



Climate Leaders Municipal Decarbonization Roadmap

Prepared for: The Town of Dedham, MA
April 2025



Introduction

In 2021, the Commonwealth of Massachusetts amended the state’s signature climate law with *An Act Creating a Next Generation Roadmap for Massachusetts Climate Policy*, also known as the 2021 Climate Law.^{1,2} The 2021 Climate Law requires the Secretary of the Executive Office of Energy and the Environment (Secretary) to set statewide greenhouse gas (GHG) emissions limits and set sector-specific emissions sublimits that are to be met every five years. These limits require GHG emissions to be at least thirty-three percent below 1990 levels in 2025, and fifty percent below 1990 levels in 2030.

In accordance with An Act Relative to Green Communities, the Climate Leader Community certification has also provided a framework for municipalities to reach the Secretary’s set limits. To become a certified Climate Leader, a municipality must 1) commit to eliminating on-site fossil fuel use by the municipality by 2050 and, 2) develop a roadmap for decarbonizing municipal operations. The roadmap will focus on eliminating the use of fossil fuels by municipal buildings and vehicles, and will use a “Zero Over Time” approach as suggested in Table 1.^{3,4} PowerOptions developed this Climate Leaders Municipal Decarbonization Roadmap for the Town of Dedham as the second action for certification. The roadmap is intended to function as a guideline for the Town. To determine the feasibility of executing this roadmap and the associated costs, a technical assessment will be required.

Table 1. Suggested minimum Emission Reduction Timeline, as provided in roadmap guidance document, established by DOER.⁴

Targets	2027	2030	2040	2050
Emissions reductions from onsite fossil fuels	-20%	-35%	-60%	-100%
Zero emission vehicles (ZEVs) in light-duty fleet adoption	5%	20%	75%	100%
Zero emission vehicles (ZEVs) in heavy-duty fleet adoption	0%	20%	50%	100%
Energy Use Intensity reduction	-20%	-25%	-25%	-30%
Total Emissions Reduction Goals (% of 2022 emissions)	>15%	>35%	>65%	>95%

¹ Global Warming Solutions Act, 2008, <https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter298>

² 2021 Climate Law, <https://malegislature.gov/Laws/SessionLaws/Acts/2021/Chapter8>

³ [Green Communities 2.0](#)

⁴ [Climate Leaders Municipal Decarbonization Commitment and Roadmap Guidance](#)

Baseline Emissions

Since becoming a Green Community in 2010, the Town of Dedham, Massachusetts (Dedham) has received \$0.66 million in funding to complete energy conservation projects focused on building efficiency, weatherization, and lighting upgrades, heat pump installation, and electric vehicles and charging stations. In Fiscal Year 2022, Dedham’s municipal operations (municipal and school buildings, lighting, and the Town’s municipal and school fleets), emitted 4,282 metric tons of carbon dioxide equivalent (MT CO₂e) (Table 2). To become a certified Climate Leader, Dedham will move forward with planned and ongoing projects aimed at reducing energy consumption and GHG emissions and strive to implement the measures outlined in the following roadmap.

This roadmap evaluates the following strategies to decarbonize Dedham’s facilities: energy efficiency, electrification (fuel-switching away from fossil fuel equipment to electric alternatives), and on-site solar photovoltaics. The roadmap also analyzes 98 vehicles in Dedham’s fleet to match each existing vehicle with the best candidates for battery electric vehicles (BEV). A combination of in-house economic models, a virtual energy audit, and Helioscope solar software were used to produce this roadmap. Because this roadmap focuses on reducing on-site fossil fuel usage, the results of the solar assessment are provided only in the Appendix.

By 2050, the measures highlighted in this roadmap are estimated to reduce Dedham’s GHG emissions by over 97 percent, lowering the Town’s Energy Use Intensity (EUI) by 52 percent, and meeting the emissions reductions goals set by the Secretary.

KEY FACTS

BUILDINGS

- 22 Buildings in analysis
 - Total 822,872 ft²
- FY2022 Usage:
 - 4,160 MWh
 - 33,762 MMBTU natural gas
 - 65,303 gallons fuel oil
 - 10,744 gallons propane
 - 3,530 MT CO₂e

VEHICLES

- Included in analysis
 - 60 LDV
 - 22 MDV
 - 16 HDV
- Excluded from analysis
 - 21 unidentified or non-road vehicles
- FY2022 Fleet Usage:
 - 52,231 gallons of gasoline
 - 22,126 gallons of diesel
 - 684 MT CO₂e

Table 2. Town of Dedham's municipal GHG Emissions, Fiscal Year 2022, grouped by Town buildings, school buildings, and vehicles. Based on energy consumption and vehicle data provided by the Town.

Department and Facility Name	Fiscal Year 2022 Emissions (MT CO ₂ e)			
	Electricity	Fossil Fuels	Total	Percent of Total
School Department	760	1,883	2,643	61.7%
Dedham High School	286	682	968	22.6%
Dedham Middle School	174	364	538	12.6%
Oakdale Elementary School	74	289	363	8.5%
Riverdale Elementary School	32	201	233	5.4%
Greenlodge Elementary School	65	159	224	5.2%
Avery Elementary	110	81	191	4.5%
Early Childhood Education Center (ECEC)	18	107	125	2.9%
Dexter School	1	-	1	0.0%
Vehicles	-	684	684	16.0%
Fleet Vehicles	-	684	684	16.0%
Parks and Recreation	131	301	431	10.1%
Dedham Pool	63	194	257	6.0%
Capen Building - YMCA/BLUE Hills	32	74	106	2.5%
Dolan Center	12	18	30	0.7%
Barnes Memorial Park	16	-	16	0.4%
Parks and Recreation Facility Garage	-	14	14	0.3%
Fairbanks Field Concession Stand	5	-	5	0.1%
Condon Park	3	-	3	0.1%
Department of Public Works	51	160	212	4.94%
DPW	18	102	120	2.8%
Public Safety Building	18	51	69	1.6%
Police Station	33	17	50	1.2%
East Dedham Fire House	7	18	26	0.60%
Elm Street Pump	18	-	18	0.42%
Brookdale Cemetery Office Building	4	7	11	0.26%
Glenway Street Pump	1	-	1	0.02%
National Drive Pump	-	0	0	0.01%
Washington Street Pump	-	0	0	0.00%
Recreation Department	51	160	212	4.94%
Endicott Estate	13	59	72	1.68%
Ames Town Hall	18	51	69	1.60%
Main Library	13	33	46	1.07%
Endicott Library	5	17	23	0.53%
Old Avery - Motherbrooks Art Center	2	-	2	0.05%
Council on Aging	1	-	1	0.01%
Endicott Estate	13	59	72	1.68%
Streetlighting	18		18	0.41%
Streetlighting	18	-	18	0.41%
Total	1,060	3,223	4,282	100%

Table 3. Town of Dedham's GHG Emissions from buildings included in analysis, Fiscal Year 2022. Based on energy consumption data provided by the Town.

Facility Name	Fiscal Year 2022 Emissions (MT CO ₂ e)			
	Electricity	Fossil Fuels	Total	Percent of Total
Dedham High School	286	682	968	27.43%
Dedham Middle School	174	364	538	15.23%
Oakdale Elementary School	74	289	363	10.28%
Dedham Pool	63	194	257	7.28%
Riverdale Elementary School	32	201	233	6.60%
Greenlodge Elementary School	65	134	198	5.62%
Avery Elementary	110	81	191	5.42%
Early Childhood Education Center	18	107	125	3.53%
DPW	18	102	120	3.41%
Capen Building - YMCA/BLUE Hills	32	74	106	3.02%
Endicott Estate	13	59	72	2.04%
Ames Town Hall	18	51	69	1.94%
Public Safety Building	18	51	69	1.94%
Police Station	33	17	50	1.41%
Main Library	13	33	46	1.30%
East Dedham Fire House	7	18	26	0.72%
Main Fire House	7	18	26	0.72%
Dolan Center	12	12	24	0.68%
Endicott Library	5	17	23	0.64%
DPW Garage	-	14	14	0.40%
Brookdale Cemetery Office Building	4	7	11	0.32%
Old Avery - Motherbrooks Art Center	2	-	2	0.06%
Total	1,005	2,525	3,530	100%

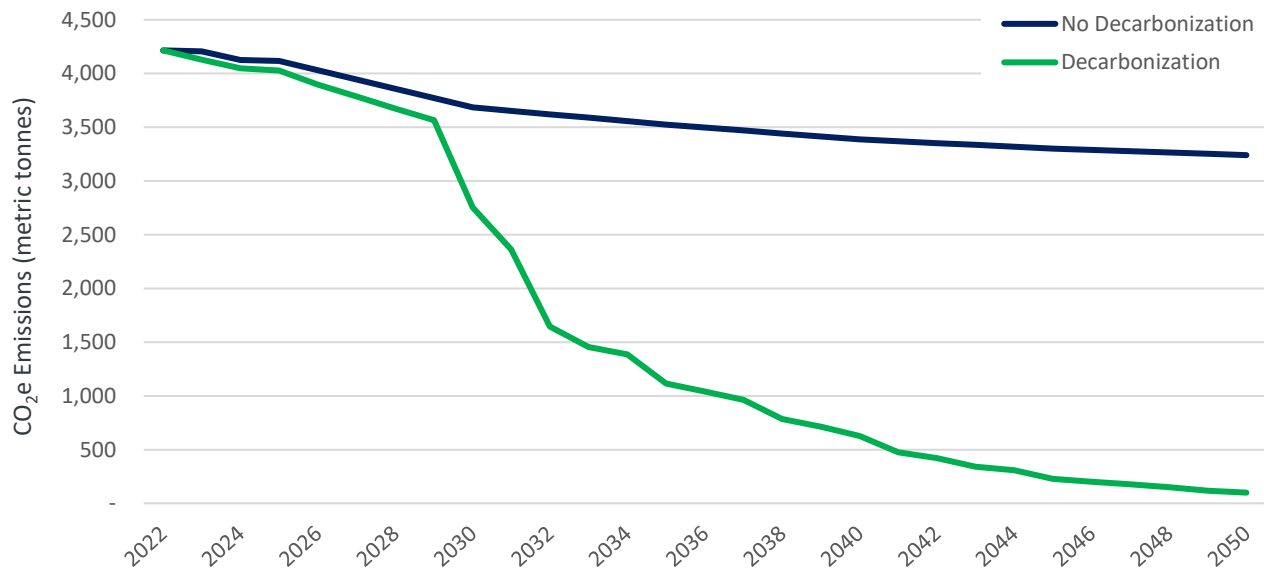
Summary of Findings

The projected reductions associated with decarbonizing the 22 buildings and 98 vehicles analyzed in this roadmap, are summarized in Table 4 and Figure 1 below. Overall, the Town could expect to see a 97 percent reduction in GHG emissions in 2050, compared to Fiscal Year 2022 baseline emissions levels.

Table 4. Projected emissions reductions as a result of decarbonizing the Town of Dedham’s 22 buildings and 98 vehicles analyzed in this roadmap.

Decarbonization Roadmap Projections	2027	2030	2040	2050
Emissions reductions from onsite fossil fuels	3%	-14%	-91%	-100%
Zero emission vehicles (ZEVs) in light-duty fleet adoption	7%	26%	94%	100%
Zero emission vehicles (ZEVs) in heavy-duty fleet adoption	0%	0%	38%	100%
Energy Use Intensity reduction	-3%	-31%	-45%	-52%
Total Emissions Reduction Goals (% of 2022 emissions)	8%	33%	85%	97%

Figure 1. CO₂e emissions by scenario, showing percent reduction as compared to FY2022 emissions (2022-2050) for facilities (22 buildings) and fleet (98 vehicles).





Decarbonization Plans for High Impact Buildings



Buildings Background

Twenty-two municipal and school buildings, which accounted for 80 percent (3,530 MT CO₂e) of total Town emissions (including non-buildings) in Fiscal Year 2022, were included in the analysis. Seven of those twenty-two buildings contributed 64 percent of the Town's total Fiscal Year 2022 emissions (Table 2), and 78 percent of the 22 buildings included in this analysis (Table 3): the Dedham High School (27%); Dedham Middle School (15%); Oakdale Elementary School (10.3%); Dedham Pool Building (7.3%); Riverdale Elementary School (6.6%); Greenlodge Elementary (5.6%); and Avery Elementary School (5.4%). Focusing efforts on these high impact facilities will reduce overall emissions and contribute significantly to the Town's overall projected emissions reductions.⁵

Since 2022, the Town has completed several facility upgrades and changes, which are reflected in the emissions projection analyses.⁶ In 2023, the Town completed construction of a new 84,000 square foot Public Safety Building. The new building houses both the police and fire departments, whose individual buildings were demolished in 2023.

In 2020, an architecture and engineering consultant updated the Dedham Public Schools' Long-Term Facilities Master Plan, identifying steps for improving, renovating, or replacing school facilities. Oakdale Elementary School was identified as the priority, followed by the Riverdale and Greenlodge Schools. As a result of this study, the Town was awarded \$30 million in 2024 to aid in replacing the existing Oakdale School with a new facility.⁷ The school is expected to utilize geothermal or air source heat pumps for heating and cooling.⁸

Since Fiscal Year 2022, Dedham has seen a reduction in energy consumption and in GHG emissions. These reductions are, in part, due to the implementation of energy efficiency measures, which the Town will continue to explore at all municipal buildings. Additionally, a virtual energy audit found that facilities with no past or ongoing projects could see a 10 to 15 percent decrease in emissions from implementation of energy conservation measures and facility equipment upgrades, between Fiscal Year 2022 and Fiscal Year 2040.

⁵ Though GHG reductions from on-site solar are not included in emissions projections, an indicative solar assessment was completed at each building analyzed. The projected system sizes are listed for each high impact building, and in Table 5 of the Appendix.

⁶ [Designing Dedham 2035: Dedham Master Plan](#)

⁷ https://www.massschoolbuildings.org/news_events/Board_10.30.24/Dedham

⁸ [Oakdale Elementary School Schematic Design Specifications](#)

Dedham High School

In Fiscal Year 2022, the Dedham High School emitted 968 MTCO_{2e}, the highest building-related emissions at the time. Natural gas emissions were responsible for 70 percent of the building’s total emissions.

Though the high school was identified as the facility in the best condition of the four included in the 2020 Dedham Public Schools’ Long-Term Facilities Master Plan, it has not undergone any major renovations or reconstruction in at least 30 years. Due to this and its high emissions, it is prioritized in this roadmap.

The heating and cooling equipment at this building have reached their projected end-of-useful life, so electrification upgrades to the existing equipment could begin in the near-term, or in conjunction with renovations or new construction. Ground-source heat pumps (GSHP) may be considered at the time of electrification due to sufficient space surrounding the school building. The 10+ acres of land and fields could provide enough space for the required wells. Though further studies would be necessary, preliminary estimates predict that about 200 wells would be required to meet the demands of the high school. The middle school’s heating equipment is significantly newer than the high school’s, but it is possible that the two schools consider utilization of the same GSHP system, increasing the estimated number of wells to over 400.

Air source variable refrigerant flow (VRF) heat pumps could also be considered at the school, if GSHPs are not feasible. The GSHPs could also be used for domestic water heating, but if GSHPs are not installed, domestic heat pump water heaters (HPWH) could be used to electrify the existing tanks. In the near-term, Dedham will also continue to explore options for energy efficiency at the school, to further reduce emissions.

Building Characteristics

Square Footage: 307,323

FY2022 Emissions: 968 MTCO_{2e}

FY2022 EUI: 55 kBtu/ft²

Existing Solar: Yes, 120 kW

Primary Space Heating: 2011, natural gas

Primary Water Heating: 2011, natural gas

Proposed Strategy

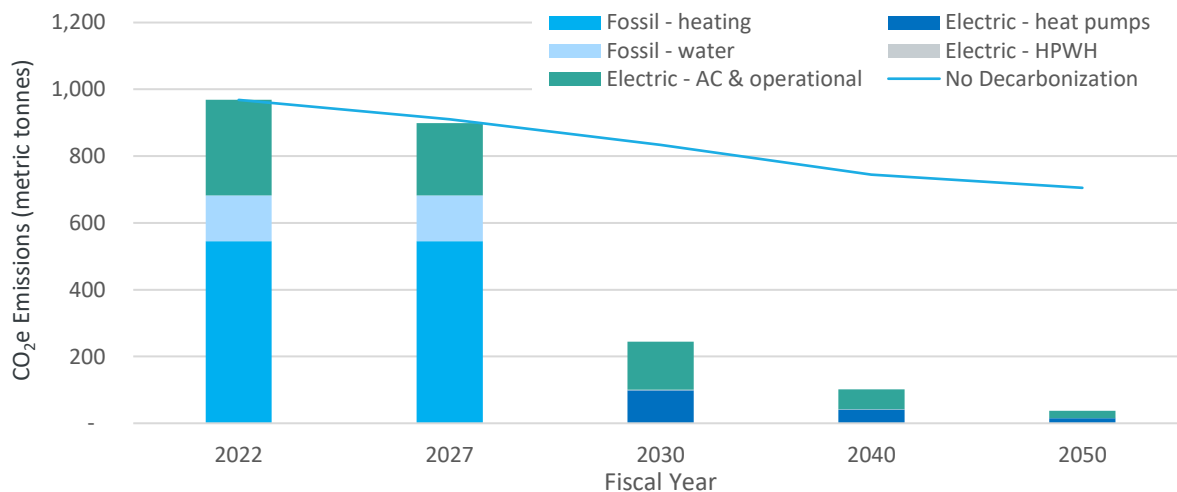
Energy Efficiency: 2025-2029

Onsite Solar: 2026, 247.8 kW

HVAC: 2030, GSHP or VRF

Water Heating: 2030, GSHP or HPWH

Figure 2. Estimated future building emissions based on proposed building efficiency and electrification plans at the Dedham High School.



Dedham Middle School

The Dedham Middle emitted the second highest GHG emissions of the Town buildings in Fiscal Year 2022. Though the school's emissions were high, the school had a lower Energy Use Intensity (EUI) likely due to the newer, more efficient heating system installed when the school was built in 2005.

Though there are no planned infrastructure improvements in the near term, the Town will consider electrification in the mid-term to reduce fossil fuel emissions. GSHPs may be a viable alternative to the existing hot water boilers, as there is ample open space surrounding the school (over 8 acres). If GSHPs were installed separately from the high school, approximately 220 wells would be required, though further studies would be needed to determine actual requirements.

Building Characteristics

Square Footage: 169,681

FY2022 Emissions: 538 MTCO_{2e}

FY2022 EUI: 55 kBtu/ft²

Existing Solar: No

Primary Space Heating: 2005, natural gas

Primary Water Heating: 2005, natural gas

Proposed Strategy

Energy Efficiency: 2025-2029

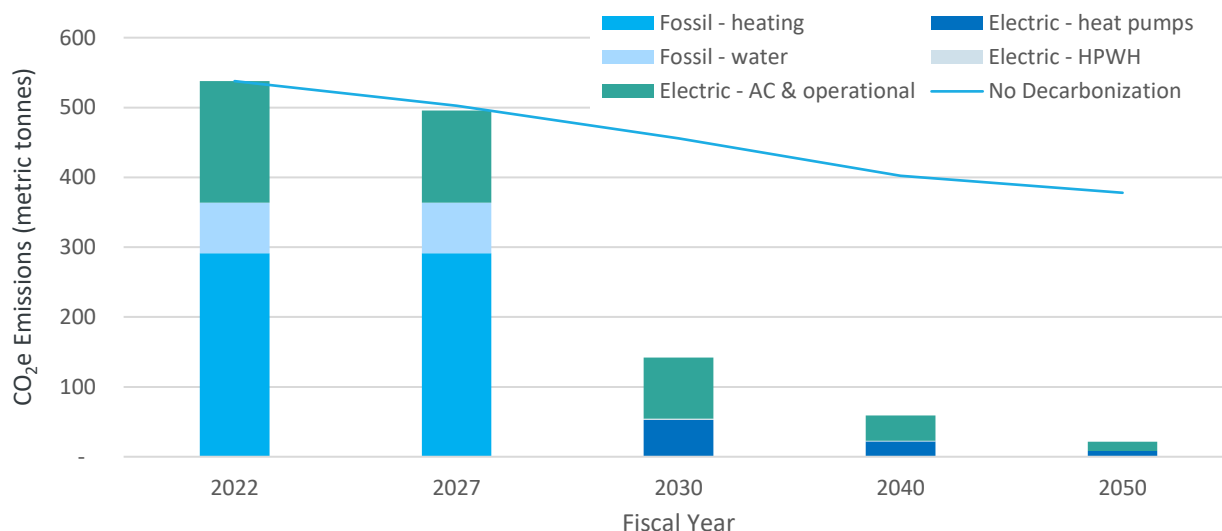
Onsite Solar: 2033, 168 kW

HVAC: 2030, GSHP or VRF

Water Heating: 2030, GSHP or HPWH

Air source VRF heat pumps could also be considered at the school, if GSHPs are not feasible. Like the high school, GSHPs could also be used for domestic water heating, but if GSHPs are not installed, domestic heat pump water heaters (HPWH) could be used to electrify the existing natural gas system. Both electrification options would reduce emissions in the mid-term, and in combination with electric water heating, would allow the school to achieve net zero emissions by 2050.

Figure 3. Estimated future building emissions based on proposed building electrification plans at the Dedham Middle School.



Oakdale Elementary School

The Oakdale Elementary School, which emitted the third highest emissions in Fiscal year 2022, was identified as first in priority in the 2020 Dedham School Department Master Plan. Though the Town was awarded \$30 million in 2024 to aid in replacing the existing Oakdale School with a new facility, the Town will not be moving forward with the project at this time.⁹ The proposed strategy in this analysis however, does align with what was described in the plans.

As described in the Schematic Design Specifications for the school, it is expected that geothermal or air source heat pumps will be utilized for heating and cooling.¹⁰ Though the construction for the school is delayed, this project is still presumed to occur in the mid term, around 2030.

Building Characteristics

Square Footage: 48,909

FY2022 Emissions: 363 MTCO_{2e}

FY2022 EUI: 101 kBtu/ft²

Existing Solar: No

Primary Space Heating: 1950 & 2011, fuel oil

Primary Water Heating: 1950, fuel oil

Proposed Strategy

Energy Efficiency: 2025-2029

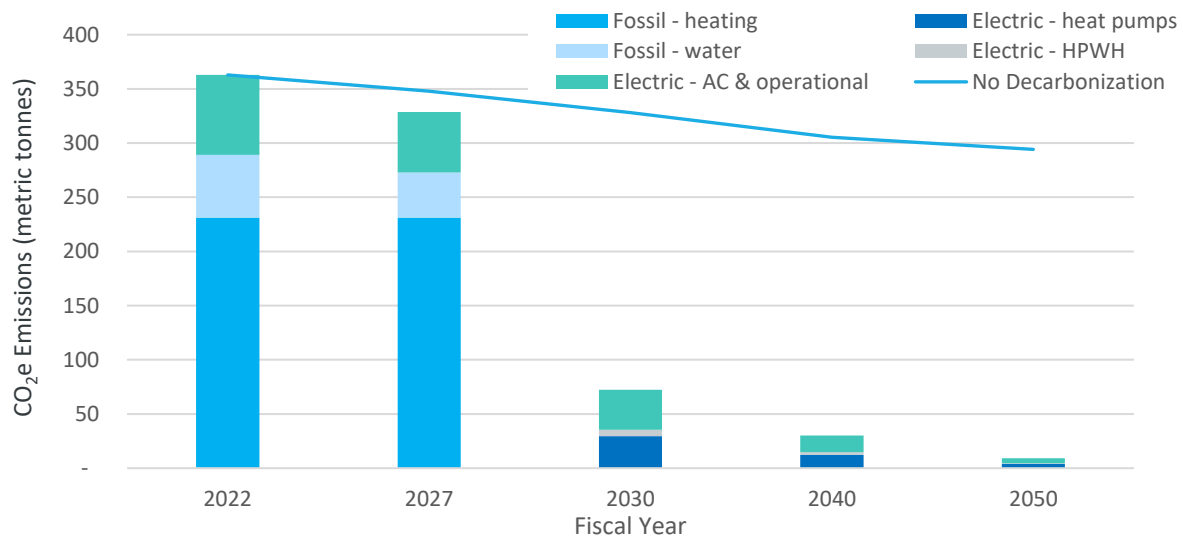
Onsite Solar: 2033, 168 kW

HVAC: 2030, GSHP

Water Heating: 2030, GSHP

Similar to the middle and high schools, GSHPs could also be used for domestic water heating, but if GSHPs are not installed, domestic heat pump water heaters (HPWH) could be used to electrify the existing fuel oil system. Both electrification options would reduce emissions in the mid-term, and in combination with electric water heating, would allow the new school to achieve net zero emissions.

Figure 4. Estimated future building emissions based on proposed building electrification plans at the Oakdale Elementary School.



⁹ https://www.massschoolbuildings.org/news_events/Board_10.30.24/Dedham

¹⁰ [Oakdale Elementary School Schematic Design Specifications](#)

Dedham Pool Building

The Dedham Pool Building’s unique use profile resulted in high fossil fuel usage in 2022. Despite recent upgrades to the the space heating and pool boilers, the inefficiencies associated with heating a pool still emmit more GHG emissions than most other buildings in the Town.

Though electrification may not occur in the near term, the Town could consider implementing energy efficiency measures such as upgrading lighting controls and fixtures, and insulation improvements, which could reduce energy consumption. In the long-term, the boilers used for space heating could be replaced with heat pump packaged units (RTU), and the pool’s water heater could be electrified using a Heat Pump Pool Heater.

Building Characteristics

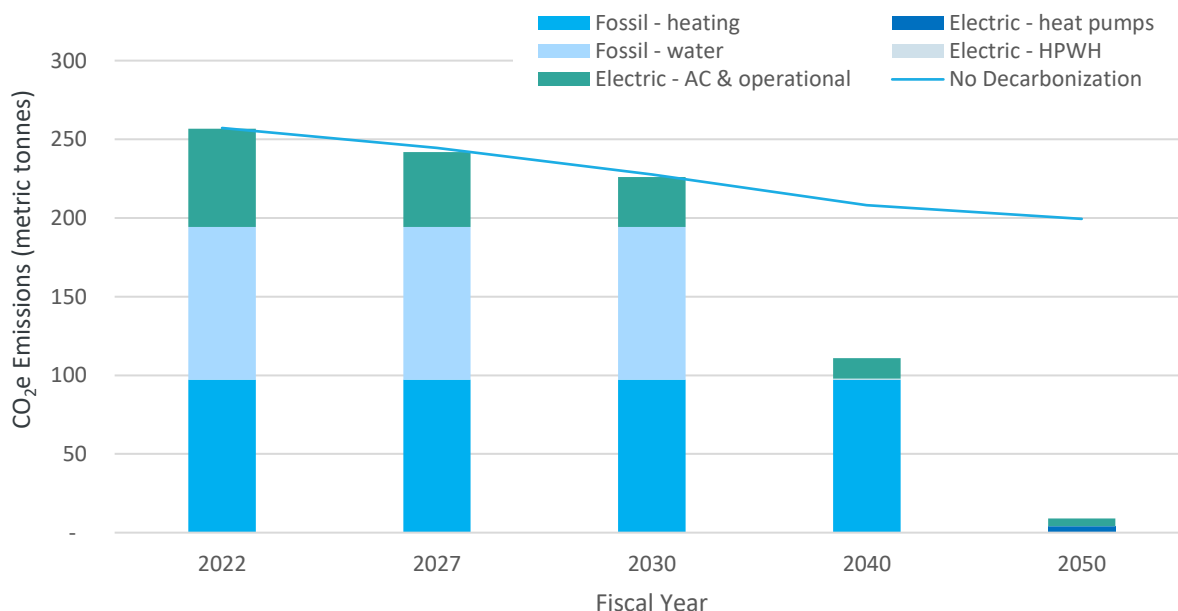
Square Footage: 11,744
FY2022 Emissions: 257 MTCO₂e
FY2022 EUI: 367 kBtu/ft²
Existing Solar: No
Primary Space Heating: 2020, natural gas
Primary Water Heating: 2023, natural gas

Proposed Strategy

Energy Efficiency: 2025-2029
Onsite Solar: 2045, 72.2 kW
HVAC: 2041, HP Packaged Unit (RTU)
Domestic Water Heating: 2038, HPWH
Heat Pump Pool Heater: 2038-2041

The pool building emitted the fourth highest emissions in Fiscal Year 2022, and is listed accordingly. The Riverdale and Greenlodge schools, however, are likely to prioritized for electrification upgrades prior to this facility.

Figure 5. Estimated future building emissions based on proposed building efficiency and electrification plans at the Dedham Pool Building.



Riverdale Elementary School

The Riverdale Elementary School was responsible for 6 percent of the Town’s building emissions included in this analysis. This school utilizes fuel oil for space heating, which accounts for 86 percent of the Fiscal Year 2022 emissions. This school building was identified as the second highest priority in the 2020 Dedham School Department Master Plan. The School Building Rehabilitation Committee (SBRC) aims to implement the next phase of the master plan by concentrating on replacement of the 102-year-old Riverdale School.

If a new school building were constructed, it would likely be larger than the existing building. VRF heat pumps could be used to electrify the new school, or the existing boilers if a new school is not feasible in the near- to mid-term. The natural gas water heater could be replaced with a heat pump water heater around the same time.

Building Characteristics

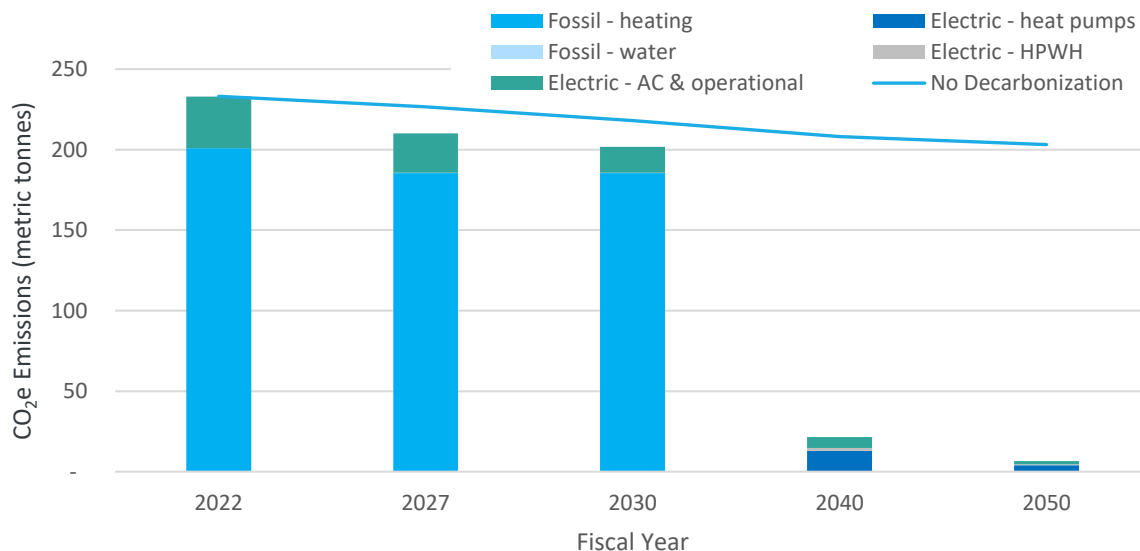
Square Footage: 37,299
FY2022 Emissions: 233 MTCO_{2e}
FY2022 EUI: 85 kBtu/ft²
Existing Solar: 2024, no
Primary Space Heating: 2011, fuel oil
Primary Water Heating: 1990, natural gas

Proposed Strategy

Energy Efficiency: 2025-2029
Onsite Solar: 2045 (or with new school), 144 kW
HVAC: 2031, VRF
Water Heating: 2031, HPWH

Though electricity consumption at the municipal building is relatively low, the high fossil fuel-related emissions suggest that there are additional opportunities for energy efficiency. Improvements to insulation, building operations, and windows may reduce emissions in the near-term, if new construction is delayed.

Figure 6. Estimated future building emissions based on proposed building electrification plans at the Riverdale Elementary School.



Greenlodge Elementary School

The Greenlodge Elementary School contributed 198 MTCO₂e in Fiscal Year 2022. This building was identified as the third highest priority in the Dedham School Department Master Plan and could be renovated or rebuilt in the mid-term.

Like the Riverdale School, if the Town decides to demolish and rebuild the school, VRF heat pumps would meet the space and energy demand needs of the new building. Otherwise, VRFs could replace the existing hot water and steam boilers. The propane-fueled domestic hot water heater could also be electrified using a heat pump water heater. Both electrification options would significantly reduce the school's annual emissions.

The high fossil fuel-related emissions at this school (68 percent of total emissions) suggest that there are additional opportunities for energy efficiency. Improvements to building operations and windows may reduce emissions in the near-term if new construction is delayed.

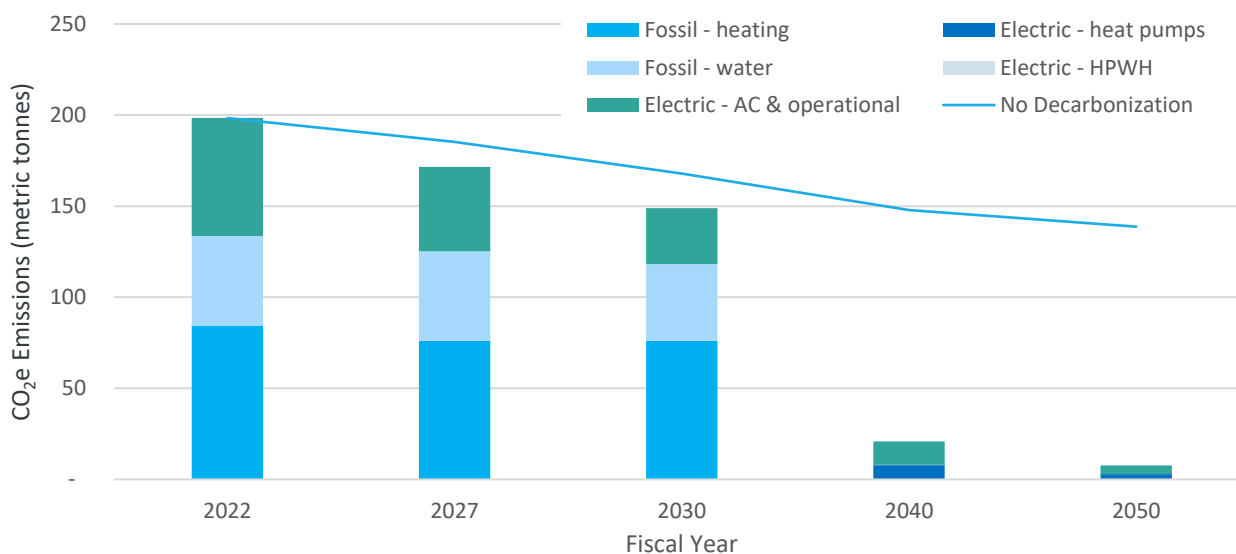
Building Characteristics

Square Footage: 51,084
FY2022 Emissions: 198 MTCO₂e
FY2022 EUI: 65 kBtu/ft²
Existing Solar: No
Primary Space Heating: 2011, natural gas
Primary Water Heating: 2011, natural gas

Proposed Strategy

Energy Efficiency: 2025-2029
Onsite Solar: 2030, 168.4 kW
HVAC: 2032, VRF
Water Heating: 2032, HPWH

Figure 7. Estimated future building emissions based on proposed building efficiency and electrification plans at the Greenlodge School.



Avery Elementary School

The Avery Elementary School contributed 191 MTCO₂e in Fiscal Year 2022. Though this emissions profile is lower than the other school buildings, it still consumes a large amount of natural gas. Like the middle school, this building, built in 2012, is much newer than the high school, Riverdale, and Greenlodge schools but can still be prioritized for electrification in the mid- to long-term.

The existing natural gas boilers and rooftop units (RTUs) are expected to reach their projected end-of-life around 2035. Electrification could therefore be considered in the mid-term, but may be considered after the other school buildings. Air source VRF heat pumps are expected to meet the demands of the building’s heating and cooling patterns.

Building Characteristics

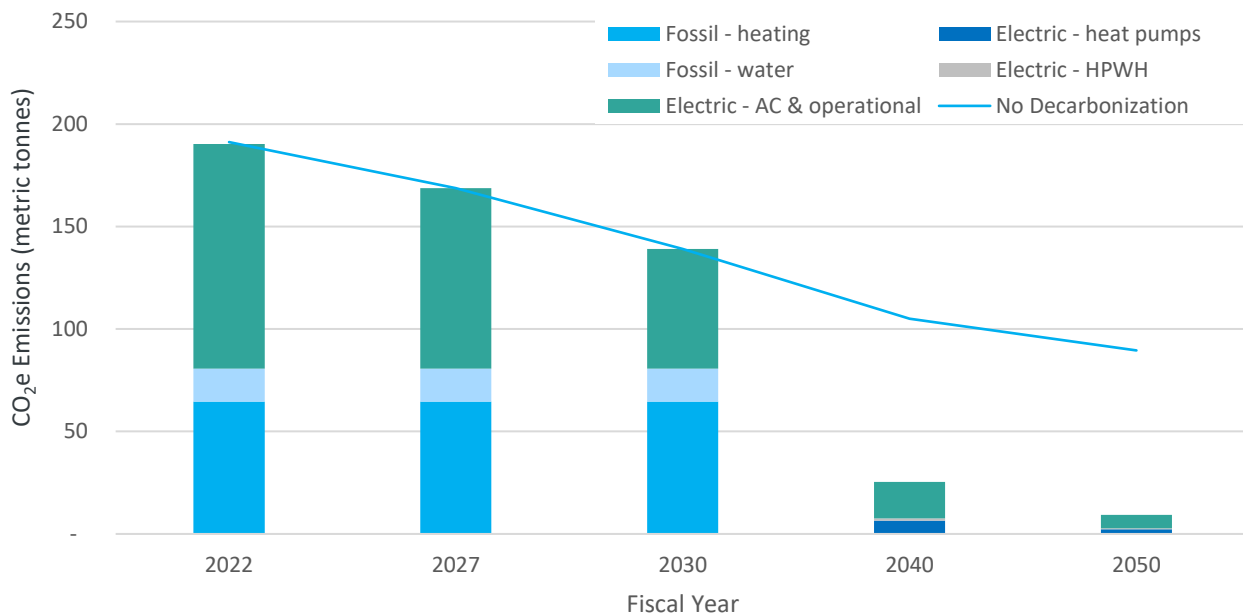
Square Footage: 61,000
FY2022 Emissions: 191 MTCO₂e
FY2022 EUI: 50 kBtu/ft²
Existing Solar: No
Primary Space Heating: 2011, natural gas
Primary Water Heating: 2011, natural gas

Proposed Strategy

Energy Efficiency: 2025-2029
Onsite Solar: 2036, 72.2 kW
HVAC: 2035, VRF
Water Heating: 2035, HPWH

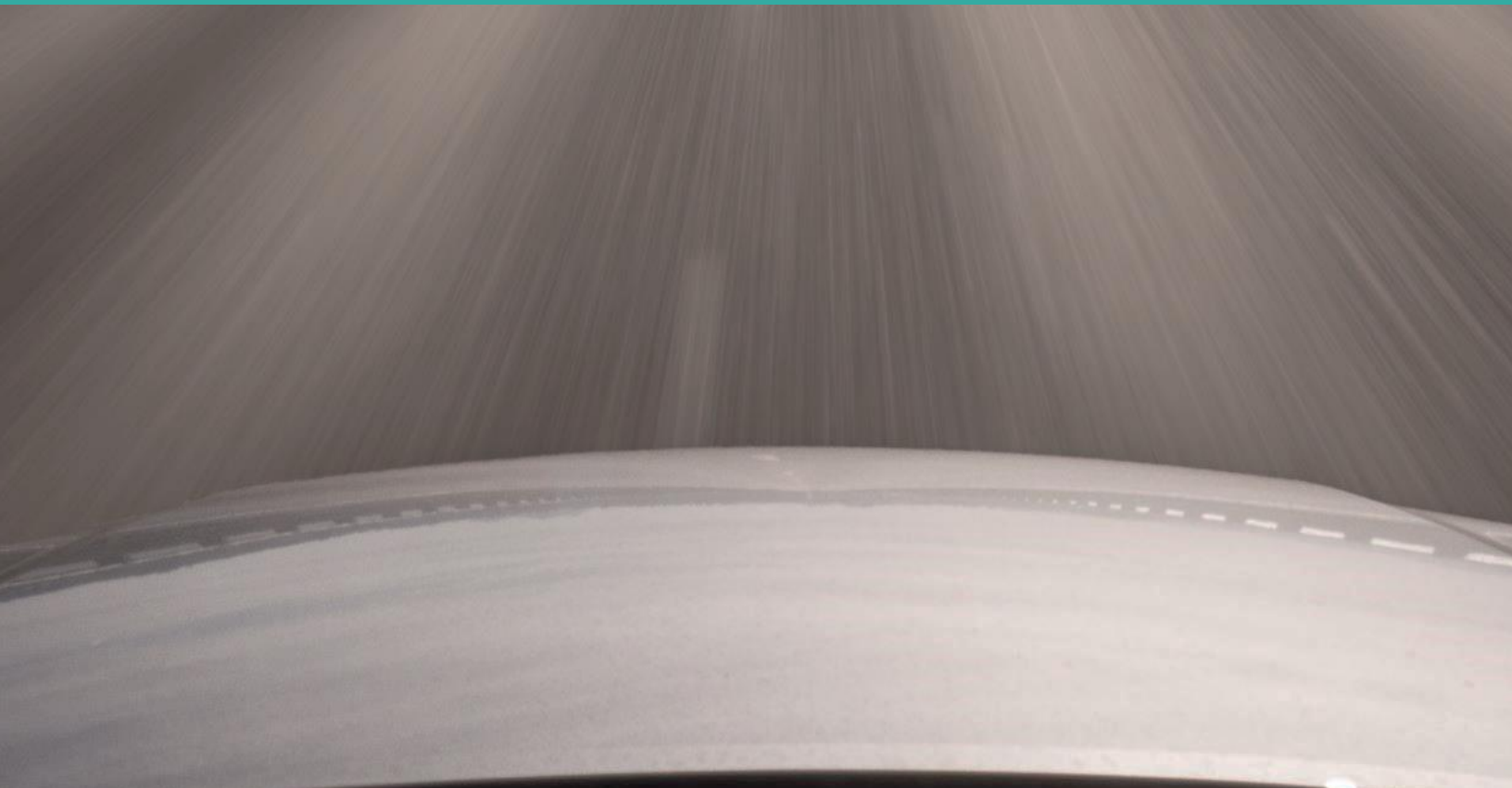
Though some energy conservation measures have been implemented at the school, updates to the BMS and insulation could further reduce energy consumption.

Figure 8. Estimated future building emissions based on proposed building efficiency and electrification plans at the Avery Elementary School.





Fleet Vehicles



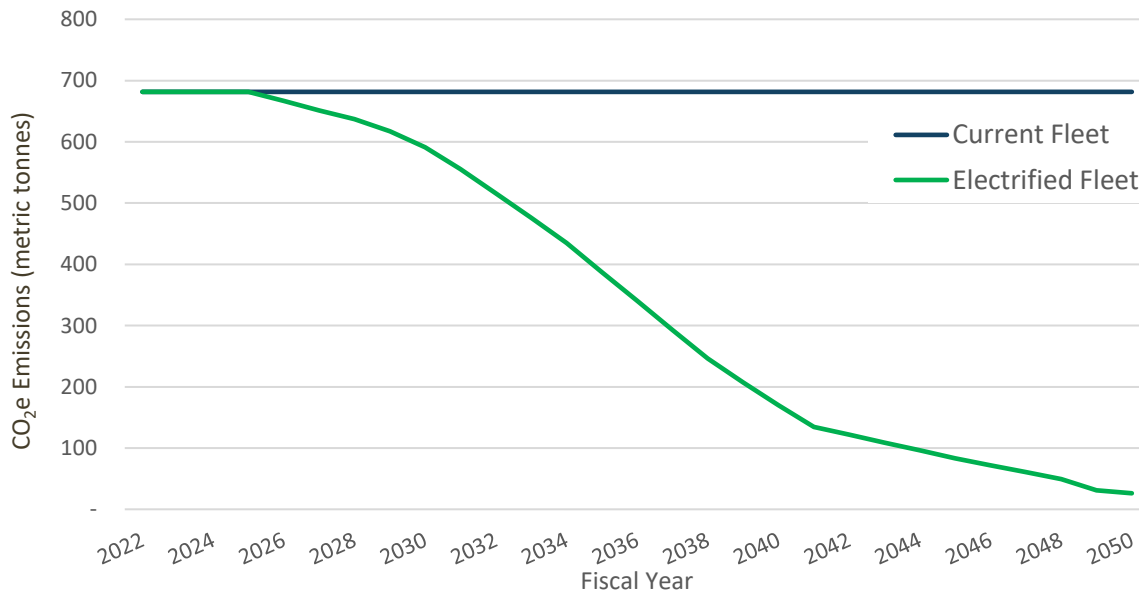
Vehicle Decarbonization

Since being designated a Green Community, the Town of Dedham is in the process of adopting the Zero-Emission Vehicle (ZEV) First policy, which is required for Climate Leader designation.¹¹ This policy requires that municipal departments and divisions prioritize the purchase of ZEVs moving forward. The requirements are intended to eliminate the combustion of fossil fuels in fleets and support broader emissions reductions in the municipality. Though there are some exempt vehicle types and exceptions, a procurement timeline that replaces vehicles at their projected end-of-useful lives or when electric alternatives become available, can be followed to comply with the policy.

As a Climate Leader Community, the Town will continue work to convert the internal combustion engine (ICE) vehicles to battery electric vehicles (BEV). Dedham’s analyzed fleet consists of 98 vehicles: 60 light-duty vehicles (LDV), 22 medium-duty vehicles (MDV), and 16 heavy-duty vehicles (HDV).¹² 21 vehicles were non-road vehicles, trailers and/or unidentifiable, and were excluded from this analysis. As of Fiscal Year 2024, Dedham had purchased 2 BEVs and 1 hybrid electric vehicle (2 Nissan Leaf’s, and 1 Ford Maverick). Existing electric vehicles were excluded from this analysis because the roadmap is specifically focused on transitioning the remaining ICE vehicles to zero-emission vehicles.

In Fiscal Year 2022, municipal and school vehicles contribute 16 percent of emissions for the Town of Dedham. Converting the current fleet of ICE vehicles to BEV platforms could result in avoiding 9.4 thousand metric tons of CO₂e emissions cumulatively through 2050 (Figure 9).

Figure 9. CO₂e (metric tonnes) emissions from Dedham’s vehicle fleet, by scenario, Fiscal Year 2022-2050.



¹¹ Climate Leaders Zero-Emission-First Vehicle Policy, <https://www.mass.gov/doc/climate-leader-communities-zev-first-policy/download>

¹² Alternative Fuels Data Center. "Vehicle Weight Classes & Categories." U.S. Department of Energy, <https://afdc.energy.gov/data/10380>.

EV Procurement Timeline

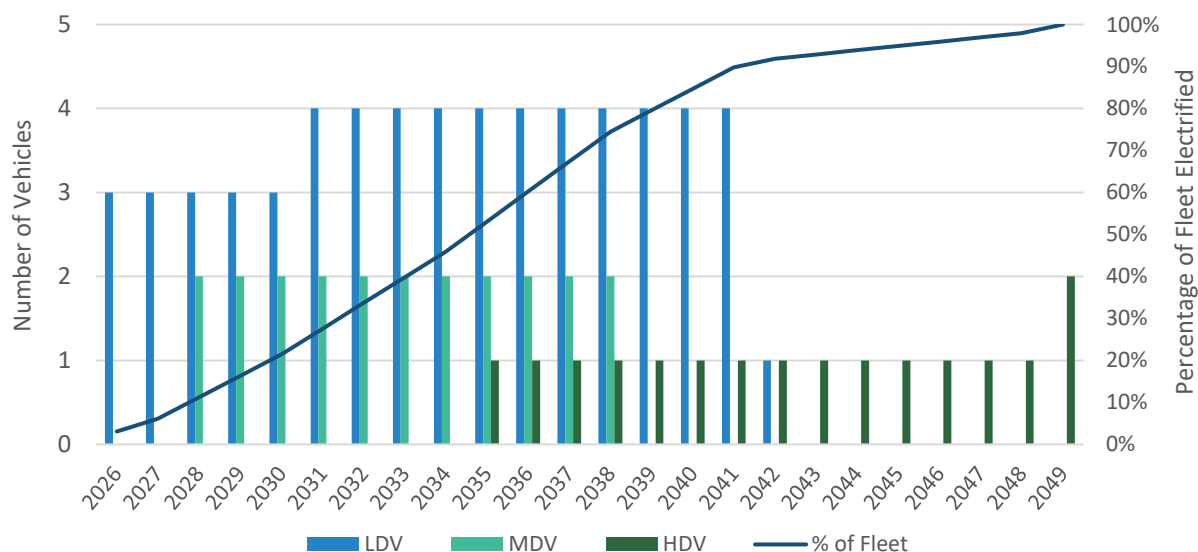
The procurement timeline is based on cost-effectiveness, annual budget considerations, and the remaining useful life of each vehicle in Dedham's existing fleet (Figure 10). The Appendix contains a detailed table that includes specific replacement years and EV model replacements for each existing vehicle. In Massachusetts, incentives for cleaner and more sustainable transportation solutions have become a cornerstone of the state's efforts to reduce emissions and promote a greener future. Though incentives can cover some costs, they do not cover all costs associated with electrifying vehicles. These assumptions are subject to change based on evolving factors such as market development and vehicle availability.

From 2025-2030, 15 light-, and 6 medium-duty vehicles may be converted to electric. These are primarily sedans, SUVs, and pickup trucks—all of which have mature EV market options that are cheaper and cleaner to operate than their gas/diesel alternatives. Strong state incentives make near-term purchase possible and recommended.

Between 2031-2040, another 40 light-, 16 medium-, and 6 heavy-duty vehicles could be replaced. These vehicles comprise of heavy-duty trucks, transit vans, and pickup trucks. The medium- and heavy-duty market is in the early stages of development, and we anticipate significant advancements will lead to increased cost-effectiveness in the future.

In 2041-2050, the remaining 5 light-, and 10 heavy-duty vehicles will be cost-competitive candidates for EV replacement. These vehicles comprise medium-duty trucks, F-350s and F-550s. Currently, electric alternatives for these vehicle types, particularly those with specialty features like mounted cranes and snowplows, are limited or non-existent. GM announced plans to launch EV heavy-duty trucks by 2035.

Figure 10. Vehicle replacement schedule by vehicle class (light-duty [LDV], and medium-duty [MDV]).



Assumptions

Emissions Factors

- Emissions factors for fossil fuels are held constant throughout the roadmap and were derived from the EPA published factors.¹³ Electricity emissions factors are sourced from Mass Energy Insight, and represent estimates based off the New England grid (Table 8).

Buildings

- *Energy Efficiency Recommendations and Savings*: The measures and associated savings outlined for buildings were derived through completion of a virtual energy audit of all buildings.¹⁴
- *Electrification Recommendations*: Existing equipment replacement year is determined by the current age of the system(s) and any planning currently underway. **The equipment ages listed in the high impact buildings and Appendix Table 5 are estimates due to limited data availability.** The type of heat pump equipment used for electrification is determined using the following data points provided by the community:
 - o System age and capacity
 - o Fuel type(s) used
 - o Building square footage
 - o Existing equipment type (i.e., boiler, furnace, RTU, etc.)

Fleet

- *Mileage Consideration*: Analysis incorporates average miles traveled to align recommendations with real-world usage patterns, unless otherwise provided by the Town.
- *Vehicle Replacement*: The year is determined by factors including:
 - o *Expected Lifetime*: Vehicles typically have a lifespan of around 10 years. This expected lifetime helps to establish a baseline for when replacement becomes necessary.
 - o *Market Availability*: Based on the availability of electric alternatives in the market, the recommendation is to wait until a specific model becomes available.
 - o *Community Budgets*: The Town's proposed budget for vehicle replacement is considered when determining how many vehicles are replaced in each year of the procurement timeline.

¹³ [Greenhouse Gas Emissions Technical Reference](#)

¹⁴ This was a "desktop" audit. In-person, technical audits will be required to validate efficiency measures to implement.

Conclusion & Next Steps

This roadmap illustrates that the Town of Dedham can effectively meet the emissions reductions targets set by the Secretary and required for the Climate Leader Community certification. By 2050, the electrification measures outlined in this roadmap are estimated to reduce Dedham's GHG emissions by over 97 percent, lowering the Town's Energy Use Intensity (EUI) by 52 percent.

To become a certified Climate Leader, Dedham will, in combination with ongoing GHG reduction efforts, strive to implement this Municipal Decarbonization Roadmap. The first step of implementation will most likely include a more detailed energy audit of the Town's buildings, that highlights actionable recommendations and cost estimates. To comply with Climate Leader guidelines, Dedham also commits to updating the proposed plan of action every three years.



Appendix

Table 5. Possible decarbonization measures, by building.

Building	Fiscal Year 2022 Emissions (MT CO ₂ e)	Building Square Footage	Possible/Existing Energy Efficiency (EE) Measures	Space Heating		Domestic Water Heating		Solar PV Potential	
				Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (roof year)	Replacement (installation year, size [kW])
Avery Elementary	191	61,000	- Ensure efficient BMS run times and temperature settings - Weatherization and insulation upgrades	2011, Natural Gas	2035, VRF	2011, Natural Gas	2035, HPWH	2011	2036, 72.2
Capen Building - YMCA/BLUE Hills	106	37,026	- Replace windows - Weatherization and insulation upgrades	1990, Oil	2035, VRF	1990, Natural Gas	2035, HPWH	1931	N/A
Dedham High School	968	307,323	- Ensure efficient BMS run times and temperature settings - Weatherization and insulation upgrades	2011, Natural Gas	2030, GSHP	2011, Natural Gas	2030, GSHP	2024	2025, energy produced is going back to the Grid

Building	Fiscal Year 2022 Emissions (MT CO ₂ e)	Building Square Footage	Possible/Existing Energy Efficiency (EE) Measures	Space Heating		Domestic Water Heating		Solar PV Potential	
				Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (roof year)	Replacement (installation year, size [kW])
Dedham Middle School	538	169,681	<ul style="list-style-type: none"> - Weatherization and insulation upgrades - Monitor temperature setpoints and/or add additional control points 	2005, Natural Gas	2032, GSHP	2005, Natural Gas	2032, GSHP	2008	2025, 277.42
Early Childhood Education Center (ECEC)	125	51,000	<ul style="list-style-type: none"> - Ensure efficient BMS run times and temperature settings - Ensure efficient ventilation rates 	2019, Natural Gas	2033, VRF	2019, Natural Gas	2033, HPWH	2017	2025, planned
Greenlodge Elementary School	198	51,084	<ul style="list-style-type: none"> - Monitor temperature setpoints and/or add additional control points - Ensure efficient ventilation rates - Replace windows 	2011, Natural Gas	2032, VRF	2011, Natural Gas	2032, HPWH	1950	2030, 168.4

Building	Fiscal Year 2022 Emissions (MT CO ₂ e)	Building Square Footage	Possible/Existing Energy Efficiency (EE) Measures	Space Heating		Domestic Water Heating		Solar PV Potential	
				Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (roof year)	Replacement (installation year, size [kW])
Oakdale Elementary School	363	48,909	- Ensure efficient BMS run times and temperature settings - Improve insulation and replace windows	1950 and 2011, Oil	2030, GSHP or VRF	1950, Oil	2027, GSHP or HPWH	1970	2030, 168.4
Riverdale Elementary School	233	37,299	- Ensure efficient BMS run times and temperature settings - Replace windows	2011, Oil	2031, VRF	1990, Oil	2031, HPWH	2024	2049, 144.4
Ames Town Hall	69	50,000	- Ensure efficient ventilation rates - Replace windows	2015, Electricity	2043, VRF	2017, Natural Gas	2043, HPWH	2024	N/A
Brookdale Cemetery Office Building	11	2,300	- Ensure efficient BMS run times and temperature settings - Upgrade lighting controls and fixtures	1960, Natural Gas	2038, Ducted ASHP	1960, Natural Gas	2038, HPWH	1960	N/A

Building	Fiscal Year 2022 Emissions (MT CO ₂ e)	Building Square Footage	Possible/Existing Energy Efficiency (EE) Measures	Space Heating		Domestic Water Heating		Solar PV Potential	
				Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (roof year)	Replacement (installation year, size [kW])
DPW	120	13,800	<ul style="list-style-type: none"> - Upgrade lighting controls and fixtures as needed - Ensure efficient BMS run times and temperature settings - Replace windows 	1967, Natural Gas	2025, planned VRF installation with Natural Gas backup	1967, Natural Gas	2032, HPWH	1950	2031, 48.1
DPW Garage	14	4,467	<i>No efficiency measures found in desktop audit</i>	1967, Natural Gas	2042, Ducted ASHP	1967, Natural Gas	2042, HPWH	2022	N/A
Dedham Pool	257	11,744	<i>No efficiency measures found in desktop audit</i>	2020, Natural Gas	2041, HP Packaged Unit (RTU)	2023, Natural Gas	2038, HPWH	2020	2045, 72.2
Dolan Center	24	8,902	- Building recently taken offline. No fossil fuel usage, Only electricity.	2006, Propane	2040, Ducted ASHP	2006, Propane	2040, HPWH	1989	N/A

Building	Fiscal Year 2022 Emissions (MT CO ₂ e)	Building Square Footage	Possible/Existing Energy Efficiency (EE) Measures	Space Heating		Domestic Water Heating		Solar PV Potential	
				Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (roof year)	Replacement (installation year, size [kW])
East Dedham Fire House	26	6,092	<ul style="list-style-type: none"> - Weatherization insulation upgrades - Ensure efficient BMS run times and temperature settings - Replace windows 	2015, Natural Gas	2030, Ductless ASHP	2015, Natural Gas	2030, HPWH	1945	N/A
Endicott Estate	72	25,228	<ul style="list-style-type: none"> - Monitor temperature setpoints and/or add additional control points - Ensure efficient BMS run times and temperature settings - Replace windows 	2002, Natural Gas	2032, VRF	2002, Natural Gas	2032, HPWH	2023	N/A
Endicott Library	23	4,276	<ul style="list-style-type: none"> - Weatherization insulation upgrades - Ensure efficient ventilation rates 	2002, Natural Gas	2033, Ducted ASHP	2002, Natural Gas	2033, HPWH	2000	N/A

Building	Fiscal Year 2022 Emissions (MT CO ₂ e)	Building Square Footage	Possible/Existing Energy Efficiency (EE) Measures	Space Heating		Domestic Water Heating		Solar PV Potential	
				Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (roof year)	Replacement (installation year, size [kW])
			- Ensure efficient BMS run times and temperature settings						
Main Library	46	17,546	- Weatherization insulation upgrades - Upgrade lighting controls and fixtures as needed - Ensure efficient BMS run times and temperature settings - Replace windows	2010, Natural Gas	2033, VRF	2010, Natural Gas	2033, HPWH	2021	N/A
Old Avery - Motherbrooks Art Center <i>(owned but not managed by Town)</i>	2	38,964	- Weatherization insulation upgrades - Replace windows - Ensure efficient ventilation rates	2015, Natural Gas	2034, VRF	2012, Natural Gas	2034, HPWH	1995	N/A

Building	Fiscal Year 2022 Emissions (MT CO ₂ e)	Building Square Footage	Possible/Existing Energy Efficiency (EE) Measures	Space Heating		Domestic Water Heating		Solar PV Potential	
				Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (roof year)	Replacement (installation year, size [kW])
Public Safety Building	69	82,564	<i>New building, no efficiency measures found in desktop audit</i>	2023, Natural Gas (30%) and Electricity (70%)	2045, VRF	2023, Natural Gas	2045, HPWH	2023 (new 75kW solar)	2048, 48.1
Main Fire House	26	Demolished in 2023							
Police Station	50	Demolished in 2023							

Table 6. Vehicle by vehicle replacement schedule and savings estimates.

Suggested replacement schedule for each of the fleet’s vehicles with the replacement year and the type of EV replacement. The table provides annual estimates for avoided greenhouse gas emissions. Total Cost of Ownership (TCO) includes vehicle costs, fuel, maintenance, and charging. The amounts vary depending on the replacement year and assume that, on average, electric vehicles (EVs) are 40% less cost-intensive than internal combustion engine (ICE) vehicles.¹⁵

Replace Year	Department	Existing Vehicle Description			Electric Vehicle Description				
		Make	Model	VIN	Make-Model-Class	EV Price	Miles per Gallon (eMPG)	Total Cost of Ownership	Avoided MT CO ₂ e (annually)
2026	DPW	STERLING TRUCK	L7500 series	2FZHALBBXYAG07884	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$462,972	20.8
2026	Parks Rec	FORD	F-250	1FTNW21L71EB12419	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$71,371	7.5
2026	Parks Rec	FORD	F-250	2FTEF25H0JCA99833	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$71,371	7.5
2027	Parks Rec	FORD	F-250	1FTNW21L31EB12420	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$71,371	7.5
2027	DPW	FORD	F-350	1FTSF31L21EB12417	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$71,371	7.5
2027	Police	TOYOTA	Tundra	5TBRT341X3S343119	Pickup-Ford-F150 Lightning-Class 1-3	\$22,795	67	\$69,477	8.2
2028	Auxiliary Police	FORD	Crown Victoria	2FABP7BV6AX133151	Sedan-Chevrolet-Bolt-Class 1	\$17,122	134	\$48,967	6.1
2028	Auxiliary Police	FORD	Crown Victoria	2FAFP71W37X100273	Sedan-Chevrolet-Bolt-Class 1	\$17,122	134	\$48,967	6.1
2028	Facilities	FORD	F-250	1FTNF21578EE53590	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2028	Parks Rec	FORD	0	2FDKS37M6NCB14551	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	8.6
2028	DPW	FORD	F-450	1FDXF47F21EB24656	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	8.6
2029	Youth Commission	FORD	E-150	1FMNE1BW0ADA98600	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$81,221	7.8
2029	DPW	FORD	F-150	1FTFX1EV6AFD05307	Pickup-Ford-F150 Lightning-Class 1-3	\$22,795	67	\$66,075	7.8
2029	Facilities	FORD	F-150	1FTMF1CW7AKA20435	Pickup-Ford-F150 Lightning-Class 1-3	\$22,795	67	\$66,075	7.8
2029	DPW	FORD	F-550	1FDAF57F91EB12418	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	8.1

¹⁵ Forbes. "What it costs to maintain an electric vehicle." *Forbes*, accessed July24, 2024. <https://www.forbes.com/sites/jimgorzelayny/2022/10/06/by-the-numbers-what-it-costs-to-maintain-an-electric-vehicle/>

Replace Year	Department Department	Existing Vehicle Description			Electric Vehicle Description				
		Make	Model	VIN	Make-Model-Class	EV Price	Miles per Gallon (eMPG)	Total Cost of Ownership	Avoided MT CO ₂ e (annually)
2029	Fire	FORD	F-550	1FDAF57F42EC27171	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	8.1
2030	Auxiliary Police	FORD	Crown Victoria	2FABP7BV9BX180689	Sedan-Chevrolet-Bolt-Class 1	\$17,122	134	\$48,967	6.1
2030	DPW	FORD	F-150	1FTFX1EF1CFC41804	Pickup-Ford-F150 Lightning-Class 1-3	\$22,795	67	\$66,075	7.8
2030	DPW	FORD	F-150	1FTFX1EF1CFC41805	Pickup-Ford-F150 Lightning-Class 1-3	\$22,795	67	\$66,075	7.8
2030	DPW	FORD	F-350	1FDWF37Y05EB01941	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2030	DPW	FORD	F-550	1FDAF57PX4EA23115	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	7.0
2031	Police	FORD	Taurus	1FAHP2M89DG164988	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	6.1
2031	Parks Rec	FORD	F-250	1FT7X2B6XDEA51697	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2031	Police	FORD	F-150	1FTMF1CM8DKF05993	Pickup-Ford-F150 Lightning-Class 1-3	\$22,795	67	\$66,075	7.8
2031	DPW	FORD	Explorer	1FM5K8B87DGC40835	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	7.2
2031	Council Aging	FORD	E-350	1FDEE3FL0BDB29860	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$81,221	7.5
2031	DPW	FORD	F-550	1FDUF5HY8BEB35560	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	7.0
2032	Police	DODGE	Charger	2C3CDXKT5EH334906	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2032	School	FORD	Escape	1FMCU9G99EUC23739	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	4.0
2032	Facilities	FORD	E-150	1FTNE1EW8DDA07819	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$81,221	7.8
2032	Facilities	FORD	E-150	1FTNE1EW8DDA07820	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$81,221	7.8
2032	DPW	FORD	F-550	1FDUF5HT0EEA60782	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	8.1
2032	DPW	FORD	F-550	1FDUF5HT2EEA60783	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	8.1
2033	School	FORD	E-250	1FTNE2EW1EDA39308	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$81,221	7.5
2033	DPW	FORD	F-150	1FTFX1EF6EKF62621	Pickup-Ford-F150 Lightning-Class 1-3	\$22,795	67	\$66,075	7.8
2033	Fire	FORD	Explorer	1FM5K8AR9EGA55374	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	7.2
2033	Fire	FORD	Expedition	1FMJU1G57EEF63309	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	7.2

Replace Year	Department Department	Existing Vehicle Description			Electric Vehicle Description				
		Make	Model	VIN	Make-Model-Class	EV Price	Miles per Gallon (eMPG)	Total Cost of Ownership	Avoided MT CO ₂ e (annually)
2033	DPW	FORD	F-350	1FD8X3B62FEB89310	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2033	Fire	FORD	F-550	1FDUF5GT4FEB36670	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	8.1
2034	Police	HARLEY-DAVIDSON	FLHPT / Electra Glide Standard Police	1HD1FMM16FB613832	Police_Motorcycle-LiveWire-S2 Mulholland-	\$16,499	385	\$34,807	3.9
2034	Police	RAM	1500	1C6RR7XT4GS180644	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	8.7
2034	School	FORD	F-350	1FD7X3B62GED41809	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2034	School	FORD	Transit	1FTNR1CM0FKB13797	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$81,221	6.6
2034	Parks Rec	FORD	F-350	1FDRF3H65GEB55054	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2034	School	FORD	F-350	1FDRF3H64GED41653	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2035	Council Aging	DODGE	Grand Caravan	2C7WDGBG6HR647427	Minivan-Chrysler-Pacifica PHEV-Class 1	\$40,000	110	\$72,434	7.5
2035	DPW	CHEVROLET	Tahoe	1GNSKFEXHR322152	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	9.8
2035	Police	FORD	Explorer	1FM5K8AT4HGA36666	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2035	DPW	FORD	Explorer	1FM5K8D87GGA37431	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	7.2
2035	School	CHEVROLET	Express	1GB6GUBG1G1158508	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$81,221	6.6
2035	DPW	FORD	F-550	1FDUF5HY9GEB43965	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	7.0
2035	DPW	FORD	L8511	1FDYX82E2WVA39847	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$427,422	8.1
2036	Police	HARLEY-DAVIDSON	FLHPT / Police Electra Glide Explorer	1HD1FMC17JB613767	Police_Motorcycle-LiveWire-S2 Mulholland-	\$16,499	385	\$34,807	3.9
2036	Police	FORD	Explorer	1FM5K8AR9JGA84187	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2036	School	FORD	F-350	1FDBF3B65HEB15021	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2036	Fire	FORD	F-250	1FTBF2B68HEB54233	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2036	DPW	FORD	F-350	1FDRF3B64LEC33035	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2036	DPW	FORD	F-550	1FDUF5HT0JEC29368	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	8.1

Replace Year	Department Department	Existing Vehicle Description			Electric Vehicle Description				
		Make	Model	VIN	Make-Model-Class	EV Price	Miles per Gallon (eMPG)	Total Cost of Ownership	Avoided MT CO ₂ e (annually)
2036	Fire	AMERICAN LAFRANCE	Eagle	4Z36ESEB8YRG31465	Fire_Truck-Pierce-Volterra-Class 8	\$870,000	9	\$975,269	18.1
2037	Police	CHEVROLET	Colorado	1GCGTBEN3K1309819	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2037	Police	FORD	F-150	1FTEW1PG7JKD95071	Pickup-Ford-F150 Lightning-Class 1-3	\$22,795	67	\$66,075	7.8
2037	Endicott Estate	FORD	F-250	1FT7X2B68JED04513	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2037	Fire	FORD	Explorer	1FM5K8ARXJGC94734	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	7.2
2037	DPW	FORD	F-350	1FDRF3H63MEE11302	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2037	DPW	FORD	F-550	1FDUF5HT6NDA19305	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	8.1
2037	Fire	E-ONE	Truck	4ENRAAA0R1003177	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$427,422	18.6
2038	Police	DODGE	Charger	2C3CDXKGM0MH562815	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2038	Council Aging	CHRYSLER	Voyager	2C4RC1AG3LR243621	Minivan-Chrysler-Pacifica PHEV-Class 1	\$40,000	110	\$72,434	7.5
2038	Police	DODGE	Durango	1C4RDJFG2MC659448	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	7.9
2038	Fire	FORD	Expedition	1FMJU1GT0LEB00620	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	7.2
2038	Facilities	FORD	F-350	1FD8X3HN1PED95573	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2038	Fire	FORD	F-550	1FD0W5HT4NEE43915	Refuse_Hauler-Mack-LR-Class 7	\$208,500	16	\$461,085	8.1
2038	DPW	STERLING TRUCK	L8500 series	2FZHAWDA47AY46672	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$427,422	20.8
2039	Police	FORD	Explorer	1FM5K8AW7MNA00907	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2039	Police	FORD	Explorer	1FM5K8AW9MNA00908	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2039	Police	FORD	Explorer	1FM5K8AW7MNA04570	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2039	Police	FORD	Explorer	1FM5K8AW2MNA04573	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2039	DPW	PETERBILT	340	2NPRLN0X38M760018	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$427,422	20.8
2040	Police	FORD	Expedition	1FMJU1GT8MEA71322	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2040	Police	FORD	Transit	1FTBW2Y85NKA20267	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$81,221	6.6

Replace Year	Department Department	Existing Vehicle Description			Electric Vehicle Description				
		Make	Model	VIN	Make-Model-Class	EV Price	Miles per Gallon (eMPG)	Total Cost of Ownership	Avoided MT CO ₂ e (annually)
2040	Facilities	FORD	F-250	1FTBF2B67NEE93089	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.5
2040	Fire	FORD	Explorer	1FM5K8AW0NNA01995	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	7.2
2040	Fire	PIERCE MANUFACTURING	Arrow XT	4P1CA01H89A010420	Fire_Truck-Pierce-Volterra-Class 8	\$870,000	9	\$975,269	18.1
2041	Town Hall	FORD	Maverick	3FTTW8E34PRA57843	Pickup2-Chevrolet-Silverado EV-Class 1-3	\$24,900	67	\$67,780	7.8
2041	Police	TOYOTA	RAV4	JTMLWRFV8PD190216	SUV-Chevrolet-Blazer 2LT-Class 1-3	\$33,995	97	\$66,746	5.5
2041	Police	FORD	Explorer	1FM5K8AW0PNA04544	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2041	Police	FORD	Explorer	1FM5K8AW0PNA04446	Police_Vehicle-Ford-Mustang Mach-E-Class 1	\$23,682	93	\$55,894	7.2
2041	DPW	INTERNATIONAL	SA525	1HTWDAAR9CJ627671	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$427,422	20.8
2042	Town Hall	FORD	Transit	1FTBW9CK5PKA92696	Transit_Van-Ford-E-Transit Cargo-Class 3	\$34,459	62	\$77,616	7.5
2042	DPW	INTERNATIONAL	SF537	1HTWPAZTXDJ348884	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$417,510	20.8
2043	DPW	INTERNATIONAL	SA525	3HAWDSTR5FL678335	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$407,598	20.8
2044	Fire	E-ONE	Truck	4EN6AHA89F2009240	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$397,685	18.6
2045	DPW	INTERNATIONAL	TR005	1HTKPSKK6GH283792	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$387,773	20.8
2046	Fire	E-ONE	Truck	4EN6ABA83G1000344	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$377,861	18.6
2047	Fire	E-ONE	Truck	4EN6AHA82K2002608	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$366,329	18.6
2048	DPW	WESTERN STAR	4700	5KKHAVFM5MLMG9820	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$354,797	20.8
2049	Fire	E-ONE	Truck	4ENDABA89P1002493	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$343,264	18.6
2049	Fire	E-ONE	Truck	4EN6AHA82N2004928	Dump_Truck-Lion Electric-Dump Truck -Class 8	\$265,000	16	\$343,264	18.6

Emissions Projections

Table 7. MT CO2e projections, provided by MA EEA in the CECP 2050.

CO2 Emissions per Unit (metric tons, MTe)	2022	2025 (projected)	2030 (projected)	2040 (projected)	2050 (projected)
Natural Gas (therms)	0.00531	0.00531	0.00531	0.00531	0.00531
Oil Savings (gallons)	0.01015	0.01015	0.01015	0.01015	0.01015
Gasoline (gallons)	0.00886	0.00886	0.00886	0.00886	0.00886
Diesel (gallons)	0.01015	0.01015	0.01015	0.01015	0.01015
Propane (gallons)	0.00576	0.00576	0.00576	0.00576	0.00576

Source: MA EEA

Table 8. Electricity Emissions Factors present and projected, listed in Mass Energy Insight.

Year Start	Year End	kilograms of CO2e/kWh
Jan-21	Dec-21	0.24350
Jan-22	Dec-22	0.24160
Jan-23	Dec-23	0.23970
Jan-24	Dec-24	0.23780
Jan-25	Dec-29	0.23590
Jan-30	Dec-34	0.12770
Jan-35	Dec-39	0.08760
Jan-40	Dec-44	0.05310
Jan-45	Dec-49	0.03170
Jan-50	TBD	0.01630