Climate Leaders Municipal Decarbonization Roadmap

Prepared for: The Town of Brookline, MA

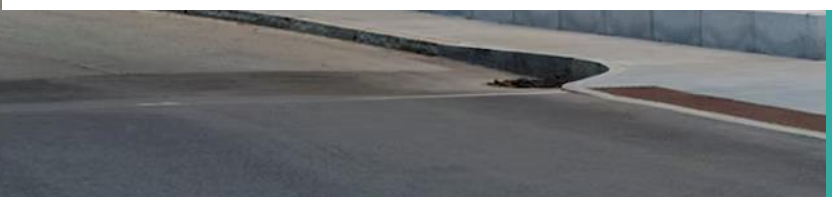
November 2025

PowerOptions

Green Communities Massachusetts Department of Energy Resources

DOER Massachusetts Department of Energy Resources

Massachusetts Clean Energy Center



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 (for municipally owned assets) 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 Brookline as the second action for certification.

The roadmap is intended to function as a guideline for the Town. It is intended for planning purposes only, and does not attempt to identify costs or funding sources. To determine the feasibility of executing this roadmap and the associated costs, a technical assessment will be required.

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

Targets	2022	2027	2030	2040	2050
Emissions reductions from onsite fossil fuels	0%	-20%	-35%	-60%	-100%
Zero emission vehicles (ZEVs) in light-duty fleet adoption	0%	5%	20%	75%	100%
Zero emission vehicles (ZEVs) in heavy-duty fleet adoption	0%	0%	20%	50%	100%
Energy Use Intensity reduction	0%	-20%	-25%	-25%	-30%
Total Emissions Reduction Goals (% of 2022 emissions)	0%	>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 2011, the Town of Brookline, Massachusetts (Brookline) has received over $1 million in funding to complete energy conservation projects focused on building efficiency, weatherization, lighting upgrades, heat pump installation, electric vehicles (EV), and EV charging stations. In the roadmap's baseline year, Fiscal Year 2022, Brookline's municipal operations (municipal and school buildings, lighting, and the Town's municipal and school fleets), emitted 11,215 metric tons of carbon dioxide equivalent (MT CO_2e) (Table 2). To become a certified Climate Leader, Brookline 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.

Per the DOER's guidelines, the twenty-two buildings formally analyzed in this roadmap, contributed 85 percent of the Town's building-related emissions in Fiscal year 2022. These buildings were analyzed for efficiency and decarbonization opportunities, using the "zero over time" approach. Though this approach is not required of all Town buildings, it is assumed that the rest of Brookline's Town building portfolio will also be decarbonized as equipment, roofs, or other systems need to be retrofitted or replaced. The buildings that are excluded from the formal roadmap process are listed in Table 4, and though included in the emissions projections, the "zero over time" approach is not outlined or described for them here.

This roadmap evaluates the following strategies to decarbonize Brookline's facilities: energy efficiency, electrification (fuel-switching away from fossil fuel equipment to electric alternatives), and on-site solar photovoltaics. The roadmap also analyzes 360 vehicles in Brookline's fleet to match each existing internal combustion engine (ICE) vehicle with the best candidates for battery electric vehicles (BEV). A combination of in-house economic models, a virtual energy audit, solar software, and data provided by the Town, 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 Table 6.

BASELINE YEAR
Fiscal Year 2022

BUILDINGS

- 22 Buildings in analysis
  - Total 723,261 ft^2
- FY2022 Usage:
  - 12,110 MWh electricity
  - 90,800 MMBTU natural gas
  - 7,755 MT CO_2e

VEHICLES

- Included in analysis
  - 215 LDV
  - 84 MDV
  - 61 HDV
- Excluded from analysis
  - 31 electric vehicles
- FY2022 Fleet Usage:
  - 134,550 gallons of gasoline
  - 38,010 gallons of diesel
  - 75 MWh electricity
  - 1,584 MT CO_2e

Table 2. Town of Brookline's municipal GHG Emissions, Fiscal Year 2022, grouped by Town buildings, school buildings, and vehicles. As reported in MassEnergyInsight (MEI).

Department and Facility Name	Fiscal Year 2022 Emissions (MT CO_2e)			
	Electricity	Fossil Fuels	Total	Percent of Total
School Department	**2,165**	**4,251**	**6,416**	**57.21%**
Brookline High School	530	1,005	1,535	13.69%
Runkle School	169	438	607	5.41%
Pierce K-8 School	149	431	580	5.17%
Edith C Baker K-8 School	140	392	532	4.74%
Ridley K-8 School (formerly Devotion)	286	232	518	4.61%
Michael Driscoll K-8 School	81	373	454	4.05%
Lawrence K-8 School	152	249	401	3.58%
Phys Ed (Tappan Gym)	133	204	337	3.00%
Old Lincoln School	92	243	336	2.99%
William H Lincoln K-8 School	138	193	331	2.95%
Hayes K-8 School	89	217	306	2.73%
Unified Arts Building	149	111	260	2.32%
22 Tappan	50	95	146	1.30%
Baldwin School	6	69	75	0.67%
Vehicles	**18**	**1,565**	**1,584**	**14.12%**
Police Unleaded Vehicles	-	347	347	3.09%
Highway Diesel Vehicles	-	249	249	2.22%
Sanitation Vehicles	-	245	245	2.18%
Highway Unleaded Vehicles	-	195	195	1.74%
Park Unleaded Vehicles	-	190	190	1.69%
Park Diesel Vehicles	-	72	72	0.65%
Fire Unleaded Vehicles	-	72	72	0.64%
Water Diesel Vehicles	-	54	54	0.48%
Building Unleaded & Electric Vehicles	-	48	48	0.42%
Fire Diesel Vehicles	-	37	37	0.33%
School Unleaded Vehicles	-	24	24	0.21%
Public EV Charging Stations	18	-	18	0.16%
Recreation Unleaded Vehicles	-	12	12	0.10%
COA Unleaded Vehicles	-	10	10	0.09%
Engineering Unleaded Vehicles	-	7	7	0.06%
Pool Cars	-	3	3	0.03%
Police Diesel Vehicles	-	1	1	0.01%
Department of Public Works	**637**	**359**	**995**	**8.87%**
Muni Service Center	122	216	338	3.02%
Streetlights	315	-	315	2.81%
Water	24	104	127	1.13%
Traffic	123	-	123	1.09%
Larz Anderson	-	35	35	0.31%
Park Streetlights	29	-	29	0.26%
Sanitation	20	-	20	0.18%
Park & Forestry	0	4	4	0.03%
Singletree	3	-	3	0.03%
Cemetery	1	-	1	0.01%

Recreation	**199**	**343**	**542**	**4.83%**
Swimming Pool	61	166	227	2.03%
Skating Rink	66	17	84	0.75%
The Lynch Center	16	53	68	0.61%
Golf Course	18	41	59	0.53%
Soule Rec	19	39	58	0.52%
Eliot	12	26	38	0.34%
Clinton Path	6	-	6	0.06%
Amory	0	-	0	0.00%
Town Buildings	**207**	**248**	**455**	**4.06%**
Town Hall	181	104	285	2.54%
Fisher Ave Building	21	104	125	1.12%
Hyslop Building	2	28	31	0.27%
Carpenter Shop	2	10	11	0.10%
Electric Shop	1	1	2	0.02%
7 Warren St.	0	-	0	0.00%
Library	**227**	**191**	**419**	**3.73%**
Main Library	165	132	297	2.65%
Coolidge Corner	32	39	71	0.64%
Putterham	30	20	50	0.45%
Fire	**91**	**237**	**328**	**2.93%**
Station 1	20	85	105	0.93%
Station 6	25	36	61	0.54%
Station 5	20	41	61	0.54%
Station 4	14	44	58	0.52%
Station 7	13	32	44	0.39%
Police	**169**	**154**	**323**	**2.88%**
Public Safety	169	154	323	2.88%
Summit	0	-	0	0.00%
COA	**43**	**43**	**86**	**0.77%**
Senior Center	43	43	86	0.77%
Health Department	**33**	**34**	**67**	**0.60%**
Health Building	33	34	67	0.60%
Total	**3,790**	**7,426**	**11,215**	**100%**

Table 3. The Town of Brookline's GHG Emissions from buildings formally outlined in this roadmap's "zero over time" approach. As reported in MEI.

Facility Name	Fiscal Year 2022 Emissions (MT CO_2e)			
	Electricity	Fossil Fuels	Total	Percent of Total
Brookline High School	530	1,005	1,535	19.79%
Runkle School K-8	169	438	607	7.82%
Pierce K-8 (demolition site)	149	431	580	7.48%
Baker School K-8	140	392	532	6.86%
Ridley School K-8	286	232	518	6.67%
Lawrence School K-8	152	249	400	5.16%
Municipal Service Center	122	216	338	4.36%
Phys Ed (Tappan Gym)	133	204	337	4.34%
Old Lincoln School	92	243	335	4.32%
William H Lincoln School K-8	138	193	330	4.26%
Public Safety	168	154	322	4.15%
Hayes School K-8	89	217	306	3.95%
Main Library	165	132	297	3.83%
Town Hall	181	104	285	3.67%
Unified Arts Building	149	111	260	3.35%
Swimming Pool	61	166	227	2.93%
22 Tappan - BHS campus	50	95	145	1.87%
Water Department Garage	23	104	127	1.64%
Senior Center	43	43	86	1.10%
Coolidge Corner Library	32	39	71	0.92%
Health Building	32	34	67	0.86%
Putterham Library	30	20	50	0.64%
Total	**2,933**	**4,822**	**7,755**	**100%**

*Table 4. Brookline's other buildings **not** formally outlined in this roadmap's "zero over time" approach. As reported in MEI.*

Facility Name	Fiscal Year 2022 Emissions (MT CO_2e)		
	Electricity	Fossil Fuels	Total
Michael Driscoll K-8 School	81	373	454
Fisher Ave Building	21	104	125
Station 1	20	85	105
Skating Rink	66	17	84
Baldwin School	6	69	75
The Lynch Center	16	53	68
Station 6	25	36	61
Station 5	20	41	61
Golf Course	18	41	59
Station 4	14	44	58
Soule Rec	19	39	58
Station 7	13	32	44
Eliot	12	26	38
Larz Anderson	-	35	35
Hyslop Building	2	28	31
Carpenter Shop	2	10	11
Park Lamp; Forestry	0	4	4
Electric Shop	1	1	2
7 Warren St.	0	-	0
Total	**336**	**1,038**	**1,373**

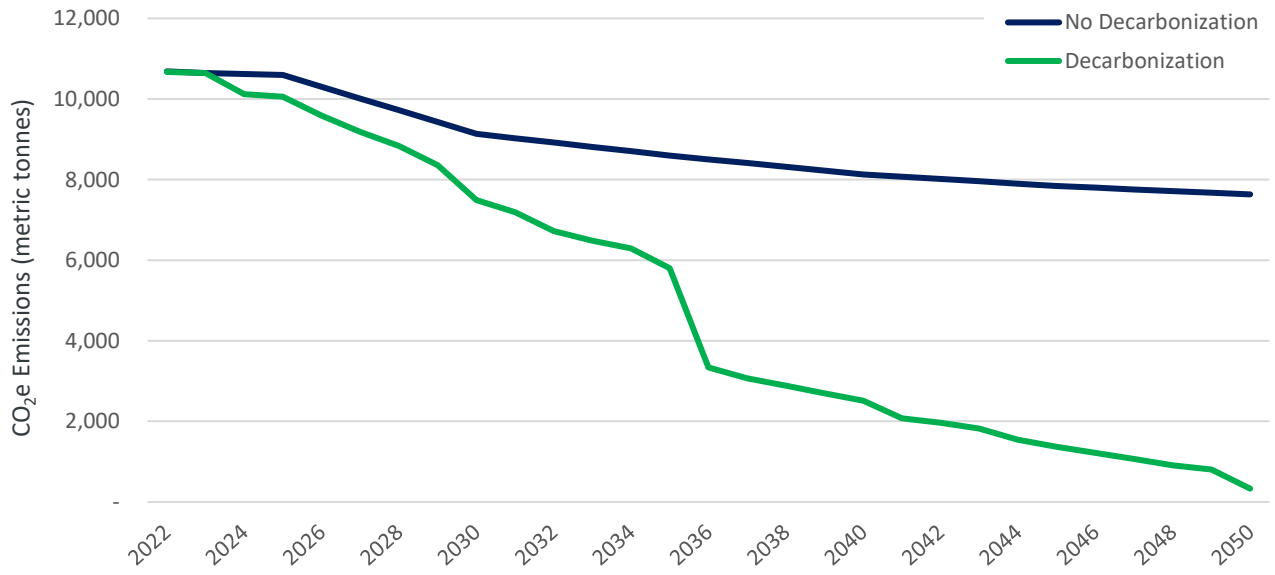
Summary of Findings

The projected reductions associated with decarbonizing Brookline's facilities and vehicles are summarized in Table 5 and Figure 1 below. In comparison to Fiscal Year 2022, the Town could see: a 100 percent reduction in on-site fossil fuel usage at all Town buildings; 100 percent of ICE vehicles converted to ZEVs; a 48 percent reduction in the Town buildings' EUI; and a total emissions reduction of 97 percent.[5] The total emissions reduction includes all Town buildings and fleet vehicles.

Table 5. Projected emissions reductions as a result of decarbonizing the Town of Brookline's buildings and vehicles, including those that are not formally presented in the "zero over time" approach.

Decarbonization Roadmap Projections	2022 (baseline)	2027	2030	2040	2050
Emissions reductions from onsite fossil fuels	0%	16%	28%	85%	100%
Zero emission vehicles (ZEVs) in light-duty fleet adoption	0%	3%	14%	70%	100%
Zero emission vehicles (ZEVs) in heavy-duty fleet adoption	0%	0%	0%	0%	100%
Energy Use Intensity reduction	0%	5%	13%	46%	48%
Total Emissions Reduction Goals (% of 2022 emissions)	0%	13%	30%	76%	97%

Figure 1. CO_2e emissions by scenario, showing percent reduction as compared to FY2022 emissions (2022-2050) for all 41 facilities and 391 fleet vehicles. The "No Decarbonization" scenario accounts for reductions in the New England electric grid's emissions from the increasing use of renewables to generate electricity (Table 8).



[5] **Table 5** is inclusive of all 41 Town buildings. Aside from the Driscoll School, is assumed that the other 19 buildings will be electrified sometime after 2040. **Table 5** is also inclusive of all Town vehicles, including the 30+ EVs that were adopted between FY22 and FY24.

Decarbonization Plans for High Impact Buildings

Buildings Background

Twenty-two municipal and school buildings, which accounted for 85 percent (7,775 MT CO_2e) of total Town municipal and school building emissions in Fiscal Year 2022, were included in the "zero over time" analysis. Ten of those twenty-two buildings contributed 68 percent of emissions, and are referred to as the Town's "High Impact Buildings" (Table 3): the Brookline High School (19.8%); Runkle School K-8 (7.8%); Pierce K-8 School (7.5%); Baker School K-8 (6.9%); Ridley School K-8 (6.7%); Lawrence School K-8 (5.16%); Municipal Service Center (4.36%). The Tappan Gym (4.3%), Unified Arts Building (3.3%), and Kirrane Swimming Pool (2.9%) were also included in the high impact building analysis because they share a natural gas meter with the Brookline High School. Focusing efforts on these high impact facilities will reduce overall emissions and contribute significantly to the Town's overall projected emissions reductions.[6]

Between Fiscal Year 2022 and Fiscal Year 2024, the Town's building-related electricity consumption decreased by 6.8 percent, and natural gas consumption decreased by 9.7 percent. This significant decrease is primarily due to the electrification of the Driscoll School (Figure 2), and operational and efficiency changes associated with a series of energy conservation measures and sustainability capital related projects. The Town will continue to explore efficiency opportunities at all municipal and school buildings.

The Town has completed, is currently undertaking, and is planning several major electrification projects. The new all-electric Driscoll School became operational in September 2023 and, as of November that year, no longer uses natural gas for heating. The school is also in the process of installing a 200-kW solar array. In addition, construction is underway on a fully electric Pierce School, which is expected to include a 332.9-kW solar array. Both schools utilize, or will utilize, heat pumps for heating and cooling. The projected increase in electricity consumption associated with the Pierce School has been incorporated into the GHG forecast presented in this analysis. Lastly, the Town is preparing to begin electrifying its fire stations, starting with Fire Station #4, which has secured funding and is expected to break ground soon.

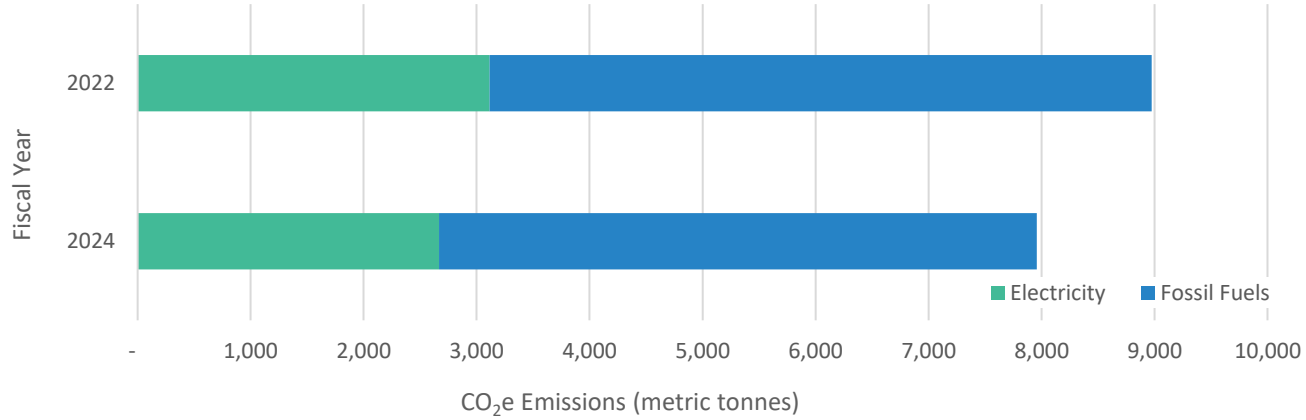
In 2023, the Town also completed an *Electrification Study for Brookline Town Hall, Health Center, and Senior Center*. The study concluded that electrification is feasible at all three facilities without the need of further energy efficiency measures or for major service upgrades, utilizing air-source heat pump central plants or rooftop units (RTUs). Although the report did not quantify the anticipated GHG reductions, it is expected that the Town will implement these recommendations in the near to mid-

[6] 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.

term. In addition, the Town will continue to prioritize energy conservation measures at these buildings to further reduce emissions within the same timeframe.

Municipal school buildings continue to be some of the highest consumers of energy for most communities. In addition to Green Communities and Climate Leaders, there are multiple funding opportunities available to support electrification projects. Mass Save maintains programs designed to aid electrification efforts, and the Massachusetts School Building Authority (MSBA) currently has funding available for school buildings through their Green Repair Program.

Figure 2. The Town's GHG emissions from Fiscal Year 2022 and Fiscal Year 2024, as reported in MassEnergyInsight (MEI), inclusive of all Town buildings, including those that fell outside of the 80 percent and excluded from the "zero over time" analysis.



Brookline High School, Unified Arts Building, Kirrane Pool & Gym

The Brookline High School, Unified Arts Building (UAB), Kirrane Pool and Tappan Gym have a unique layout (Figure 12) and distribution of energy. Two natural gas meters serve all four buildings, with one feeding the high school, UAB, swimming pool and gym, and the other providing a small amount of gas to only the high school.

Building Characteristics – 4 Buildings

Square Footage: *530,066 ft^2*
FY2022 Emissions: *2,359 $MTCO_2e$*
FY2022 EUI: *76 $kBtu/ft^2$*
Existing Solar: *Yes, 2021/2022*
Primary Space Heating: *2000/2021, natural gas*
Primary Water Heating: *2000/2015/2021*, natural gas*

Proposed Strategy

Energy Efficiency: *2026-2029*
HVAC: *2036, GSHP*
Water Heating: *2036, GSHP*
** estimate*

Since the buildings are not sub-metered, estimates were made to determine the fossil fuel use at each location. These assumptions were made based on the known heating demands of these building use-types, and current billing structure utilized by the Town.
It was assumed that the Kirrane Pool consumes 75 percent of natural gas during the summer months (June – September), when the school buildings are unoccupied, and 11 percent of the natural gas during the school year (October – May). The remaining natural gas consumption was allocated to the high school, UAB and gym based off square footage. In addition, the swimming pool and gym share an electric meter. This consumption was also allocated based off square footage.

Together, these buildings emitted 2,359 $MTCO_2e$ in Fiscal Year 2022, and 63 percent of the buildings' emissions were from fossil fuel consumption. These four buildings were together responsible for 30 percent of the total GHG emissions from the twenty-two buildings included in this analysis. In addition, between Fiscal Year 2022 and Fiscal Year 2024, the fossil fuel consumption at these three buildings increased by nearly 50 percent. This increase is due, in part, to the new STEM wing at Brookline High School. During this time, the previous STEM wing was replaced with a new wing that is about 37,000 square feet larger than the original. Though the full reason for this increase is unknown, the path towards electrification and decarbonization remains the same. A preliminary virtual energy audit found there to be potential load-reduction potential through ventilation optimization, and targeted envelope and lighting improvements that could be completed prior to electrification.

Though presented separately, the four buildings may be electrified utilizing a single ground-source heat pump (GSHP) system that could meet both electrical, and heating, cooling and ventilation (HVAC) requirements. This installation may not need to occur in the near term since the existing nine boilers

have not yet reached their end of useful life. Though further studies are necessary, preliminary estimates predict that about 150-200 vertical wells would be required to meet the demands of the four buildings. The GSHP system could be used not only for space heating/cooling but also for domestic hot water heating. These systems are able to capture heat from the ground to efficiently produce hot water through dedicated water-to-water heat pumps or by recovering waste heat from the building's cooling operations. This approach can significantly reduce overall energy use and GHG emissions compared to conventional electric or gas-fired water heaters.

While the feasibility depends on site-specific factors, GSHP integration can be particularly effective in buildings such as these, with consistent hot water demand. Incorporating this capability into future electrification projects would further advance the Town's transition toward low-carbon, all-electric municipal operations. Together, the buildings could expect to see a 98 percent reduction in GHG emissions by 2050, should this decarbonization trajectory, or something similar, be implemented.

Figure 3. Estimated future building emissions based on proposed building electrification plans at the Brookline High School, UAB, Kirrane Swimming Pool, and Tappan Gym. Displayed at the (assumed) building level.

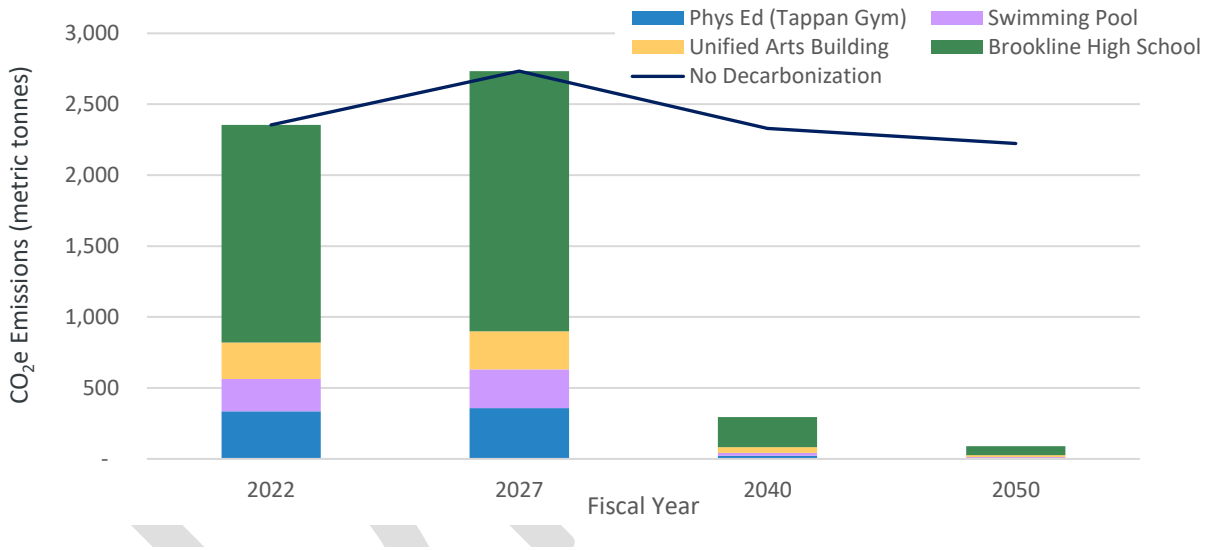
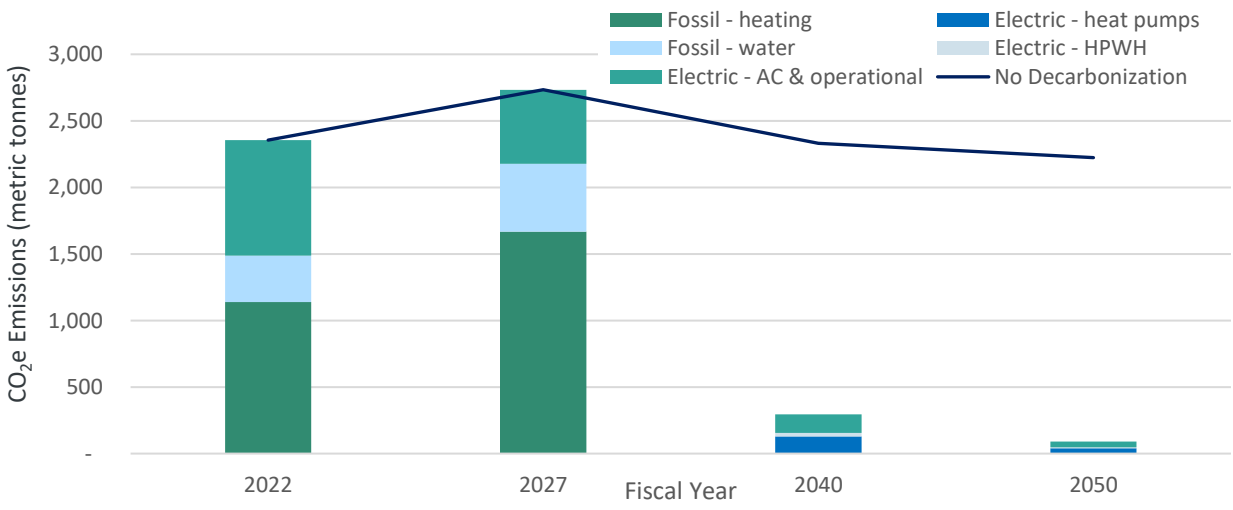


Figure 4. Estimated future building emissions based on proposed building electrification plans at the Brookline High School, UAB, Kirrane Swimming Pool, and Tappan Gym. Displayed by energy use category.



John D. Runkle School

The Runkle School emitted the fourth highest GHG emissions of the Town buildings in Fiscal Year 2022. Natural gas emissions were responsible for 74 percent of the building's total emissions, however, in Fiscal Year 2024, natural gas consumption decreased by 61 percent likely due, in part, to the installation of a new hot water heater.

Building Characteristics

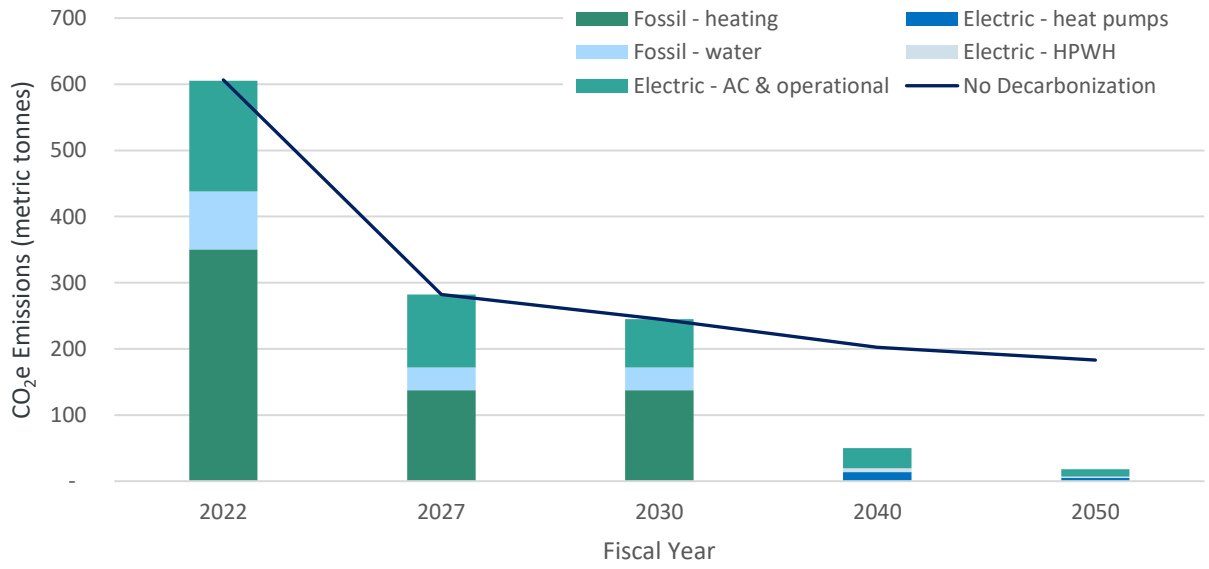
Square Footage: *107,468 ft²*
FY2022 Emissions: *607 $MTCO_2e$*
FY2022 EUI: *99 kBtu/ft²*
Existing Solar: *Yes, 2021*
Primary Space Heating: *2011, natural gas*
Primary Water Heating: *2022*, natural gas*

Proposed Strategy

Energy Efficiency: *2026-2029*
HVAC: *2035, VRF, or other heat pump*
Water Heating: *2042, HPWH*
** estimate*

In 2022, the school's EUI was 99 kBTU/ft², higher than most of the other school buildings. The natural gas equipment, installed around 2011, could be electrified in the mid-term, around 2035. VRFs could replace the existing natural gas boilers. The natural gas domestic hot water heater could also be electrified using a heat pump water heater in the long term. Both electrification projects would significantly reduce the school's annual emissions in the mid-long-term, and reduce the building's EUI.

Figure 5. Estimated future building emissions based on proposed building electrification plans at the Runkle School.



Baker School

The Baker Elementary School contributed 532 $MTCO_2e$ in Fiscal Year 2022. Though this emissions profile is lower than some of the other buildings, emissions are largely fossil fuel-driven, at 74 percent of total. This building, built in 1936, has dated heating, cooling, and ventilation (HVAC) equipment.

Building Characteristics

Square Footage: *120,838 ft^2*
FY2022 Emissions: *532 $MTCO_2e$*
FY2022 EUI: *77 $kBtu/ft^2$*
Existing Solar: *No*
Primary Space Heating: *1992, natural gas*
Primary Water Heating: *2014, natural gas*

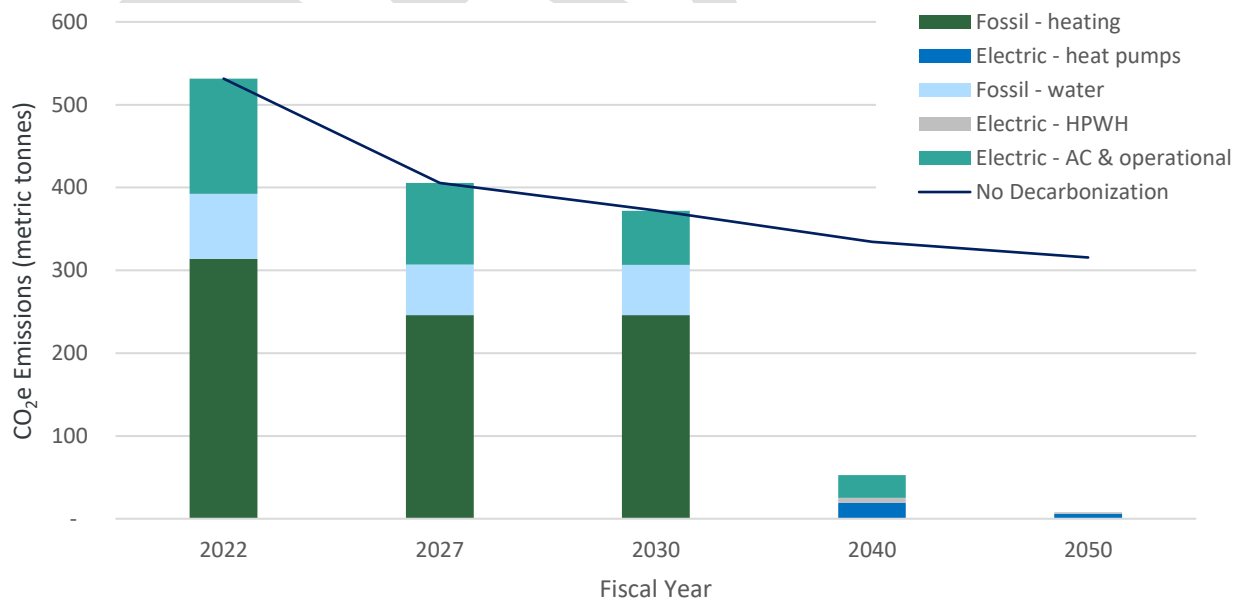
Proposed Strategy

To be determined after completion of feasibility study, but the new school building is expected to be fully electric sometime after 2030.

The Town is planning to complete a feasibility study to explore the reconstruction of the Baker School. This study will evaluate design options, energy efficiency measures, and electrification strategies to support the Town's commitment to reducing GHG emissions and transitioning toward all-electric municipal buildings. While the specific start date of the feasibility study has not yet been determined, it is expected to take place within the next few years.

Though the Baker School remains listed as a high-impact building, no construction or major renovation work will begin until the feasibility study is completed, and a detailed implementation plan is in place. The results of the study will guide the timeline, budget, and design approach for the project to ensure that the new facility meets both the educational and sustainability needs of the community.

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



Ridley School

The Ridley School (K–8) is the fifth highest emitter in Brookline's municipal building portfolio, accounting for roughly 6% of total building emissions. The school's Fiscal Year 2022 emissions were 518 $MTCO_2e$, split between approximately 53 percent from electricity and 47 percent from fossil fuels.

The building's EUI is relatively low at 38 kBtu/ft². Because the school's emissions are more evenly divided between electricity and fossil fuel use than some of the other analyzed buildings, and HVAC equipment is fairly new (installed in 2021), an effective decarbonization plan may be to first target electrical end-use efficiency such as lighting, and ventilation.

Building Characteristics

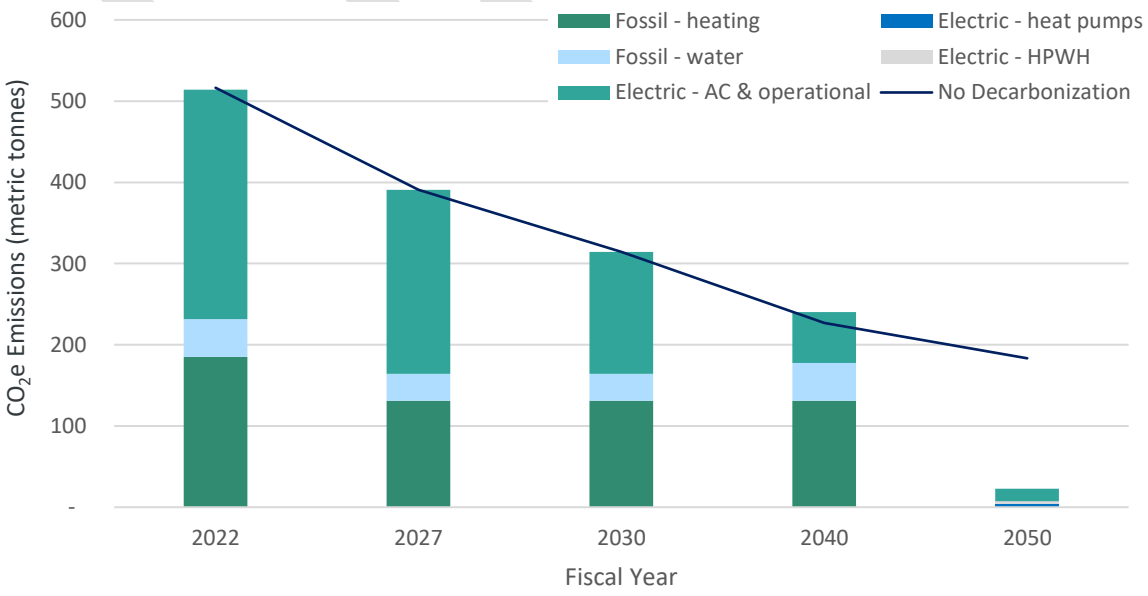
Square Footage: *222,087 ft^2*
FY2022 Emissions: *518 $MTCO_2e$*
FY2022 EUI: *38 kBtu/ft^2*
Existing Solar: *Yes, 2021*
Primary Space Heating: *2021, natural gas*
Primary Water Heating: *2021*, natural gas*

Proposed Strategy

Energy Efficiency: *2026-2029*
HVAC: *2041, GSHP, or other heat pump*
Domestic Water Heating: *2041, HPWH*
** estimate*

GSHPs could be used to electrify the existing boilers in the long-term. Though further studies are necessary, preliminary estimates predict that about 60-90 wells would be required to meet the demands of the school. Air source 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

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



Lawrence School

The Lawrence School emitted 400 $MTCO_2e$, the ninth highest building-related emissions at the time. Natural gas emissions were responsible for 62 percent of the building's total emissions.

The school currently utilizes three forced hot water boilers to heat the building. This equipment, installed in 1991, has reached its projected end of life and may be electrified in the near term, around 2029. At that time VRF heat pumps may be considered to replace the existing boilers.

The domestic hot water heating tanks installed in 2016 may be replaced with domestic heat pump water heaters around the same time. In the near term, Brookline will also continue to explore options for energy efficiency at the school, to further reduce emissions.

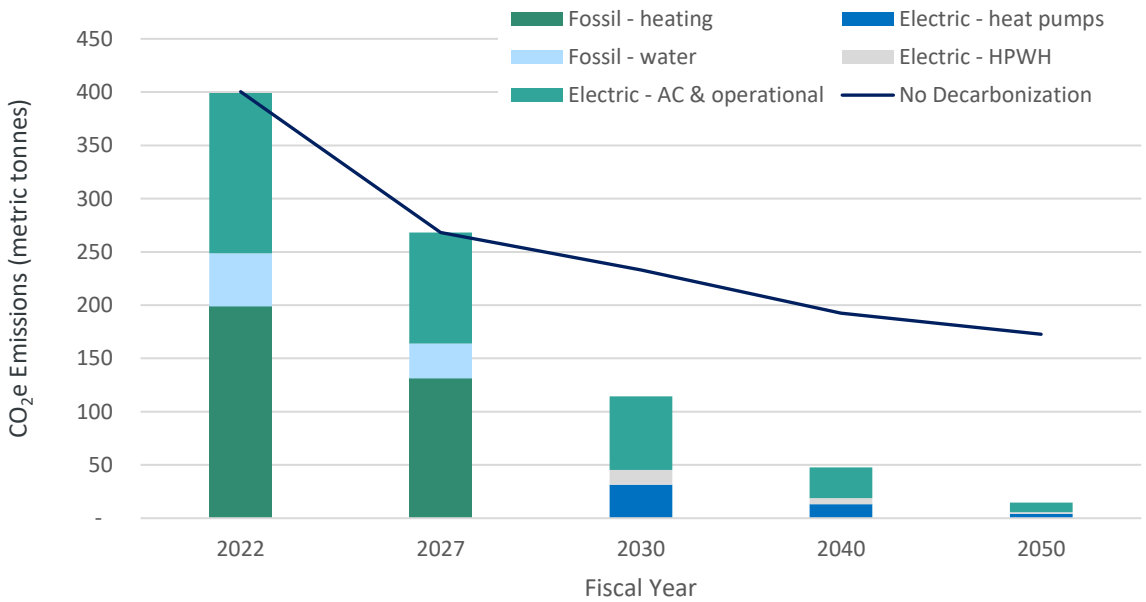
Building Characteristics

Square Footage: *106,420 ft^2*
FY2022 Emissions: *400 $MTCO_2e$*
FY2022 EUI: *64 $kBtu/ft^2$*
Existing Solar: *No*
Primary Space Heating: *1991, natural gas*
Primary Water Heating: *2016, natural gas*

Proposed Strategy

Energy Efficiency: *2026-2029*
HVAC: *2029, VRF, or other heat pump*
Water Heating: *2029, HPWH*
On-site Solar Potential: *150 kW*
** estimate*

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



Municipal Service Center

The Municipal Service Center contributed 338 $MTCO_2e$ in Fiscal Year 2022. Though this building's GHG emissions were lower, fossil fuels still accounted for 64 percent of total building emissions.

VRF heat pumps could be used to electrify the existing three natural gas boilers installed in 1997. These boilers have reached their end of useful life and may be replaced as soon as the Town is able. The natural gas water heater could be replaced with a heat pump water heater around the same time

Though some energy conservation measures have been implemented at the building, optimizing building operations and temperature setpoints, adding or checking on economizers, and updating windows may further reduce emissions in the near term.

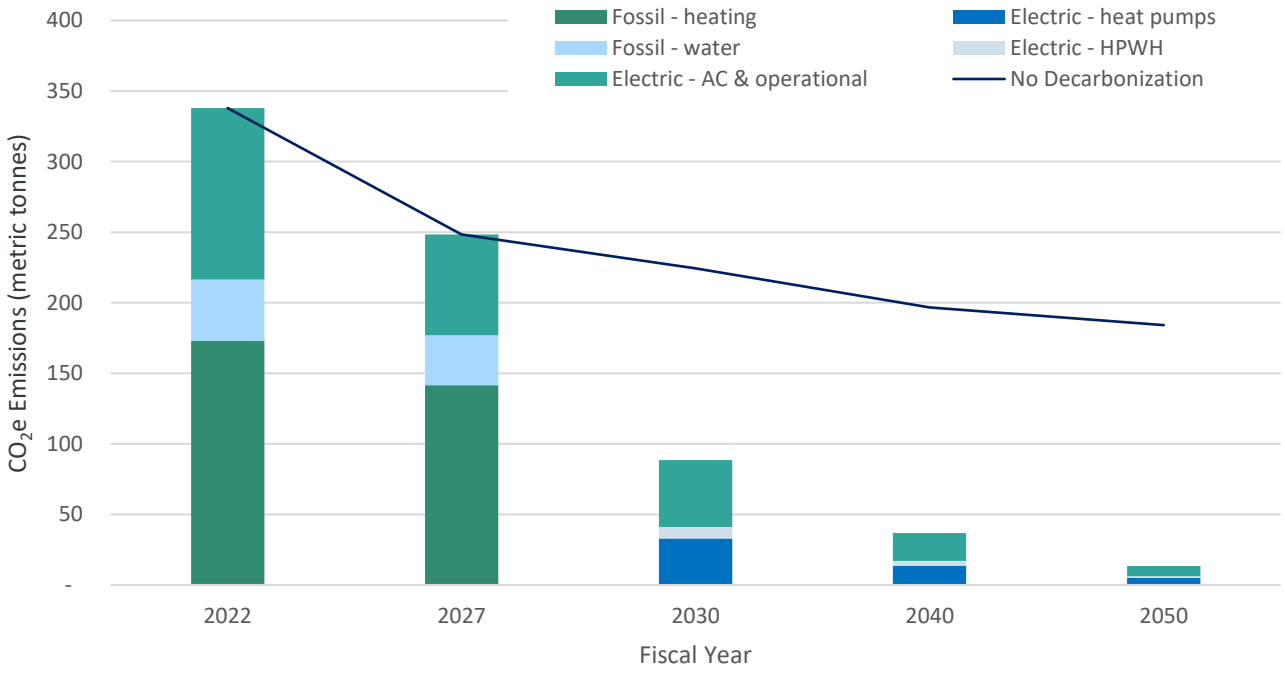
Building Characteristics

Square Footage: *63,253 ft^2*
FY2022 Emissions: *338 $MTCO_2e$*
FY2022 EUI: *92 $kBtu/ft^2$*
Existing Solar: *Yes, 2022*
Primary Space Heating: *1997, natural gas*
Primary Water Heating: *1997*, natural gas*

Proposed Strategy

Energy Efficiency: *2026-2029*
HVAC: *2030, VRF, or other heat pump*
Water Heating: *2030, HPWH*
** estimate*

Figure 9. Estimated future building emissions based on proposed building efficiency and electrification plans at the Municpal Service Center.



Fleet Vehicles

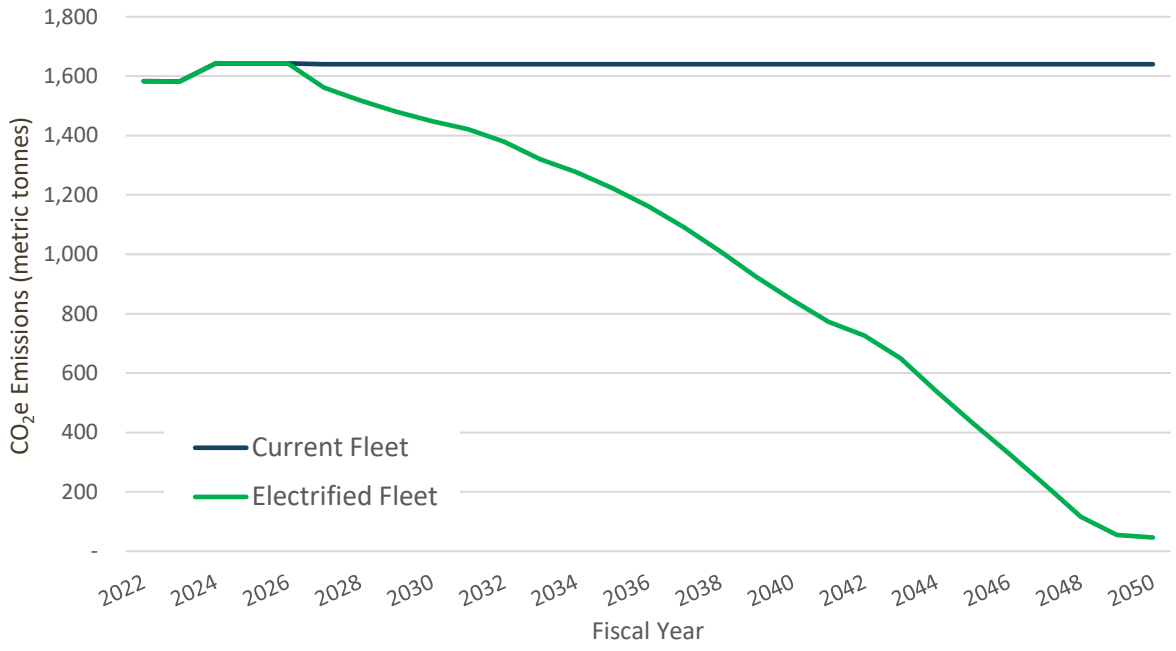
Vehicle Decarbonization

The Town of Brookline has adopted a Zero-Emission Vehicle (ZEV) First policy, which is required for Climate Leader designation.[7] 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), and to install EV charging stations at all municipal and school buildings. Brookline's analyzed fleet consists of 360 vehicles: 215 light-duty vehicles (LDV), 84 medium-duty vehicles (MDV), and 61 heavy-duty vehicles (HDV).[8] As of Fiscal Year 2024, Brookline had purchased 31 BEVs.[9]

In Fiscal Year 2022, municipal and school vehicles contributed 14 percent of emissions for the Town of Brookline. Converting the current fleet of ICE vehicles to BEV platforms could result in avoiding 16 thousand metric tons of CO_2e emissions cumulatively through 2050 (Figure 10).

Figure 10. CO_2e (metric tonnes) emissions from Brookline's vehicle fleet, by scenario, Fiscal Year 2022-2050.



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

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

[9] Existing electric vehicles were excluded from this analysis because the roadmap is specifically focused on transitioning the remaining ICE vehicles to zero-emission vehicles.

EV Procurement Timeline

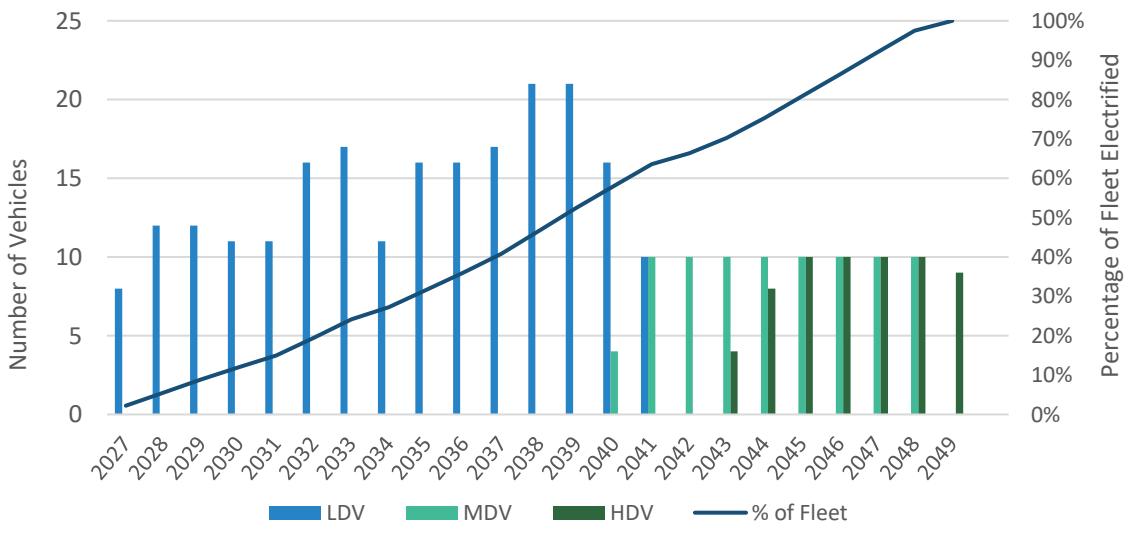
The procurement timeline is based on cost-effectiveness, annual budget considerations, and the remaining useful life of each vehicle in Brookline's existing fleet (Figure 11). The Appendix contains a detailed table that includes specific replacement years and EV model replacements for each existing vehicle. 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 2026-2030, 43 light-duty vehicles may be converted to electric. These are primarily sedans and SUVs—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 162 light-, 4 medium-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 10 light-, 80 medium-, and 61 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 11. Vehicle replacement schedule by vehicle class (light-duty [LDV], medium-duty [MDV], and heavy-duty [HDV]).



Assumptions

Emissions Factors

- Emissions factors for fossil fuels are held constant throughout the roadmap and were derived from the EPA published factors.[10] 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.[11]
- *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 6 are estimates at times 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:
    - System age and capacity
    - Fuel type(s) used
    - Building square footage
    - 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:
    - *Expected Lifetime*: Vehicles typically have a lifespan of around 10 years. This expected lifetime helps to establish a baseline for when replacement becomes necessary.
    - *Market Availability*: Based on the availability of electric alternatives in the market, the recommendation is to wait until a specific model becomes available.
    - *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.

[10] Greenhouse Gas Emissions Technical Reference

[11] 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 Brookline 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 Brookline's GHG emissions by 97 percent, lowering the Town's Energy Use Intensity (EUI) by 48 percent compared to the 2022 baseline year.

To become a certified Climate Leader, Brookline will, in combination with ongoing GHG reduction efforts, strive to implement this Municipal Decarbonization Roadmap. The first step of implementation will need to include a more detailed energy audit of the Town's buildings, that highlights actionable recommendations and cost estimates.

To comply with Climate Leader guidelines, The Town's Deputy Director of Sustainability will serve as the lead for maintaining and updating the community's roadmap. This role will include coordinating with relevant departments, project managers, and external partners to track progress on ongoing and planned initiatives, assess emerging technologies, and incorporate updated building performance and emissions data. The Director will ensure that the roadmap remains a living document that reflects both completed milestones and new opportunities for emissions reduction and energy efficiency.

Although committed to decarbonization, Brookline does not yet have a consistent, known source of Town funding for feasibility studies, engineering scope, or cost estimate development to implement the roadmap recommendations. A combination of grant funding, utility incentives, and other funding will need to be identified and secured to proceed with decarbonization projects. At least every three years, the Deputy Director of Sustainability will facilitate a roadmap update process as required by the Climate Leaders Community program. This process will include reviewing progress against established goals, integrating results from completed electrification and energy conservation projects, and reassessing targets based on the latest GHG inventories, policy developments, and funding opportunities. The updated roadmap will be shared with Town leadership and the public to ensure continued transparency, accountability, and alignment with the Town's long-term sustainability objectives.

Appendix

Table 6. Possible decarbonization measures, by building.

Building	**Fiscal Year 2022 Emissions (MT CO_2e)**	**Building Square Footage**	**Sustainability Information** *Master Town Properties List with Sustainability Info*	**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)	**Installation** (installation year, size [kW])
Phys Ed (Tappan Gym)	337	80,000	*nothing noted*	2021, Natural Gas	2036, GSHP, or other heat pump	2021, Natural Gas	2036, GSHP	Existing, 2022	N/A
Swimming Pool	227	36,550	requires service upgrade	2021, Natural Gas	2036, GSHP, or other heat pump	2021, Natural Gas	2036, GSHP	Existing, 2007	N/A
Unified Arts Building	260	43,540	*nothing noted*	2021, Natural Gas	2036, GSHP, or other heat pump	2015, Natural Gas	2036, GSHP	2013/2025	2033, 37.83 kW
Brookline High School	1,535	369,976	some ductless splits	2000, Natural Gas	2036, GSHP, or other heat pump	2021, Natural Gas	2036, GSHP	Existing, 2021	N/A
Pierce K-8 (demolition site)	580	270,110	construction project - to be all electric	2000, Natural Gas	2026, ASHP, other heat pump	2000, Natural Gas	2026, HPWH	Under construction	2026, ~332.9 kW

Building	Fiscal Year 2022 Emissions (MT CO_2e)	Building Square Footage	Sustainability Information ***Master Town Properties List with Sustainability Info***	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)	**Installation** (installation year, size [kW])
Main Library	297	70,780	would need service upgrade to electrify	1954, Natural Gas	2030, Ducted ASHP, or other heat pump	2012, Natural Gas	2030, HPWH	1993/2003/2014	2034, 60 kW
Town Hall	285	73,728	electrification proposal in place; no funding	2009, Natural Gas	2030, Ducted ASHP, or other heat pump	2009, Natural Gas	2030, HPWH	2008	2038, 15 kW
Baker School K-8	532	120,838	*Feasibility study being discussed*	1992, Natural Gas	tbd, GSHP, or other heat pump	2014, Natural Gas	tbd, GSHP or other HPWH	1992/2000	2028, 150 kW
Ridley School K-8	518	222,087	*nothing noted*	2021, Natural Gas	2041, GSHP, or other heat pump	2021, Natural Gas	2041, GSHP	Existing, 2021	N/A
William H Lincoln School K-8	330	92,227	ductless splits in half of school-should be completed summer of 2025	1993, Natural Gas	2031, Ductless ASHP, or other heat pump	2012, Natural Gas	2031, HPWH	1994	N/A
Lawrence School K-8	400	106,420	close to "hybrid"	1991, Natural Gas	2029, VRF, or other heat pump	2016, Natural Gas	2029, HPWH	1994/2004/2015	2035, 127 kW

Building	Fiscal Year 2022 Emissions (MT CO_2e)	Building Square Footage	Sustainability Information ***Master Town Properties List with Sustainability Info***	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)	**Installation** (installation year, size [kW])
Runkle School K-8	607	107,468	*nothing noted*	2011, Natural Gas	2035, VRF, or other heat pump	2022, Natural Gas	2035, HPWH	Existing, 2021	N/A
Hayes School K-8	306	84,379	ductless splits installed - close to "hybrid" boilers used as back up	1960, Natural Gas	2035, Ductless ASHP, or other heat pump	2012, Natural Gas	2035, HPWH	1994/1998	2028, 146.6 kW
Old Lincoln School	335	87,380	"hybrid"	2021, Natural Gas	2036, VRF, or other heat pump	2021, Natural Gas	2036, HPWH	2011	N/A
22 Tappan - BHS campus	145	118,000	*nothing noted*	2021, Natural Gas	2041, GSHP, or other heat pump	2020, Natural Gas	2041, GSHP	2021	2045, 119.85 kW
Municipal Service Center	338	63,253	*nothing noted*	1997, Natural Gas	2030, VRF, or other heat pump	1997, Natural Gas	2030, HPWH	Existing, 2022	N/A
Public Safety	322	55,000	*nothing noted*	2001, Natural Gas	2036, VRF, or other heat pump	2014, Natural Gas	2036, HPWH	2002	2027, 28.1 kW

Building	Fiscal Year 2022 Emissions (MT CO_2e)	Building Square Footage	Sustainability Information ***Master Town Properties List with Sustainability Info***	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)	**Installation** (installation year, size [kW])
Water Department Garage	127	15,605	*nothing noted*	2022, Natural Gas	2037, VRF, or other heat pump	2022, Natural Gas	2037, HPWH	2008	N/A
Senior Center	86	22,056	electrification proposal in place; no funding	2018, Natural Gas	2033, VRF, or other heat pump	2018, Natural Gas	2033, HPWH	2001	2027, 20.8 kW
Coolidge Corner Library	71	24,634	*nothing noted*	2004, Natural Gas	2030, Ducted ASHP, or other heat pump	2004, Natural Gas	2030, HPWH	2018	2038, 83.3 kW
Health Building	67	15,980	electrification proposal in place; no funding	2005, Natural Gas	2033, Ducted ASHP, or other heat pump	2017, Natural Gas	2033, HPWH	Existing, 2000	N/A
Putterham Library	50	9,425	*nothing noted*	2009, Natural Gas	2034, Ducted ASHP, or other heat pump	2009, Natural Gas	2034, HPWH	Existing, 1988/1999	N/A

Table 7. 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 annual electric miles per gallon, and avoided greenhouse gas emissions.

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2027	Chevrolet	G-Series	2GCEG25Z1H4137533	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.4
2027	Ford	Ltd	2FABP43G9DBI3244A	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2027	Ford	Ltd	2FABP43G9FX215526	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2027	Ford	Ltd	2FABP43FXDB108597	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2027	Ford	Ltd	2FABP43G0FX141879	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2027	Ford	Crown Victoria	2FABP72GXHX180002	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2027	Ford	Crown Victoria	2FABP72G0HX229952	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2027	Gmc	C/K Pickup	1GDGC34M4BV557774	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	3.8
2028	Ford	E-350	1FTJE34L4VHB76912	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.0
2028	Ford	E-350	1FDHS34M2KHA51284	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.5
2028	Ford	Crown Victoria	2FALP71W6RX166127	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2028	Ford	Crown Victoria	2FALP71W7TX186345	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2028	Ford	Crown Victoria	2FACP72W7NX213433	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2028	Ford	Crown Victoria	2FALP71WXTX186324	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2028	Ford	Crown Victoria	2FACP71W2PX135986	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2028	Ford	Crown Victoria	2FABP72F9JX181557	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2028	Ford	Crown Victoria	2FACP72G5MX155992	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2028	Ford	Crown Victoria	2FABP72G0KX219364	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2028	Ford	Crown Victoria	2FACP72G4MX156132	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2028	Ford	Explorer	1FMDU34X2RUC87003	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2029	Chevrolet	Astro Van	1GCDM19X62B116287	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2029	Ford	E-250	1FTNE24L2XHC17259	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.0
2029	Ford	E-250	1FTNE24L5YHB23300	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.0
2029	Ford	E-350	1FTSS34LX3HB35291	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.0
2029	Ford	Crown Victoria	2FALP71W1VX189521	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2029	Ford	Crown Victoria	2FAFP71W51X191358	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2029	Toyota	Prius	JT2BK18U220067887	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2029	Ford	Taurus	1FAFP52U0WA261270	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2029	Ford	Taurus	1FAFP52S7WG268339	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2029	Ford	E-350	1FBNE31L7WHB13606	Transit_Van-Ford-E-Transit Cargo-Class 3	67	4.0
2029	Ford	E-350	1FBNE31L8YHB70884	Transit_Van-Ford-E-Transit Cargo-Class 3	67	4.0
2029	Ford	Taurus	1FAFP57U4WA267386	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.2
2030	Chevrolet	Express	1GCGG25V371254848	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.4
2030	Chevrolet	Express	1GCGG25V271107601	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.4
2030	Toyota	Prius	JTDKB20U673290304	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2030	Toyota	Prius	JTDKB20U273290560	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2030	Toyota	Prius	JTDKB20U853019032	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2030	Toyota	Prius	JTDKB20U077603792	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2030	Ford	Crown Victoria	2FAFP71W93X126418	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2030	Toyota	Prius	JT2BK12U830083764	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2030	Toyota	Prius	JT2BK12U630080197	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2030	Chevrolet	Tahoe	1GNEK13V74J289723	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	5.2

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2030	Chevrolet	Express	1GAHG35UX71141182	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2031	Ford	E-250	1FTNE24L19DA04569	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.0
2031	Chevrolet	Express	1GCHG35C681138683	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.4
2031	Toyota	Prius	JTDKB20U393487756	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2031	Toyota	Prius	JTDKB20U093466234	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2031	Toyota	Prius	JTDKB20U297850332	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2031	Toyota	Prius	JTDKB20U597850809	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2031	Toyota	Prius	JTDKB20U797849791	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2031	Toyota	Prius	JTDKB20UX97850529	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2031	Harley-Davidson	Police Electra Glide	1HD1FMM159Y624791	Police_Motorcycle-LiveWire-S2 Mulholland-	385	2.1
2031	Harley-Davidson	Police Electra Glide	1HD1FMM139Y632811	Police_Motorcycle-LiveWire-S2 Mulholland-	385	2.1
2031	Chevrolet	Tahoe	1GNFK03079R272173	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	5.9
2032	Ford	F-350	2FTHF36G6DCA24373	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2032	Gmc	R Conventional	1GTGR24K5HS532601	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2032	Ford	F-150	1FTEF14H8SNA44103	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2032	Ford	F-150	1FTEF14H6SNA44097	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2032	Chevrolet	Gmt-400	2GCEC14H7K1193791	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2032	Ford	E-350	1FTSE3EL5CDA24032	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.0
2032	Toyota	Prius	JTDKN3DU7C1540968	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2032	Toyota	Prius	JTDKN3DU1A1267314	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2032	Toyota	Prius	JTDKN3DU6A1268118	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2032	Toyota	Prius	JTDKN3DU1C1480864	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2032	Toyota	Prius	JTDKN3DU2A1268262	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2032	Toyota	Prius	JTDKN3DU9C1476626	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2032	Toyota	Prius	JTDKN3DU6C1480388	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2032	Ford	Fusion	3FAHP0HA2BR109550	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2032	Ford	Taurus	1FAHP2HW1AG104028	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2032	Ford	Transit Connect	NM0LS7BN9AT016834	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2033	Ford	F-250	1FTFF28L0VND28077	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2033	Ford	F-250	1FTNF21LX1EA52474	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2033	Ford	F-250	1FDNF21LX1ED14733	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2033	Chevrolet	Colorado	1GCDT196948147334	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2033	Chevrolet	Silverado	1GCHK24U03E273999	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2033	Ford	E-250	1FTNE2EL5DDA07823	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.0
2033	Ford	Transit Connect	NM0LS7E73E1135946	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2033	Chevrolet	Cruze	1G1PH5SB5E7413025	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2033	Ford	Fusion	3FADP0L34CR445824	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2033	Ford	Fusion	3FA6P0LU1ER245018	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2033	Ford	Taurus	1FAHP2H83EG107357	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2033	Ford	Explorer	1FM5K8D88EGA18335	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2033	Chevrolet	Express	1GB0G2BA1E1191561	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2033	Ford	Transit Connect	NM0LS6AN4DT126044	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2033	Ford	Transit Connect	NM0LS6AN6DT126045	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2033	Ford	Transit Connect	NM0LS6AN5DT175057	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2033	Ford	Transit Connect	NM0KS9BN8DT168471	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2034	Chevrolet	Silverado	1GBHK34U15E315285	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2034	Chevrolet	Silverado	1GCHK24U56E144483	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2034	Chevrolet	Colorado	1GCCS14E388159997	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2034	Chevrolet	Silverado	1GCHK24K78E109963	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2034	Chevrolet	Silverado	1GCHK24K58E109914	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2034	Ford	Transit	1FTYR1ZM8GKA10150	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2034	Ford	Transit Connect	NM0LS6E71F1184736	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2034	Ford	Fusion	3FA6P0LU4FR228506	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2034	Chevrolet	Sonic	1G1JA5SG6F4107587	Sedan-Chevrolet-Bolt-Class 1	134	2.7
2034	Ford	Taurus	1FAHP2H81FG184715	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2034	Ford	Taurus	1FAHP2H83FG106503	Sedan-Chevrolet-Bolt-Class 1	134	3.3

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2035	Chevrolet	Silverado	1GCHK24K18E139301	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2035	Chevrolet	Colorado	1GCJTBDE3A8108225	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2035	Chevrolet	Colorado	1GCJTBFE2C8116266	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2035	Chevrolet	Silverado	1GC5KVBG7AZ251425	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2035	Chevrolet	Silverado	1GC0KVCG9BZ427403	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2035	Ford	Transit Connect	NM0LS7E75G1268209	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2035	Ford	Transit Connect	NM0LS7F7XH1309403	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2035	Ford	Transit Connect	NM0LS7E74H1302688	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2035	Ford	Transit Connect	NM0LS7F72H1309394	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2035	Ford	Transit Connect	NM0LS7E71G1268210	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2035	Toyota	Prius	JTDKBRFU5H3056124	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2035	Toyota	Prius	JTDKBRFU6G3008565	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2035	Harley-Davidson	Police Road King	1HD1FHM18GB640684	Police_Motorcycle-LiveWire-S2 Mulholland-	385	2.1
2035	Chevrolet	Cruze Limited	1G1PC5SGXG7153704	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2035	Ford	Expedition	1FMJU1GT6GEF06312	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2035	Chevrolet	Express	1GAZGNFF8G1145909	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2036	Chevrolet	Silverado	1GCNCPEH6EZ381988	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2036	Chevrolet	Silverado	1GC2KXCG9DZ372393	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2036	Chevrolet	Silverado	1GC0KVCG0DZ358555	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2036	Ford	F-250	1FT7X2B64FEB82210	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2036	Chevrolet	Silverado	1GB0KUEG1FZ541249	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2036	Chevrolet	Silverado	1GCVKREC7FZ385133	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2036	Ford	Transit Connect	NM0LS7E7XJ1351299	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2036	Toyota	Prius	JTDKBRFU7J3082293	Sedan-Chevrolet-Bolt-Class 1	134	1.6
2036	Harley-Davidson	Police Road King	1HD1FHC18JB655520	Police_Motorcycle-LiveWire-S2 Mulholland-	385	2.1
2036	Chevrolet	Cruze	1G1BC5SM6H7136643	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2036	Chevrolet	Cruze	1G1BC5SM9H7136913	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2036	Ford	Fusion	3FA6P0LU4HR344727	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2036	Ford	Explorer	1FM5K8AR0HGB55772	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2036	Ford	Explorer	1FM5K8AR7HGB55770	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2036	Ford	Explorer	1FM5K8D86HGA89635	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2036	Chevrolet	Express	1GAWGEFF4H1247616	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2037	Chevrolet	Silverado	1GC0KUE89FZ132551	Pickup-Ford-F150 Lightning-Class 1-3	67	5.6
2037	Chevrolet	Silverado	1GC0KUEG3FZ546125	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2037	Chevrolet	Silverado	1GC0KUEG5FZ545994	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2037	Chevrolet	Silverado	1GC0KUEG6FZ546023	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2037	Chevrolet	Silverado	1GC0KUEG4FZ547168	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2037	Chevrolet	Silverado	1GC0KUE8XFZ132543	Pickup-Ford-F150 Lightning-Class 1-3	67	5.6
2037	Chevrolet	Express	1GCWGAFG9K1147379	Transit_Van-Ford-E-Transit Cargo-Class 3	62	4.4
2037	Ford	Transit	1FTYE1ZM3KKA18838	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2037	Ford	Transit	1FTYR3XM9KKA63933	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2037	Ford	Transit	1FTYR1ZM7KKB53311	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2037	Ford	Transit Connect	NM0LS7E24K1424303	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2037	Dodge	Grand Caravan	2C7WDGBG8KR521433	Minivan-Chrysler-Pacifica PHEV-Class 1	110	4.2
2037	Ford	Fusion	3FA6P0LU2JR120071	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2037	Ford	Explorer	1FM5K8AR7JGA32203	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2037	Ford	Explorer	1FM5K8AR3JGA32201	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2037	Ford	Explorer	1FM5K8AR9JGA32204	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2037	Ford	Explorer	1FM5K8AR0JGA32205	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2038	Ford	F-150	1FTFX1EF0GFB03502	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2038	Chevrolet	Silverado	1GCVKREC2GZ346077	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2038	Chevrolet	Silverado	1GCNKNEC3HZ354912	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2038	Chevrolet	Silverado	1GC2KUEG6GZ130872	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2038	Chevrolet	Colorado	1GCGTBEN4J1308015	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2038	Chevrolet	Silverado	1GC2KVEG6HZ362251	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2038	Chevrolet	Silverado	1GC0KUEG7HZ325131	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2038	Ford	Transit	1FTBR1Y87LKA02089	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2038	Ford	Transit	1FTBW3X88LKB00571	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2038	Ford	Transit	1FTBR1Y83LKA02090	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2038	Ford	Transit Connect	NM0LS7E21L1466803	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2038	Ford	Transit Connect	NM0LS7E28L1453854	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2038	Chevrolet	Cruze	1G1BC5SM8K7106938	Police_Vehicle-Ford-Mustang Mach-E-Class 1	93	3.8
2038	Ford	Fusion	3FA6P0G71KR151706	Sedan-Chevrolet-Bolt-Class 1	134	3.3
2038	Ford	Escape	1FMCU9GD9KUA26909	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	2.9
2038	Ford	Escape	1FMCU9GD5KUA25675	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	2.9
2038	Ford	Explorer	1FM5K8ARXKGA11928	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2038	Ford	Explorer	1FM5K8AR8KGA11927	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2038	Ford	Explorer	1FM5K8AR8KGA11930	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2038	Ford	Explorer	1FM5K8AR3KGA11933	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2038	Ford	Explorer	1FM5K8AR1KGA11929	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Chevrolet	Colorado	1GCGTBEN7J1270764	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2039	Chevrolet	Silverado	1GCVKREC4JZ344614	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2039	Chevrolet	Silverado	2GCVKREC1J1100587	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2039	Chevrolet	Silverado	1GC0KUEG0JZ343282	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2039	Chevrolet	Silverado	1GC0KUEG0JZ350393	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2039	Chevrolet	Silverado	1GC2KUEG4JZ160637	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2039	Ford	F-250	1FD7X2B67KED31750	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2039	Harley-Davidson	Police Road King	1HD1FHP13LB606805	Police_Motorcycle-LiveWire-S2 Mulholland-	385	2.1
2039	Ford	Explorer	1FMSK8DH2LGB30628	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW7LGA18150	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW6MNA00901	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW4LGA19966	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2039	Ford	Explorer	1FM5K8AW4LGA18154	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AWXMNA00903	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW0LGA71983	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW6LGA19967	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW0LGA18152	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8FW8MNA01170	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW0MNA00893	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW2LGA18153	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2039	Ford	Explorer	1FM5K8AW6LGA18155	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Chevrolet	Silverado	1GCRYDED2LZ321542	Pickup-Ford-F150 Lightning-Class 1-3	67	4.9
2040	Ford	F-350	2FDKF38F4SCA19742	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.6
2040	Ford	F-350	2FDKF38F2SCA19741	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.6
2040	Ford	F-350	2FDKF37H0SCA60999	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.0
2040	Chevrolet	C/K Pickup	1GBJC33M4FS155129	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.0
2040	Harley-Davidson	Police Road King	1HD1FHP18PB641202	Police_Motorcycle-LiveWire-S2 Mulholland-	385	2.1
2040	Harley-Davidson	Police Road King	1HD1FHP1XPB641217	Police_Motorcycle-LiveWire-S2 Mulholland-	385	2.1
2040	Ford	F-150	1FTFW1P88PKD58634	Pickup-Ford-F150 Lightning-Class 1-3	67	4.0
2040	Ford	Explorer	1FM5K8AW3PNA09494	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AW5PNA09223	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AW8PNA09488	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AW2NNA08835	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8FW1NNA10942	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AW0NNA00846	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AW8NNA00738	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AWXNNA00904	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AW3NNA00873	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AW7NNA00729	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2040	Ford	Explorer	1FM5K8AW1MNA00904	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2040	Ford	Explorer	1FM5K8AW1MNA04578	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2041	Ford	F-350	1FDWF37S2XEE02483	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.0
2041	Chevrolet	Silverado	1GBJK34K18E191765	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2041	Ford	E-450	1FDXE45F33HA93831	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2041	Ford	F-450	1FDXF47F5XEA90916	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2041	Ford	F-550	1FDAF56FXXED05123	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2041	Ford	F-550	1FDAF57YX7EB30369	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	3.6
2041	Ford	F-550	1FDAF57Y67EB31230	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	3.6
2041	Ford	F-650	3FRWF65H68V681328	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2041	Ford	F-Super Duty	1FDLF47F5SEA41996	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2041	Ford	Low Cab Forward	3FRML55Z38V691270	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2041	Ford	Explorer	1FM5K8AWXSGB13204	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2041	Ford	Explorer	1FM5K8AW1SGB13754	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2041	Ford	Explorer	1FM5K8AW4SGB13084	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2041	Ford	Explorer	1FM5K8AW4SGB13571	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2041	Ford	Explorer	1FM5K8AW0PNA09596	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2041	Ford	Explorer	1FM5K8AW4PNA09374	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2041	Ford	Explorer	1FM5K8AW6PNA09375	SUV-Chevrolet-Blazer 2LT-Class 1-3	97	3.8
2041	Ford	Transit	1FBAX2C81RKB09800	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2041	Ford	Transit	1FBAX2C85SKA02125	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2041	Ford	Transit	1FBAX9XG1RKA94578	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2042	Chevrolet	Silverado	1GB4KZCG9CF228903	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2042	Chevrolet	Silverado	1GB4KZCG1DF227634	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2042	Chevrolet	Silverado	1GB4KZCG0CF213948	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2042	Chevrolet	Silverado	1GB3KZCG7BZ413993	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2042	Chevrolet	Silverado	1GB4KZCGXDF227633	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2042	Chevrolet	Silverado	1GB3KZCG1BF252462	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2042	Chevrolet	Silverado	1GB3KZCGXDF227627	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2042	Chevrolet	Silverado	1GBJK74699F171088	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	5.0
2042	Chevrolet	C5	1GBE5C3959F407488	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.7
2042	Ford	E-450	1FDFE4FS9CDB11148	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	3.6
2043	Chevrolet	Silverado	1GB3KYC81FF182695	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	5.0
2043	Chevrolet	Silverado	1GB3KYC83FF179796	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	5.0
2043	Chevrolet	Silverado	1GB3KYC85FZ510621	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	5.0
2043	Chevrolet	Silverado	1GB3KYCG1FZ549746	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2043	Chevrolet	Silverado	1GB3KYCG7FZ547094	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2043	Chevrolet	Silverado	1GB4KYCGXFF656414	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2043	Chevrolet	Silverado	1GC3KZCG0DZ355014	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2043	Ford	F-550	1FDUF5HT6FEC59384	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2043	Ford	F-550	1FDUF5HT6FEC42567	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2043	International	Tr005	1HTKPSKK3EH016624	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	10.9
2043	Chevrolet	C7	1GBP7D1Y1JV115222	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2043	Chevrolet	C7	1GBP7D1Y5HV108008	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2043	Mack	Mc	1M2H144C2GM001189	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2043	Mack	Mc	1M2H144B4GM001203	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2044	Chevrolet	Silverado	1GB3KYC8XGF121802	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	5.0
2044	Chevrolet	Silverado	1GB3KYCG0JZ310438	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2044	Chevrolet	Silverado	1GB3KYCG5HZ181445	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2044	Chevrolet	5500Xd	JALEEW165H7302527	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.7
2044	International	Ta005	1HTJSSKK2FH692283	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	10.9
2044	International	Ta005	1HTJSSKK8HH511545	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	10.9
2044	International	Ta005	1HTJSSKK9GH404227	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	10.9
2044	Ford	E-350	1FDEE3FS2FDA35041	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	3.6
2044	Ford	Transit	1FDES6PM9GKA93493	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2044	Ford	Transit	1FBVU4XG0GKA18473	Transit_Van-Ford-E-Transit Cargo-Class 3	62	3.3
2044	Pierce Manufacturing	Fixed Cab	4P1CA02S6SA000579	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2044	Pierce Manufacturing	Tilt Cab	4P1CT02D7NA000400	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2044	Chevrolet	C7	1GBM7H1J0LJ203475	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2044	Navistar	F-2674	1HTZVGBT1JH582205	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2044	Ford	L8000	1FDYK82E7SVA37181	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2044	Whitegmc	Wb	4V2JABMD1SR839984	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	6.6
2044	Whitegmc	Wb	4V2JABMD3SR839985	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	6.6
2044	Whitegmc	Wb	4V2JABMD8SR839982	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	6.6
2045	Chevrolet	Silverado	1GB3YSE72LF254497	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2045	Chevrolet	Silverado	1GB3YSE76LF236634	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2045	Chevrolet	Silverado	1GB4YSE75LF325891	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2045	Chevrolet	Silverado	1GB4YSE74LF313599	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2045	Chevrolet	Silverado	1GB3YSE76LF237296	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2045	Chevrolet	Silverado	1GC5YLE79LF281948	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2045	Chevrolet	Silverado Hd	1GB3KVCG2KF137815	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2045	Chevrolet	Silverado Hd	1GB3KVCG2KF147051	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2045	Chevrolet	5500Xd	JALEEW169J7300608	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.7
2045	Gm	Gm515	1HTKHPVK1KH388061	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2045	Sutphen	Custom	1S9A1BLD144003085	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2045	Sutphen	Custom	1S9A1BLD724003038	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2045	Sutphen	Custom	1S9A1BLD844003083	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2045	Pierce Manufacturing	Fixed Cab	4P1CA02S4WA000683	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2045	Chevrolet	C8	1GBP8J1C73F506937	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2045	Ford	L9511	1FDYZ92K8WVA33699	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2045	Ford	L9511	1FDYZ92K0WVA33700	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2045	Mack	Mr	1M2K195C11M018591	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2045	Mack	Mr	1M2K195C11M018378	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2045	Whitegmc	Wb	4V2JABMDXSR839983	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	6.6
2046	Chevrolet	Silverado	1GC5YLE7XLF181583	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2046	Chevrolet	Silverado	1GC3YLE71LF203848	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2046	Chevrolet	Silverado	1GC3YLE76LF195147	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2046	Chevrolet	Silverado	1GC3YLE74LF302034	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2046	Chevrolet	Silverado	1GC3YSE7XLF203387	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2046	Chevrolet	Silverado Hd	1GC5YLE7XNF191873	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2046	Gm	Gm515	1HTKJPVK6LH639775	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2046	Gm	Gm515	1HTKJPVK3LH242363	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2046	Gm	Gm515	1HTKHPVK7LH389670	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2046	Gm	Gm515	1HTKJPVK9MH069837	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2046	E-One	Truck	4ENGAAA8161000565	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2046	E-One	Truck	4ENGAAA8461001774	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2046	Sterling Truck	Acterra	2FZACHBS04AM17513	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2046	Mack	Mr	1M2K189CX4M024186	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2046	Volvo Truck	Vhd	4V5KC9GF36N442703	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2046	Volvo Truck	Vhd	4V5KC9GF94N367602	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2046	Volvo Truck	Vhd	4V5K39GF56N442704	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2046	Volvo Truck	Vhd	4V5K39GF85N392492	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2046	Volvo Truck	Vhd	4V5K39EF28N489971	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2046	Volvo Truck	Vhd	4V5K39GFX5N392493	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2047	Chevrolet	Silverado Hd	1GB3YSEY8PF204654	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	5.0
2047	Chevrolet	Silverado Hd	1GB3YSE78PF245647	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2047	Chevrolet	Silverado Hd	1GC5YLE73NF243179	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2047	Chevrolet	Silverado Hd	1GC3YLE75PF231870	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2047	Chevrolet	Silverado Hd	1GC3YLE73PF257044	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2047	Chevrolet	Silverado Hd	1GC5YLE77NF236865	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2047	Ford	F-600	1FDFF6LT6NDA13915	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2047	Gm	Gm515	1HTKHPVK2PH736201	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2047	Gm	Gm515	1HTKHPVK6PH765409	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2047	Gm	Gm515	1HTKJPVM0PH387786	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2047	Pierce Manufacturing	Arrow Xt	4P1CA01H0AA010710	Fire_Truck-Pierce-Volterra-Class 8	9	5.8

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2047	Kovatch Mobile Equipment	Kovatch Mobile Equipment	1K9AF428XFN058830	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2047	Peterbilt	320	3BPZL7EX3EF249656	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2047	Autocar	C & Dc	1WBRECJD0BU092896	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2047	International	Ma035	1HTMKAAN3CJ420655	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2047	Mack	Mru (Terrapro)	1M2AV02C0BM007924	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2047	International	Sf637	1HTWNAZT9EH018670	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2047	Volvo Truck	Vhd	4V5K39EF19N285910	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2047	Volvo Truck	Vhd	4V5KC9DF5CN562552	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2047	Volvo Truck	Vhd	4V5K39EF08N489970	Heavy_Duty_Truck_8-Volvo-VNR Electric-Class 8	16	5.5
2048	Chevrolet	Silverado Hd	1GB4YSE72RF392859	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2048	Chevrolet	Silverado Hd	1GB4YSE75RF392936	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2048	Chevrolet	Silverado Hd	1GC3YLE74RF415894	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2048	Chevrolet	Silverado Hd	1GC3YLE73RF417457	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2048	Chevrolet	Silverado Hd	1GC3YLE71RF415917	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2048	Chevrolet	Silverado Hd	1GC3YLE70RF322404	Pickup2-Chevrolet-Silverado EV-Class 1-3	67	4.4
2048	Chevrolet	5500Xd	JALEEW167R7309139	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	4.8
2048	Gm	Gm515	1HTKHPVK1RH228465	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2048	Gm	Gm515	1HTKHPVK3RH228466	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2048	Gm	Gm515	1HTKJPVM3PH693932	Heavy_Duty_Truck_7-Volvo-VNR Electric-Class 7	12	4.2
2048	Pierce Manufacturing	Aerial	4P1BCAGF2GA016311	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2048	Kovatch Mobile Equipment	Kovatch Mobile Equipment	1K9AF6M81GN058175	Fire_Truck-Pierce-Volterra-Class 8	9	5.8

Replace Year	Existing Vehicle Description			Electric Vehicle Description		
	Make	Model	VIN	Make-Model-Class	Miles per Gallon (eMPG)	Avoided MT CO_2e (annually)
2048	Kovatch Mobile Equipment	Kovatch Mobile Equipment	1K9AF4S86GN058227	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2048	Kovatch Mobile Equipment	Kovatch Mobile Equipment	1K9AF6M89JN058643	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2048	Peterbilt	348	2NP3HJ8X5HM414766	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2048	Peterbilt	520	3BPDL7EX0HF173425	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2048	Peterbilt	520	3BPDL7EX2HF173426	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2048	Mack	Gu (Granite)	1M2AX13C4HM038987	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2048	Mack	Mru (Terrapro)	1M2AV01C4JM001446	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2048	International	Sa525	3HAWDSTR0GL275154	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2049	Kovatch Mobile Equipment	Kovatch Mobile Equipment	1K9AF4S81KN058807	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2049	Pierce Manufacturing	Pumper	4P1BAAFF8RA027498	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2049	Pierce Manufacturing	Pumper	4P1BAAFFXRA027499	Fire_Truck-Pierce-Volterra-Class 8	9	5.8
2049	Mack	Granite	1M2GR2GC4SM044204	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2049	Mack	Granite	1M2GR1ACXMM001587	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2049	Mack	Granite	1M2GR3GC7KM003085	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2049	Mack	Granite	1M2GR2AC2LM001393	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2049	Mack	Granite	1M2GR1AC1MM001588	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9
2049	Mack	Terrapro	1M2TE1ACXMM001082	Dump_Truck-Lion Electric-Dump Truck - Class 8	16	5.9

Figure 12. Photo depicting location of UAB, Kirrane Pool, and Tappan Gym.

Emissions Projections

Table 8. 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 9. 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