more detail about how the estimates were calculated.

Table 2. Annual Investment Needed for Charging Infrastructure and Expanded LMI EV Rebate Program

(Values in bold are in millions $2021. Numbers in parentheses are new plugs or EVs rebated)[a,b]

	2022	2023	2024	2025
Public L2 Charging [c]	**$4.1M** (200 plugs)	**$4.9M** (247 plugs)	**$5.5M** (291 plugs)	**$6.0M** (334 plugs)
Public DCFC Charging [c]	**$7.7M** (55 plugs)	**$10.6M** (77 plugs)	**$14.4M** (104 plugs)	**$17.6M** (132 plugs)
Residential L1 Charging [d]	**$0.4M** (1045 plugs)	**$0.5M** (1269 plugs)	**$0.6M** (1474 plugs)	**$0.6M** (1664 plugs)
Residential L2 Charging [d]	**$1.8M** (1568 plugs)	**$2.2M** (1903 plugs)	**$2.6M** (2212 plugs)	**$2.9M** (2495 plugs)
LMI New EV Rebate [e]	**$6.4M** (853 EVs)	**$7.0M** (1028 EVs)	**$7.5M** (1203 EVs)	**$7.7M** (1377 EVs)
LMI Used EV Rebate [e]	**$4.6M** (1139 EVs)	**$6.0M** (1655 EVs)	**$7.7M** (2320 EVs)	**$8.8M** (2996 EVs)
Total	**$25.0M**	**$31.2M**	**$38.2M**	**$43.7M**

Table notes:

[a] Future EV population associated with estimates in this table use the ACC II Lower/Upper Bound scenarios. See the full roadmap document for more information on scenarios.

[b] The LMI EV Rebate estimates are aligned with California LMI EV Rebate levels. However, the rebate values will likely require year-to-year adjustments in per-vehicle incentive to achieve the desired uptake.

[c] Public charger refers to publicly accessible chargers (as opposed to chargers at workplaces, apartment complexes, hotels, etc.). The number of new Level 2 and DCFC charging plugs are estimated by multiplying the EV population by ratios of plugs/EVs from the EVI-Pro Lite tool. Ratios are given in the full roadmap document. Assumed per-plug costs are in the full roadmap document. Costs in this table are the net present value (NPV) of costs and revenues associated with the station over the assumed 10-year life of equipment and assumed 30-year lifetime of make-ready infrastructure. A 4% discount rate is used. Costs include customer-side make-ready, station installation, equipment, revenue from drivers, electricity (using CMP commercial tariff including demand charges), maintenance, warranty, and networking costs. Station revenues are $0.25 per kWh for Level 2 plugs and $0.37 per kWh for DCFC plugs. Assumed utilization of stations aligns with current utilization in Maine and increase over time.

[d] Number of new residential charging plugs are estimated using ratios of existing residential plugs / EVs and applying an assumed gradual shift over time toward slightly greater public charging. Ratios are given in the full roadmap document. Assumed per-plug costs are in the full roadmap document. These costs reflect costs at a detached, single-family home rather than a multi-unit dwelling (MUD). A program to fund MUD charging should be funded separately. See Note c for assumptions on discount rate and equipment lifetime. Costs include customer-side make-ready, station installation, equipment, maintenance, and warranty (and networking costs for L2 chargers).

[e] New and used EV rebate assumptions are described in the full roadmap document and assume rebates are available only to households with income under $50,000 per year. New and used EV rebates start at $7,500 and $4,000 per vehicle in 2022, respectively, and decline over time to $5,500 and $3,000 per vehicle by 2025, respectively. In alignment with the new and used car market, households earning $50,000 or less are assumed to be 21% of the new EV market and 52% of the used EV car market.

The State of Maine has limited existing funding for charging infrastructure and EV rebates:

- **$8 million** available for charging infrastructure through its Fiscal Year 2026 from the *Maine Jobs & Recovery Plan*.[17]
- **$19 million** available for charging infrastructure through 2025 the federal *Infrastructure Investment and Jobs Act (IIJA)* formula funding to Maine for charging infrastructure.
- **$3.75 million** for EV rebates and **$1.25 million** for qualified low-income EV rebates from the New England Clean Energy Connect stipulation and the potential for an additional **$8 million** for charging infrastructure over four years. The $3.75 million will likely be fully used by June 2022.

Clearly, existing funding sources are insufficient to meet the funding needs described in Table 2. For example, if the State of Maine funds only new DCFC charging, it would need **$7.7 million** in 2022 and **$17.6 million** in 2025. Fully funding and distributing rebates under the LMI EV Rebate program would

[17] Maine fiscal year runs from July 1 through June 30. The values in Table 2 are for calendar year.

require an additional **$11.0 million** in 2022 and **$16.5 million** by 2025**.** Together, these programs exceed existing funding. The IIJA's **$2.5 billion** of competitive grant funding for charging infrastructure could help partially fill the funding gap. A fair share allocation of this $2.5 billion based on Maine's population would imply approximately **$10 million**. Additionally, Maine could develop a new funding source, such as a clean fuel standard, road user charge (or VMT tax), gas tax, carbon mechanism, and/or vehicle feebate program.

Table 2 does not include these five cost categories that may require public funding support in the future: (1) electricity distribution system expansion; (2) installation of chargers at multi-unit dwellings (MUDs); (3) installation of MHDV chargers; (4) installation of workplace charging; and (5) MHDV rebates.

Future Research

Finally, during the development of this roadmap, several new knowledge gaps and research needs arose. Table 3 summarizes future research opportunities.

Table 3. Recommendations for Future Research

Opportunities for Future Research	Description
Zero-Emissions MHDV Roadmap	In support of the implementation of programs such as Advanced Clean Trucks (ACT), develop a MHDV roadmap and corresponding stakeholder group that focuses on charging needs, funding, duty cycles, range, timeline on vehicle availability, and costs of electric and other zero-emissions MHDVs. Also, the MHDV roadmap could examine the feasibility of "lead by example" programs with zero-emissions MHDVs.
Make-Ready Mapping	Develop a publicly available ArcGIS map that shows areas suitable for fleet charging without a need to upgrade the local distribution system. Such a map could be especially important for electric MHDV fast chargers as well as for charging providers looking to site new stations.
Tourism Study	Maine's GHG inventory counts emissions from all fuel purchased in the state, including from tourists. Yet, relatively little data exist about how much fuel is purchased by in-state versus out-of-state drivers. The State of Maine should conduct a study to investigate opportunities and barriers for lowering emissions from out-of-state drivers. Such a study could also examine the feasibility of programs that increase EV penetration among tourists through rental cars and/or other incentives and fees.
Case Studies on Rural Transit and/or Electrification	Develop case studies on jurisdictions (in or outside of Maine) that have successful electric micro-transit or rural transit programs that simultaneously increase access and decarbonize transportation.
Loan Loss Reserve Program for EVs	Loan Loss Reserve (LLR) programs provide loan loss coverage to financing partners such as local and regional banks and credit unions. LLR programs, often used in clean energy financing, are a form of credit enhancement that can be constructed to offer below-market-rate terms to increase participation by low-income consumers, who often have poor or limited credit to access financing of a vehicle. Program could be modeled after New York's LLR program or California's Clean Vehicle Assistance Program (CVA Program).
Government Fleet Electrification	Develop a study of costs and feasibility of fleet electrification within state, local, and utility-owned vehicles. Estimate costs of charging infrastructure and vehicles. Additionally, study reimbursement options for drivers who park at home overnight and charge.
School Bus Electrification Study	Conduct an analysis of feasibility, power supply, duty cycle, market availability, and other factors related to school bus electrification in Maine. Coordinate with ongoing research by The Nature Conservancy and the Vermont Energy Investment Corporation (VEIC).
Emergency Management Plans	Identify opportunities through state planning processes to ensure that future energy assurance or emergency management plans consider high penetrations of vehicle electrification and the impacts of necessary infrastructure. This could include events such as natural disasters, mass evacuations, and prolonged grid blackouts.