Amherst Municipal Decarbonization Roadmap

6 December 2024

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Purpose and Acknowledgements

Amherst is committed to taking action to mitigate climate change. The Town developed and adopted a Climate Action, Adaptation and Resilience Plan (CAARP) in June 2021 with a goal of becoming carbon neutral by 2050. The purpose of this *Decarbonization Plan* is to provide a project pathway in support of this goal. The town has created policies, inventories and strategies in order to facilitate reaching its target. A *Zero Energy Town Buildings Bylaw* was passed which requires all new municipal building construction or additions with a total project cost of more than $2,000,000 to design a Zero Energy Capable Project. In addition, the Town adopted the Stretch Energy Code, and more recently the Specialized Stretch Energy Code, which provides Amherst with a more energy efficient alternative to the existing *State Building Code's* base energy code.

Amherst aims to lead by example and reduce emissions from Amherst's facilities, equipment, and operations to support climate and sustainability goals and make operations more efficient. As a participant in the Massachusetts Green Communities program, Amherst has already begun to identify and implement strategies to reduce energy use and costs by implementing clean energy projects in municipal buildings, facilities, and schools. This Decarbonization Roadmap provides a framework for Amherst to further these efforts and continue implementing clean energy strategies to eliminate the use of fossil fuels on-site by 2050.

While Amherst's goal is to decarbonize municipal facilities by 2050, not all buildings and facilities are included in this roadmap. 85.9% of municipal emissions are covered by the buildings included in the roadmap, and buildings and facilities not included in the formal roadmap will be described a high level at the end of the Municipal Emissions Baseline section, and recommended decarbonization efforts will be suggested in the Decarbonization Roadmap Narrative. For the purpose of estimating the municipal emissions over time, these buildings and facilities will be assumed to uniformly reduce emissions over the twenty-six years covered in the roadmap.

Acknowledgements

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Executive Summary

This Decarbonization Roadmap[1] describes Amherst's building portfolio and covers the various aspects of municipal emissions from building construction, operation, and maintenance as well as vehicle fleet emissions. The goal of this Roadmap is to identify Energy Conservation Measures (ECMs) to achieve complete fossil fuel elimination for municipal buildings and vehicles as well as reduce overall energy use intensity by the year 2050. This Roadmap considers how emissions are generated throughout Amherst's facilities and vehicles and the potential costs associated with the ECMs necessary to achieve decarbonization by the target year. Amherst staff worked closely with their technical assistance team to identify the scope of the roadmap, incorporate stakeholder feedback, develop the municipal goals, and identify implementation processes and roles to achieve the strategies outlined in the Roadmap.

Summary of Amherst

Amherst is a town of roughly 40,000 residents which hosts Amherst College, Hampshire College, and the University of Massachusetts at Amherst. The town shares a proud history of academic institutional excellence and a rich agricultural history. It is home to a diverse population and promotes a strong local government providing services, quality education, and support for environmental and decarbonization initiatives.

Amherst was designated a Green Community in 2012 and has received funding to support energy initiatives that have helped progress the town towards its goal of greater energy efficiency and carbon neutrality. The Town participated in the *ICLEI Cities for Climate Protection Program* in 2000 and developed its first *Climate Action Plan* in 2005 as part of that process. With the advent of the town's 2021 *CAARP*, *Greenhouse Gas Emissions Inventory* update (2023), *Municipal Building HVAC Inventory* (2023) and most recently the town's *Amherst Municipal Fleet Greenhouse Gas Emissions Inventory and Vehicle Transition Timeline* (2024) and launch of the *Valley Green Energy Intermunicipal Community Choice Aggregation* (in partnership with the City of Northampton and the Town of Pelham), the town continues to demonstrate its longstanding commitment to achieving environmental sustainability. Amherst plans to build on this history of sustainable initiatives going forward through its efforts to achieve designation as a Climate Leader Community.

Facility Name
Town Hall
Fort River ES
Wastewater Treatment Facility
Wildwood Elementary School
Crocker Farm Elementary School
Atkins Water Treatment Plant
Amherst Police Station
Water Pump Stations
Amherst Bangs Senior Center
Public Works Building
Amherst North Fire Station
Central Fire Station
Munson Memorial Library
Amherst Landfill

Summary of Municipal Building Portfolio

Amherst manages 25 facilities ranging from schools to public works and public safety facilities. These facilities are a critical part of Amherst's operations and services and are directly utilized by the community. Some of the largest energy users include the three elementary schools.

The Facilities Manager in collaboration with the Director of Sustainability leads the implementation of energy management strategies and programs impacting building operations and maintenance. The

[1] The decarbonization roadmap is distinct from a community's ERP in that it lays out the path to municipal decarbonization by 2050, while an ERP is designed to create a path to at least a 20% energy reduction. The roadmap focuses on electrification opportunities and EUI reduction strategies.

Facilities Manager works closely with Director of Sustainability to assess building needs, identify opportunities for clean energy improvements, and budget for or identify additional funding opportunities to implement facility upgrades.

Summary of Municipal Emissions

As shown in Table 1, Amherst's emissions profile is primarily comprised of four categories: buildings (for the Municipality, and for the RSD), the town's water and sewer facilities, and the town's vehicles

Table 1. Summary of Metric Tons of CO2 equivalent emissions (MTCO2e)

Emission Category	Emissions in Baseline Year (MTCO2e)	Ownership
Buildings	1,735.8	Municipality
Open Space	30.2	Municipality
Street/Traffic Lights	65.6	Municipality
Vehicle	1202.4	Municipality
Water and Sewer	902.3	Municipality

Source: MEI (2024)

The recommendations laid out in this roadmap represent the next steps that the town of Amherst should consider on their path to net-zero emissions. While additional actions can be taken to further reduce emissions and energy consumption, this roadmap proposes a realistic approach to eliminating onsite fossil fuel usage while simultaneously reducing overall energy consumption through reasonable building management and system changes.

Summary of Emissions Reduction Potential

Based on the analysis detailed in this roadmap, the potential for Amherst to reduce their overall emissions to net-zero by 2050 follows a path of consistent work and incremental improvements over the coming 26 years. Ongoing work through ECM implementation during Amherst's time as a Green Community demonstrates a strong commitment to decarbonizing the town's facilities, and continuing those projects will be crucial to achieving the milestones set out in this roadmap. As projects by Table 2, Amherst will meet both the onsite fossil fuel elimination by 2050, but also will adopt strategic EUI reduction projects at their facilities to exceed recommended EUI reduction targets of 30% by 2050.

Table 2. Summary of Municipal Emissions Reductions

Targets	2022	2027	2030	2040	2050
Reduce emissions from onsite fossil fuels via electrification	0%	-38%	-54%	-91%	-100%
Zero emission vehicles (ZEVs) in light-duty fleet adoption (% of fleet)	0%	10%	50%	80%	100%
Zero emission vehicles (ZEVs) in medium-/heavy-duty fleet adoption (% of fleet)	0%	10%	50%	80%	100%
Energy Use Intensity reduction (deep energy retrofits/retro commissioning)	EUI**	-21%	-33%	-54%	-60%
Total Emissions Reduction Goals (% of 2022 emissions)	0%	23%	50%	85%	97%

Amherst has a long track record of participating in DOER's programs to achieve energy efficiency, reduction, and decarbonization. Over the coming 26 years, they commit to continuing that by working with their regional school district partners to transition the Amherst High School and Middle School away from fossil fuels and push for more efficient building systems to mitigate overall energy consumption.

Municipal Building Portfolio

The Amherst Municipal Decarbonization Roadmap includes fifteen of the thirty-four municipal facilities comprising 79.3% of municipal building emissions: Town Hall, Fort River Elementary School, Wastewater Treatment Facility, Wildwood Elementary School, Crocker Farm Elementary School, Water Treatment Plants, Amherst Police Station, Water Pump Stations, Amherst Bangs Senior Center, Wastewater Pumping, Public Works Building, Amherst North Fire Station, Central Fire Station, Munson Library, and the Amherst Landfill.

Data sources used to develop baseline building emissions and characteristics include MassEnergyInsight (MEI), and data provided by Amherst on each of the included facilities.

Municipal Emissions Baseline

The first step in developing this decarbonization roadmap was to assess the current greenhouse gas (GHG) emissions trends for the municipality's buildings. The baseline assessment provides a year-by-year view of GHG emissions. This section provides an overview of the methodology used to develop the emissions baseline, the municipal level emissions trends, and the facility level emissions for the baseline year of FY2022.

As of the completion of this roadmap, MA EEA is finalizing electricity emission factors for 2022. This roadmap uses 0.0002345 MTCO2e/kWh and MEI, as of October 2024, uses 0.000243 MTCO2e/kWh. As a result, minor differences in baseline emissions may exist when comparing the baselines here and in MEI. DOER is aware of this difference and has approved the distinct emission factors for this roadmap.

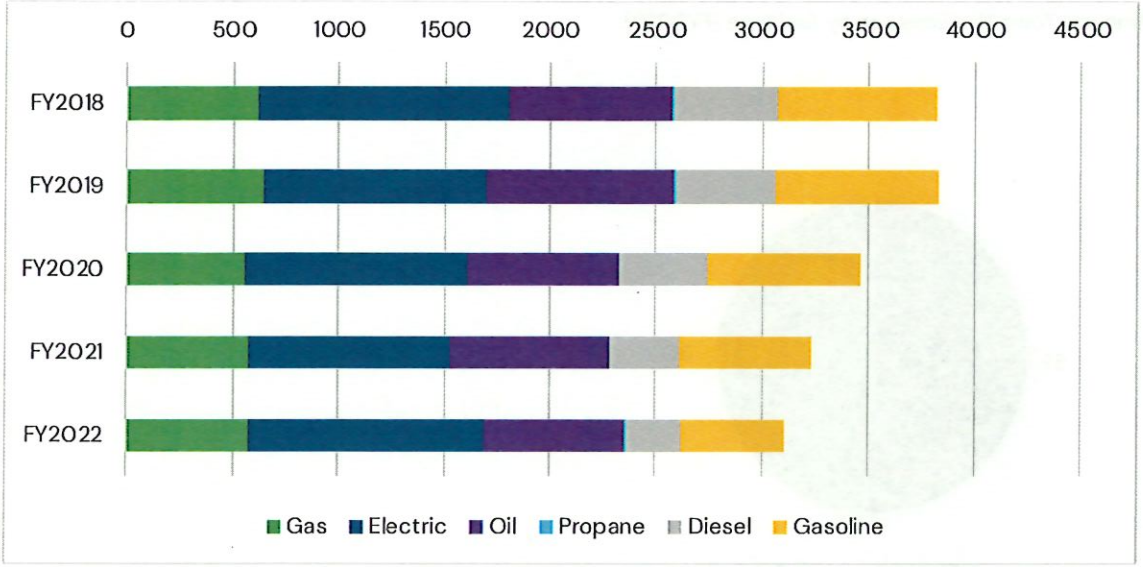
Identification of Inventory Tool

The fuel consumption and emission baseline used for the Amherst buildings is MEI. Emission factors utilized by MEI are reported in Appendix D.

Municipal Emissions Over Time

As shown in Figure 1, Amherst's municipal emissions have been decreasing over time, with lower consumption of all on-site fossil fuels from FY18 – FY22. Decreases range from a 10% decrease in oil to a 26% decrease in propane consumption. As a Green Community, Amherst has been continually engaging in ECMs and EUI reduction strategies. Recent ECM and EUI reduction projects include LED lighting retrofits at the Town Hall, Police Station, Munson Library, as well as efficiency upgrades at the Wastewater Treatment Facility.

Figure 1. Amherst Municipal Emissions FY18-FY22 (MTCO2e)



During the baseline year of FY2022, Amherst's emissions were comprised of 17.7% natural gas, 16.2% electricity, 15.3% oil, 16.2% gasoline, 7.7% diesel, and .1% propane.

Facility Specific Fuel Consumption and Emissions for the Baseline Year

This section lays out baseline fuel consumption at a facility level for each of the fifteen municipal buildings included in the decarbonization roadmap. For each building, a brief narrative description of the building uses including regular and outlier cases, a brief overview of building characteristics[2], a summary of fuel usage by emissions in the baseline year (FY2022), and a summary of implemented ECMs.

Amherst Town Hall

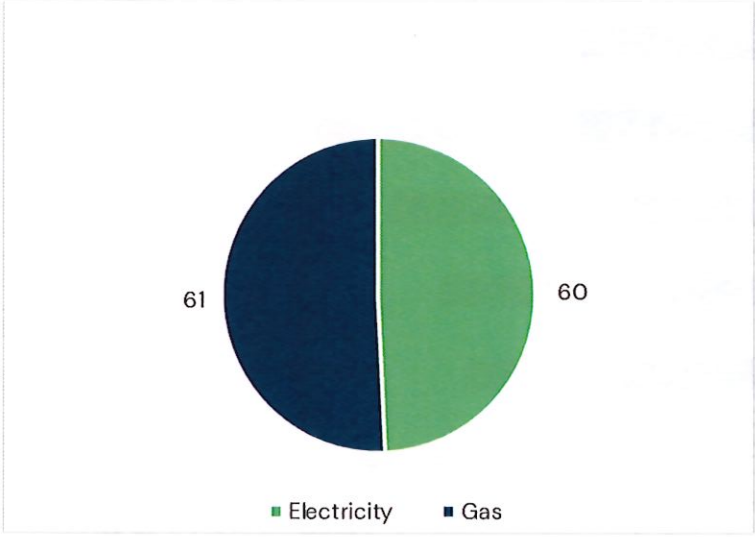
The Amherst Town Hall, while not the largest source of municipal GHG emissions in the town, is a symbolic building that represents the town's commitment to decarbonization through the central municipal use it houses. The Town Hall utilizes primarily gas and electricity in the baseline year of FY2022.

Building Characteristics	
Year Built	1850
Square Footage	19,784
Future Plans	Keep
GHG (FY22)	123.1
EUI (FY22)	102.4
Building Condition	Fair

The fuel types used at the Amherst Town Hall during FY2022 are shown in Figure 2. Emissions at the Town Hall have increased by over 8 MTCO2e from FY18 – FY22. Over this period, gas usage decreased by 3 MTCO2e, and electricity usage increased by 9 MTCO2e.

[2] The building characteristics are categorized as poor, fair and good indicating the presence of significant deferred maintenance (poor), some deferred maintenance (fair), or no deferred maintenance, but aging equipment (good), or no deferred maintenance and no aging equipment (excellent)

Figure 2. Amherst Town Hall Emission by fuel type (FY2022)



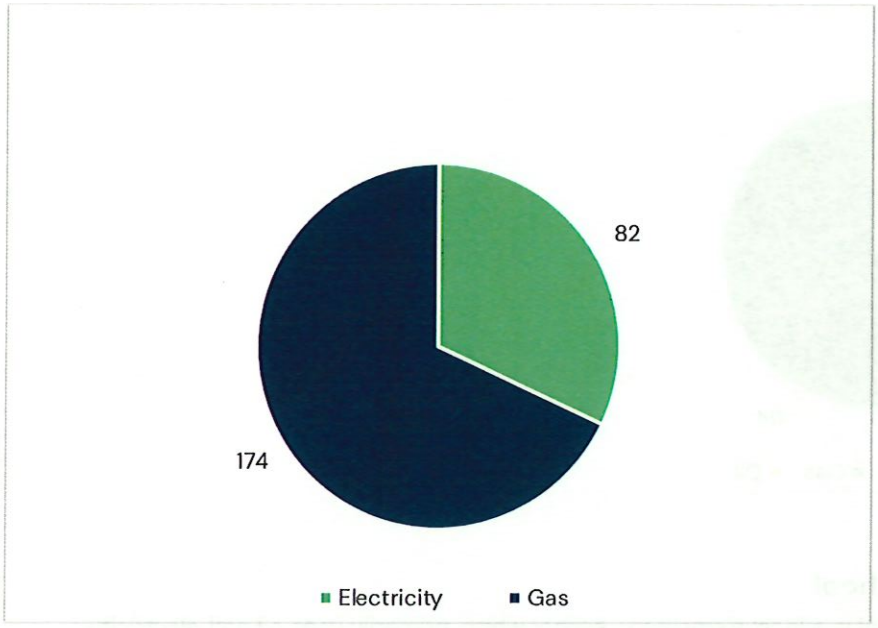
Fort River Elementary School

The Fort River Elementary School is one of the largest sources of municipal GHG emissions in the town. The Elementary school facility utilizes gas and electricity in the baseline year of FY2022. There are plans to build a new Fort River Elementary School to encompass both the existing Fort River student population as well as the Wildwood Elementary School population.

Building Characteristics	
Year Built	1972 New Construction: 2026
Square Footage	79,330
Future Plans	Keep
GHG (FY22)	258.5
EUI (FY22)	56.3
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 3. Emissions at the Middle school have decreased by over 170 MTCO2e from FY18 – FY22.

Figure 3. Fort River Elementary School Emission by fuel type (FY2022)



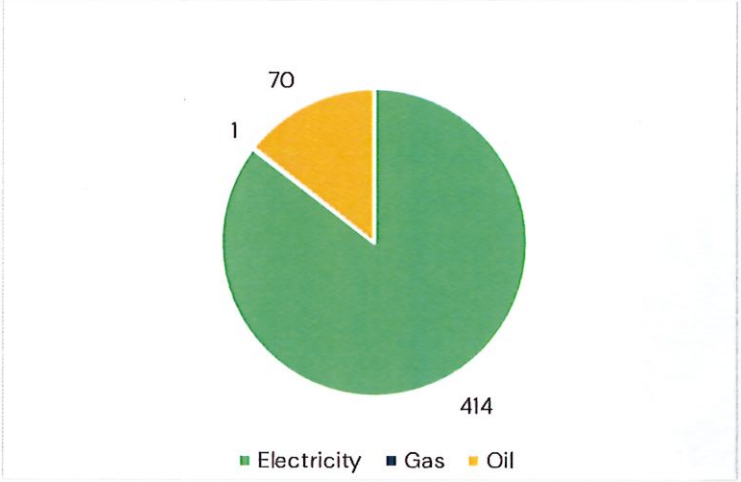
Wastewater Treatment Facility

The Wastewater Treatment Facility is a major electricity user in the town of Amherst. Recent efficiency ECMs for pumps have improved emissions.

Building Characteristics	
Year Built	1976
Square Footage	25,000
Future Plans	Keep
GHG (FY22)	484.8
EUI (FY22)	240.3
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 4.

Figure 4. Wastewater Treatment Facility Emission by fuel type (FY2022)



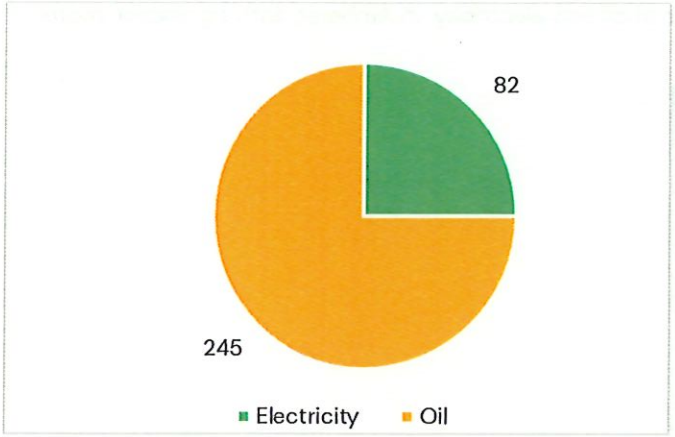
Wildwood Elementary School

The Wildwood Elementary School is a local elementary school which primarily uses oil and electricity. There are plans to replace the existing Wildwood Elementary School with a new Fort River Elementary School. Construction has begun and the decarbonization roadmap models the forecasted usage of the new combined Fort River Elementary School and Wildwood as the sum of their independent decarbonized components.

Building Characteristics	
Year Built	1970
Square Footage	79330
Future Plans	Keep
GHG (FY22)	326.8
EUI (FY22)	57.3
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 5.

Figure 5. Wildwood Elementary School Emission by fuel type (FY2022)



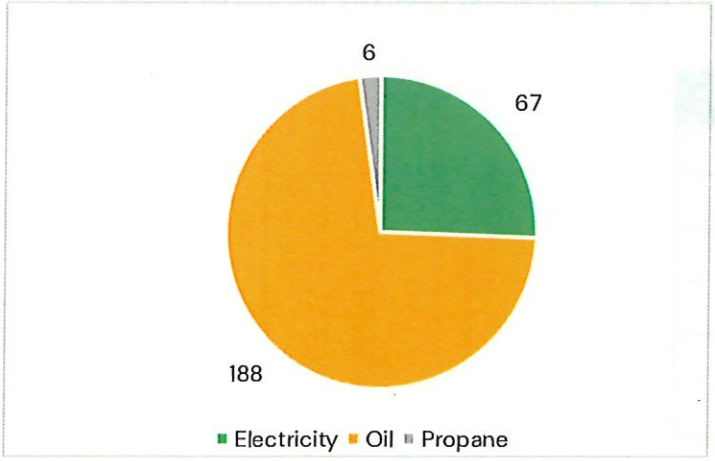
Crocker Farm Elementary School

The Crocker Farm Elementary School is a local facility that primarily uses oil and electricity, with some minor annual propane usage.

Building Characteristics	
Year Built	2002
Square Footage	69396
Future Plans	Keep
GHG (FY22)	254.7
EUI (FY22)	52.5
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 6.

Figure 6. Crocker Farm Elementary School Emission by fuel type (FY2022)



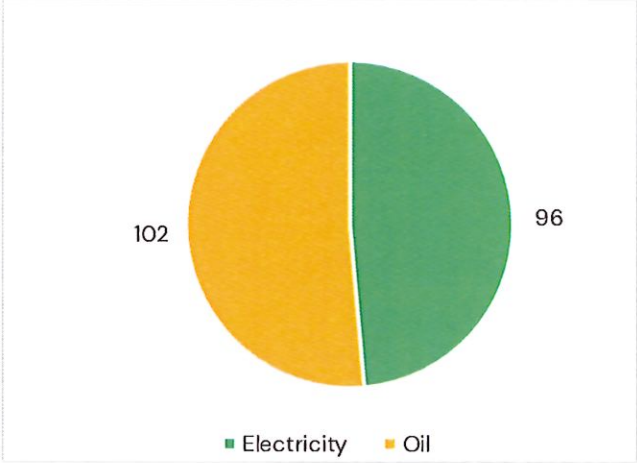
Water Treatment Plants

The Water Treatment Plants are another core user of oil and electricity in Amherst, with significant motor usage on an annual basis.

Building Characteristics	
Year Built	1968
Square Footage	12,500
Future Plans	Keep
GHG (FY22)	198
EUI (FY22)	279.8
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 7.

Figure 7. Atkins Water Treatment Plant Emission by fuel type (FY2022)



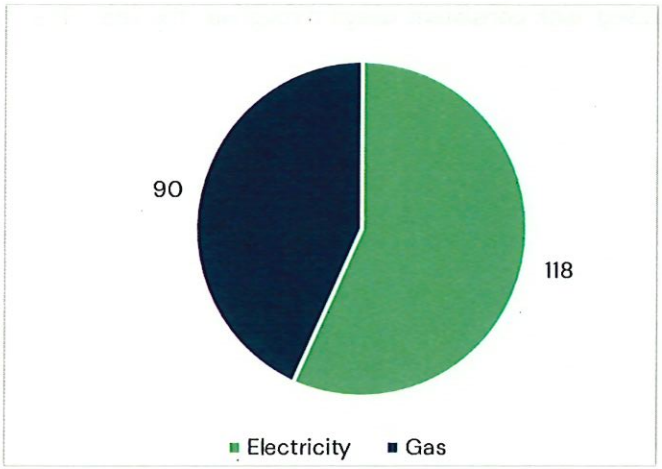
Amherst Police Station

The Amherst Police Station is a core town service that uses primarily electricity and gas for annual fuel uses.

Building Characteristics	
Year Built	1989
Square Footage	31,000
Future Plans	Keep
GHG (FY22)	208
EUI (FY22)	107.3
Building Condition	Good

The fuel types used at the Amherst High School during FY2022 are shown in Figure 8.

Figure 8. Amherst Polic Station Emission by fuel type (FY2022)



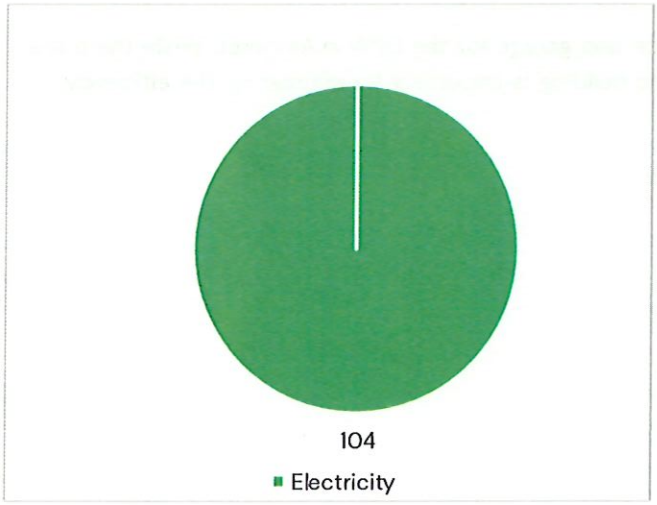
Water Pump Stations

The Water Pump Stations are significant electricity users for the town.

Building Characteristics	
Year Built	N/A
Square Footage	800
Future Plans	Keep
GHG (FY22)	104
EUI (FY22)	1,887.6
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 9.

Figure 9.Water Pump Stations Emission by fuel type (FY2022)



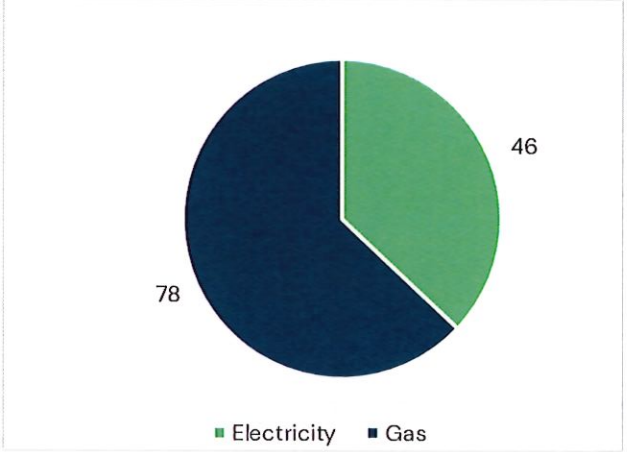
Amherst Bangs Senior Center

The Bangs Senior Center is a central community building, with consistent usage throughout the year. The facility primarily uses gas and electricity fuels.

Building Characteristics	
Year Built	1929
Square Footage	20,000
Future Plans	Keep
GHG (FY22)	120
EUI (FY22)	81.7
Building Condition	Good

The fuel types used at the Amherst High School during FY2022 are shown in Figure 10.

Figure 10. Amherst Bangs Senior Center Emission by fuel type (FY2022)



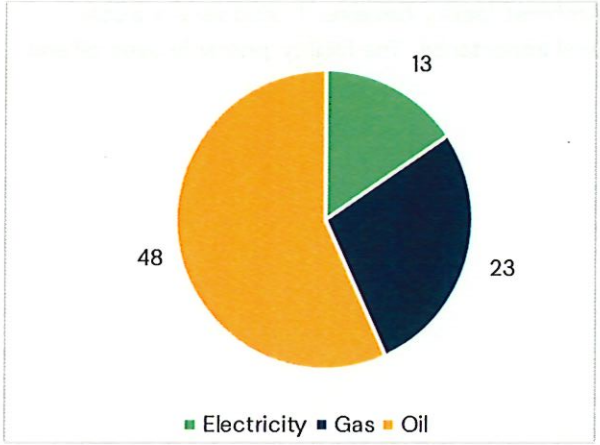
Public Works Building

The Public Works Building operates as a central office and garage for the DPW in Amherst. While there are plans to replace the facility, the baseline usage of the building is important for estimating the efficiency and energy needs of a replacement.

Building Characteristics	
Year Built	
Square Footage	30,000
Future Plans	Replace
GHG (FY22)	84
EUI (FY22)	141.3
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 11.

Figure 11. Amherst Public Works Building Emission by fuel type (FY2022)



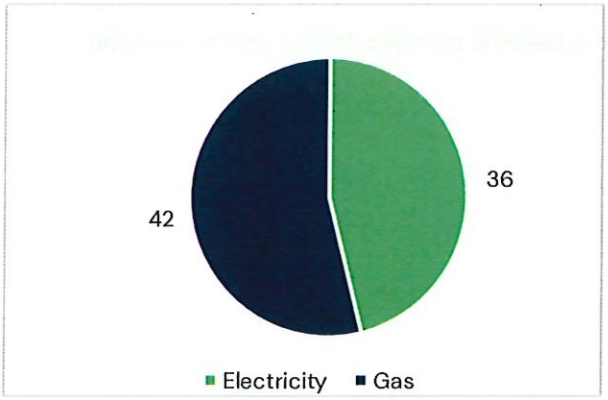
Amherst North Fire Station

The Amherst North Fire Station is one of the two fire stations in the town's baseline. Serving core public safety functions, the operation of the facility is of vital importance. The facility primarily uses gas and electricity.

Building Characteristics	
Year Built	
Square Footage	12584
Future Plans	Keep
GHG (FY22)	77.8
EUI (FY22)	104
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 12.

Figure 12. Amherst North Fire Station Emission by fuel type (FY2022)



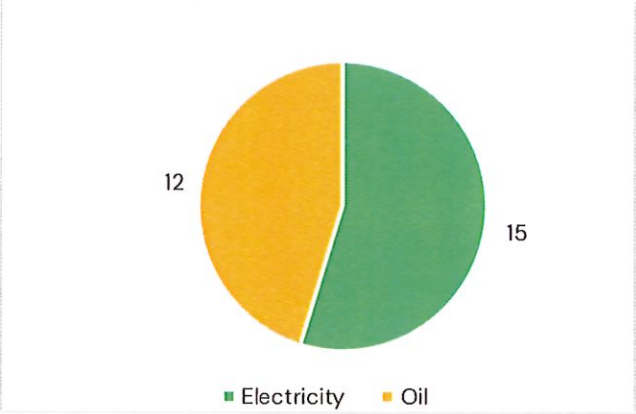
Central Fire Station

The Central Fire Station is the second fire station in the Amherst facility baseline. It also serves a core public safety function; the operation of the facility is of vital importance. The facility primarily uses oil and electricity.

Building Characteristics	
Year Built	1930
Square Footage	6389
Future Plans	Keep
GHG (FY22)	27.7
EUI (FY22)	59
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 13.

Figure 13. Central Fire Station Emission by fuel type (FY2022)



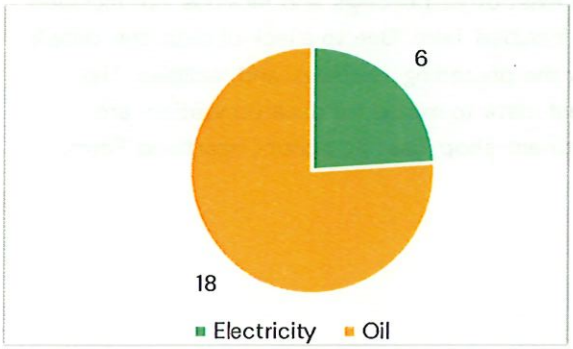
Munson Library

The Munson Library is the only town library included in the baseline portfolio. It uses primarily oil and electricity on an annual basis.

Building Characteristics	
Year Built	1929
Square Footage	8,182
Future Plans	Keep
GHG (FY22)	24.2
EUI (FY22)	40.7
Building Condition	Fair

The fuel types used at the Amherst High School during FY2022 are shown in Figure 14.

Figure 14. Munson Library Emission by fuel type (FY2022)



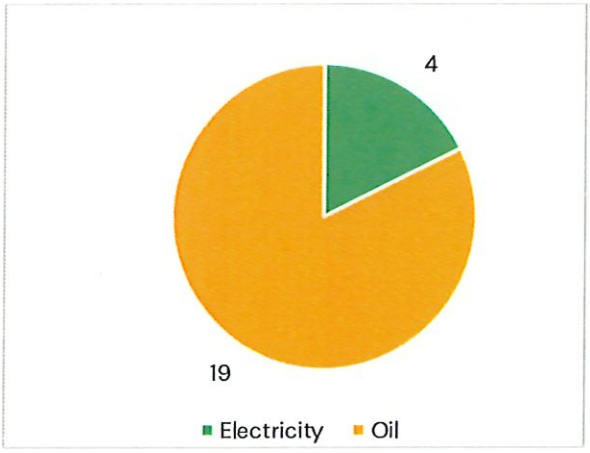
Amherst Landfill

The Amherst Landfill is a core facility for the continued operation of the town. The core fuel types for the Landfill are oil and electricity, and ECMs are targeted to reduce overall EUI over the decarbonization period prior to replacing the fossil fuel HVAC system.

Building Characteristics	
Year Built	N/A
Square Footage	1936
Future Plans	Keep
GHG (FY22)	24
EUI (FY22)	158.8
Building Condition	Fair

The fuel types used at the Amherst Landfill during FY2022 are shown in Figure 15.

Figure 15. Amherst Landfill Emission by fuel type (FY2022)



Other Buildings

As mentioned at the beginning of the Municipal Building Portfolio section, this roadmap includes the majority of Amherst's municipal emissions. However, there exist other buildings and facilities not included in the formal roadmap process, that for completeness are included here. Due to a lack of data, the details included in this section will be less than that presented for the preceding buildings and facilities. The Municipal facilities listed in MEI that do not contain sufficient data to model for decarbonization are: Cherry Hill Golf Course, Jones Library, Conservation Department shop, East St. School, Heartland Farm, DPW Parks and Rec Garage, Red Shed, and Ruxton.

Decarbonization Roadmap Narrative

Amherst's building portfolio presents multiple opportunities to implement decarbonization strategies and meet Amherst's decarbonization goals. The following section describes the key strategies that Amherst can implement at their facilities to eliminate onsite fossil fuel use by 2050 and make incremental emissions reductions beginning in the near term. While this Roadmap identifies building-specific strategies for Amherst to incorporate into capital and facility planning, it is also important for all building development, design, and maintenance activities to adhere to decarbonization principles to the extent possible. This may include the integration of efficiency and electrification measures into Amherst's planning and procurement processes and advancing building standards and equipment requirements in addition to the specific strategies described in this section.

This section provides a high-level overview of decarbonization strategies to be implemented by the community, as well as facility specific recommendations. These actions are presented in four distinct time categories (2027, 2030, 2040, and 2050) to capture and effectively distribute fiscal and technical capacity for the community and ensure that the decarbonization process aligns with existing equipment replacement where possible. The high-level summary provides an overview of the community's goals for actions in the near term (2027 and 2030), followed by their goals for the long term (2040 and 2050).

As Amherst is required to maintain emergency shelter functionality at its designated facilities, current technical electrification solutions do not exist where self-sufficiency can be consistently delivered for 72 hours. As electrification options such as batteries, distributed energy projects, and other technologies come onto the market and are financially feasible, Amherst will adopt them and add that transition to their decarbonization roadmap.

This roadmap breaks down implementation into six main categories: Lighting Retrofits, Weatherization Measures, Envelope/Insulation Improvements, HVAC Electrification and Controls Retrofit, Water Heating Electrification, and Solar PV Installation. These comprise the majority of projects that facilities can implement to either reduce their EUI or transition away from fossil fuel usage. This roadmap characterizes those six types with the following definitions.

Lighting Retrofits: Lighting retrofits entail the replacement of inefficient lighting, such as incandescent, halogen, HID, or T12 fluorescent, with highly efficient LED lighting. Best practices include replacing existing bulbs with LEDs and installing occupancy controls, such as timers, to reduce lighting consumption when spaces are unoccupied. ENERGY STAR provides a detailed list of LED fixtures.

Weatherization Measures: Weatherization measures increase the efficiency of buildings by improving heating and cooling. These include mechanical system upgrades or improvements, health and safety measures, and building shell measures. Weatherization best practices include completely air sealing the facility, replacing windows and doors with triple-pane, and incorporating weather-stripping to further reduce envelope holes. For roof replacement and retrofitting, incorporating solar ready roof replacements when feasible will reduce costs of rooftop solar array installation.

Envelope/Insulation Improvements: Building envelope/insulation improvements are modifications made to a building's outer shell to improve insulation and reduce energy loss. Envelope/insulation best practices include improving insulation by utilizing R-49 if some insulation exists, or R-60 if there is none. ENERGY STAR provides a detailed list of insulation best practices, as well as incentive information.

HVAC Electrification and Controls Retrofit[3]: HVAC electrification and controls retrofits include the replacement of fossil-fueled HVAC system components with electrified equipment such as high-efficiency heat pumps. HVAC system retrofits must comply with any applicable building codes for HVAC system designs, efficiency ratings or permits. Best practices for electrification include audits and assessments to determine optimal systems for specific buildings and phased implementation of new technologies. Best practices for HVAC controls include settings occupancy, pre-set heating and cooling controls to reduce demand when areas aren't used and to reduce heating and cooling loads by reducing the differential from outdoor temperatures and optimize system operation. Ongoing monitoring and optimization help to ensure that system functions are meeting building needs.

Water Heating Electrification[3]: Water heating electrification includes the replacement of fossil-fueled water heating equipment with electric equipment, such as conventional storage, tankless or demand-type, and heat pump water heaters or the combination of equipment types. When feasible, tankless alternatives should be considered due to the lower energy use. Equipment replacement must plan on integration with existing plumbing and electrical systems, including upgrading panels and wiring where needed. As with HVAC equipment, ongoing monitoring and optimization of water heaters helps to ensure that system functions are meeting building needs.

Solar PV Installation

Installing rooftop solar panels on facilities can reduce onsite electricity usage, and while the grid continues to decarbonize, solar arrays will mitigate some emissions from the facility. For facilities with relatively flat or appropriately aspected roofs, solar arrays can be a beneficial investment.

Summary

Amherst is proposing to thoroughly assess and address structural, energy efficiency and decarbonization of 10 buildings in 10 years. Assessments are being completed in 2024. Targeted facilities include Town Hall; Amherst Police Dept; Munson Library; Bangs Center; AFD North Station; WWTP; Atkins Water Treatment; Wildwood Elementary School. Other targeted bldgs. NOT in the GC baseline: North Amherst School; Amherst Childcare; ARMS (Rec Dept. only).

In addition, Amherst will be working to decarbonize its vehicle fleet according to the Zero Emissions Vehicle Fleet Policy. Passenger vehicles and cargo vans and trucks will be the first categories of vehicles to transition to more efficient or alternative fuels options.

Overview of Goals for implementation to 2027 and 2030

Amherst has identified the primary goals of their roadmap through 2030 to be the rightsizing of building energy use. Due to the lack of immediate replacements for major equipment such as HVAC and water heaters, initial ECM recommendations are based on reducing EUI for the town's buildings.

Overview of Goals for calendar years 2040 and 2050

Amherst's goals through 2040 and 2050 include the replacement of key fossil fuel equipment with electric alternatives. By prioritizing the rightsizing of facilities during the earlier periods, HVAC and water heaters can have reduced capacity and lower overall costs. Several of Amherst's facilities are designated as emergency shelters and require 72 hours of self-sufficient power generation. At this time, battery

[3] *Note: The projections in this Roadmap assume that weatherization and envelope/insulation improvements will be made prior to HVAC electrification to reduce overall energy consumption. This aligns with best practices to reduce energy load prior to electrification to minimize increases in electricity use.*

storage alternatives to generators are not financially viable, however as options enter the market and prices decrease, Amherst will re-evaluate the electrification of emergency shelters.

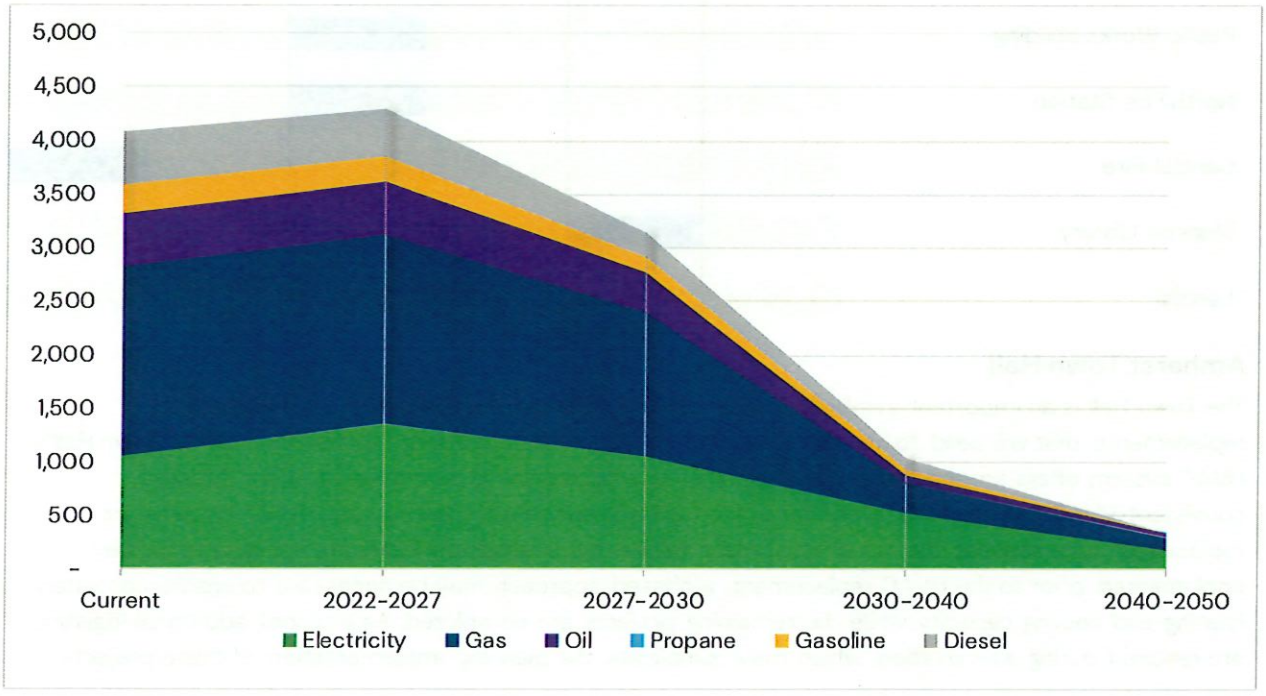
Areas of highest emissions and greatest opportunity for impact

Due to Amherst's ongoing commitment to reducing their climate impact, and efforts to reduce energy consumption, many of the easiest opportunities for emissions reduction have been achieved, such as LED replacements. However, with aging buildings, and the presence of some fossil fuel HVAC and water heater equipment, those areas offer the largest opportunity for emission reduction. As a result, this roadmap proposes each of the five facilities undergo rightsizing of energy use through weatherization and insulation prior to replacing significant equipment.

Achieving Elimination of Onsite Fossil Fuel Use by 2050

Through the recommended actions at the facility level discussed below, Amherst will achieve decarbonization of their facilities by 2050 (as shown in Figure 16). As technical and financial limitations allow, recommendations can be implemented sooner, which would result in decarbonization well before 2050 if fossil fuel equipment is targeted for replacement. In addition to the main recommendations and equipment replacements, ongoing energy audits maintenance is a core piece of the decarbonization roadmap, as it allows Amherst to better monitor its building portfolio and identify replacement needs and upcoming maintenance.

Figure 16. MEI Emissions Forecast 2022 Through 2050

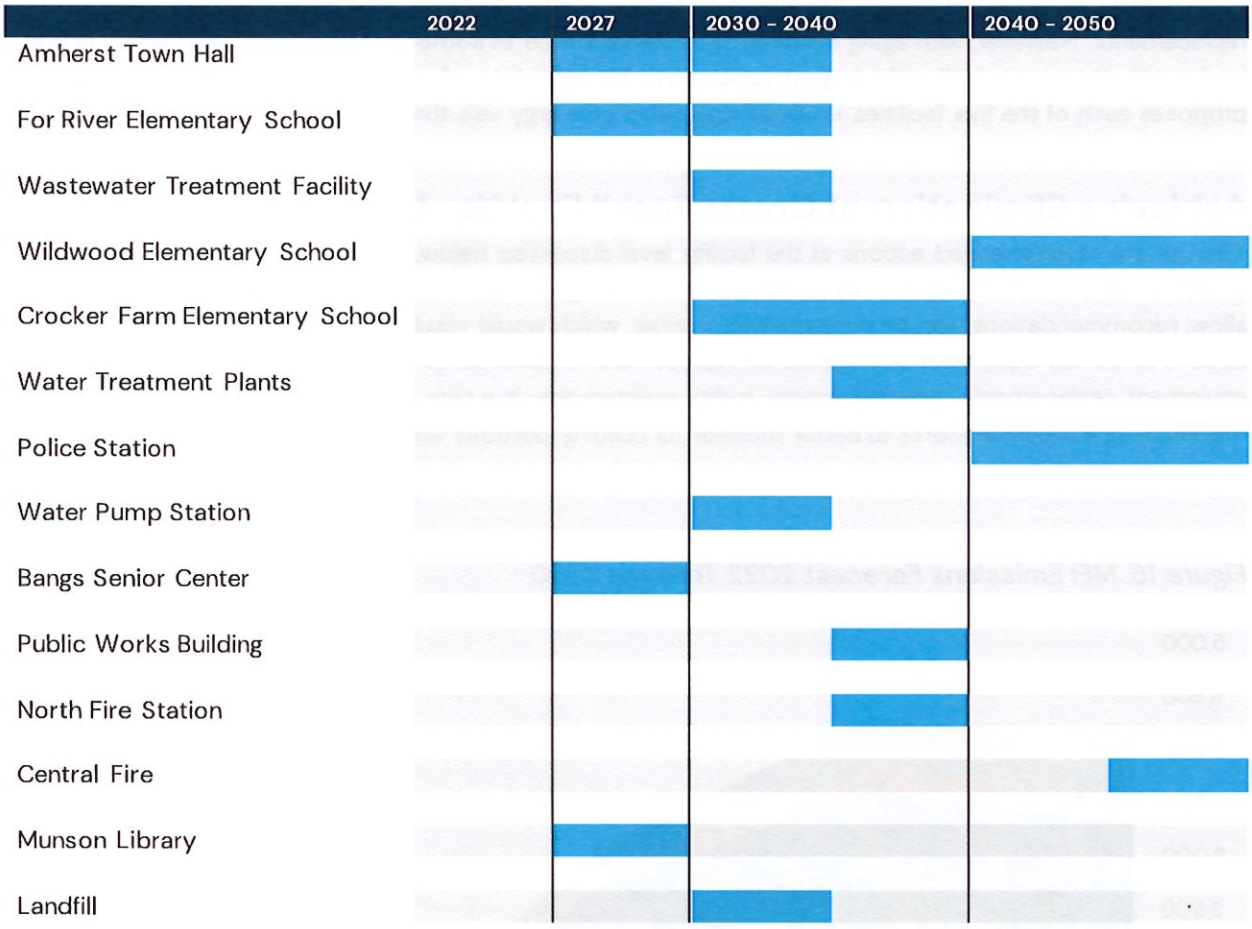


Description of Major Trigger Events to Achieve Onsite Fossil Fuel Elimination

This section lays out the timelines for major equipment replacements and retrofits categorized as greater than $250,000 along the timeline for 2027 – 2050. The goal of this timeline is to distribute major events over a broad period of time to eliminate the occurrence of overlapping projects which may increase the

risk of deviating from the roadmap. While events may appear to overlap in later years, note that the trigger event timeline shifts to 5-year increments following 2030.

Figure 17. Trigger Event Timeline



Amherst Town Hall

The Town Hall is an important symbolic facility for Amherst, and there are near term equipment replacements that will need to be addressed before 2030. The upcoming replacement of the Town Hall's HVAC system offers an opportunity to begin the decarbonization ECM implementation. Because consistent HVAC performance is critical to the facility's operation, ensuring that HVAC systems are replaced on time reduces the risk of equipment failure. If EUI reduction ECMs are not able to be fully implemented prior to the HVAC replacement, a phased approach may be necessary to ensure consistent heating and cooling capacity while the remaining projects are completed. As a school, additional logistics are required during a renovation, which may complicate the planning implementation of these projects.

Fort River Elementary School

The Fort River Elementary School is a significant user of energy for Amherst, and the new facility will be opened in 2026. As a result, equipment will be new in FY2026, and replacements will need to be addressed closer to 2050. EUI reduction ECMs are planned to be fully implemented prior to the HVAC replacement. As a school, additional logistics are required during a renovation, which may complicate the planning implementation of these projects.

Wastewater Treatment Facility

The Wastewater Treatment Facility's decarbonization is scheduled for the middle of the 2030 – 2040 period, likely after the High School and Middle School projects are completed to reduce logistical and financial load on Amherst.

Wildwood Elementary School

Wildwood Elementary School is planned to be replaced by the new Fort River Elementary School. However the facility will remain in the town's portfolio, and the equipment at the is rated to reach end of life in the early 2030 – 2040 period. The goal of decarbonizing the Wildwood Elementary School is to prepare the structure of the facility in the early 2030's by weatherizing and insulating the building to reduce overall EUI as much as possible prior to electrifying remaining on site fossil fuel equipment. As a school, additional logistics are required during a renovation, which may complicate the planning implementation of these projects.

Crocker Farm Elementary School

The Crocker Farm Elementary School is a significant user of energy for Amherst, and the equipment at the school is rated to reach end of life in the early 2040 – 2050 period. The goal of decarbonizing the Wildwood Elementary School is to prepare the structure of the facility in the early 2040's by weatherizing and insulating the building to reduce overall EUI as much as possible prior to electrifying remaining on site fossil fuel equipment. As a school, additional logistics are required during a renovation, which may complicate the planning implementation of these projects.

Water Treatment Plants

The Wastewater Treatment Facility's decarbonization is scheduled for the end of the 2030 – 2040 period, likely after the Crocker Farm Elementary School and Wastewater Treatment Plant projects are completed to reduce logistical and financial load on Amherst.

Amherst Police Station

As a core public safety building, the roadmap proposes delaying the beginning of their EUI reduction projects to FY40 – FY50 and continuing with the current HVAC equipment until end of life before replacing it and water heating equipment with electrified alternatives.

Water Pumping Stations

As a central community operations facility, and one of the larger consumers of energy, the roadmap proposes delaying the beginning of their EUI reduction projects to FY30 – FY45 before replacing the HVAC and water heating equipment with electrified alternatives.

Bangs Senior Center

As a central community building, the roadmap proposes beginning of the EUI reduction projects in the FY27 – FY30 period so that the facility can be right sized by the time the current HVAC equipment reaches end of life and then replacing it and water heating equipment with electrified alternatives.

Public Works Building

With the Public Works Building likely being replaced, the roadmap proposes delaying the beginning of the new facility until the FY35 – FY40 period so that there is sufficient time to design and fund a decarbonized facility.

North Fire Station

As a core public safety building the roadmap proposes delaying the beginning of their EUI reduction projects to FY35 – FY40 and continuing with the current HVAC equipment until end of life before replacing it and water heating equipment with electrified alternatives.

Central Fire Station

As a core public safety building, the roadmap proposes delaying the beginning of their EUI reduction projects to FY45 – FY50 and continuing with the current HVAC equipment until end of life before replacing it and water heating equipment with electrified alternatives.

Munson Library

As a central community building, the roadmap proposes beginning the EUI reduction projects in the FY27 – FY30 and to right size the facility before the current HVAC equipment reaches end of life and then replacing it and water heating equipment with electrified alternatives.

Amherst Landfill

As a core town operations facility, the roadmap proposes beginning the EUI reduction projects to FY30 – FY35. Due to the relatively small size of the Landfill, these projects will be easier to complete and fit within the overall town's objectives and goals.

Facility Level Recommendations to Achieve Onsite Fossil Fuel Elimination

The following sections outline on a facility level basis the recommended ECMs to be implemented and a proposed timeline to avoid unrealistic implementation timing based on logistic and financial constraints. The goal of these profiles is to outline on a facility level what types of projects should be implemented and in what order to best match the needs of the facility with the decarbonization steps required. At the core of each facility's recommendation is the goal of reducing overall energy consumption for the facility to an efficient level before investing in replacement equipment that decarbonizes the facility.

In cases where equipment fails prior to the expected replacement year, this roadmap can serve as a tool for facility managers to identify replacement equipment well in advance of the lifespan end. By maintaining the roadmap with implemented projects and planned replacements, Stow can leverage the timing of replacements to best match the available offerings in the market and customize their decarbonization pathway to best suit the needs and limitations of the town in a given year.

Amherst Town Hall

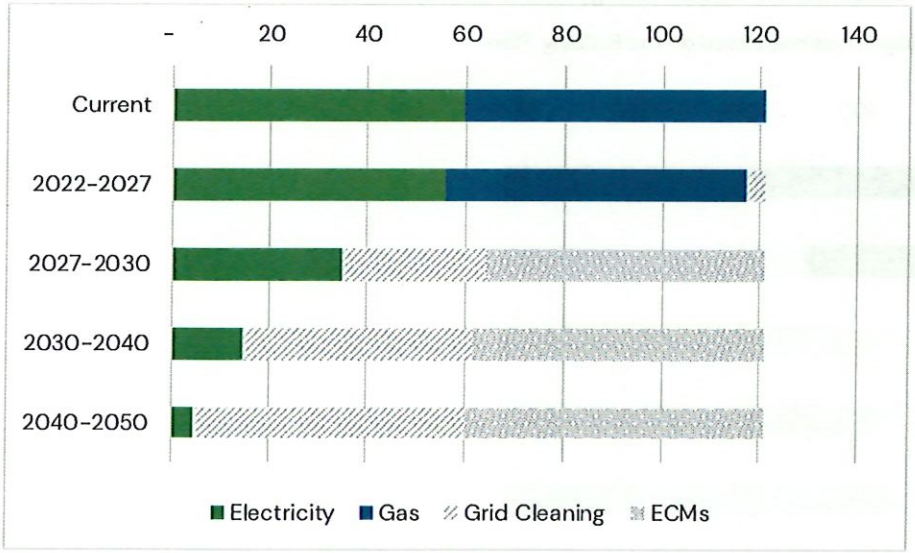
As noted in the baseline inventory, Amherst Town Hall is the central building of the town and utilizes electricity and gas in the baseline year of FY2022. As a symbolic facility, Town Hall is being prioritized for decarbonization to demonstrate the town's commitment to eliminating fossil fuel usage at municipal facilities. The Town Hall's HVAC equipment is anticipated to reach end of life before 2030, so EUI reductions projects should begin as soon as the town is able to replace the HVAC equipment with a properly sized electric alternative before it reaches end of life. The town should consider the capital planning aspect of these replacements and determine a feasible timeline for the equipment upgrades in line with the other proposed ECM projects in this roadmap.

Table 4. Amherst High School Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2027	**Weatherization Measures**	$98,920	3,351
FY2028	**Envelope/Insulation Improvements**	$385,788	8,378
FY2029	**HVAC Electrification and Controls Retrofit**	$412,892	10,492

By implementing the proposed decarbonization plan in Table 4, the projected building emissions for the Town Hall are described in Figure 18. Some anticipated challenges for the Town Hall include those related to the historic nature of the building: historic preservation of the structure itself; difficulty accessing and insulating spaces such as the roof; building occupancy; accessing materials (slate roof) and cost.

Figure 18. Estimated Future Building Emissions based on the Building Plan



Fort River Elementary School

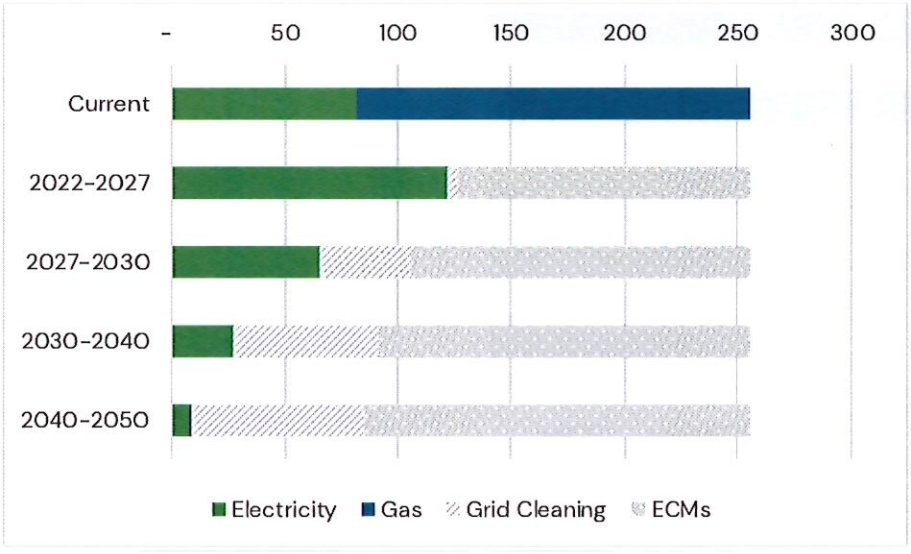
As noted in the baseline inventory, Amherst Fort River Elementary School utilizes electricity and gas in the baseline year of FY2022. With the opening in FY2026 of the new "Net-Zero" Fort River Elementary School, the HVAC equipment will be brand new, and as a result will reach end of life late into the decarbonization roadmap. EUI reduction projects are anticipated to be useful prior to replacing the HVAC system to ensure the facility is right sized. The town should consider the capital planning aspect of these replacements and determine a feasible timeline for the equipment upgrades in line with the other proposed ECM projects in this roadmap.

Table 5. Amherst Middle School Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2026	**Weatherization Measures**	$158,660	3,004
FY2026	**Envelope/Insulation Improvements**	$618,774	7,509
FY2026	**HVAC Electrification and Controls Retrofit**	$1,655,617	15,237

By implementing the proposed decarbonization plan in Table 5, the projected building emissions for the Fort River Elementary School are described in Figure 19. Some anticipated challenges for the Fort River Elementary School include: The existing building (Fort River ES) is being completely torn down and replaced with a new structure that will combine both the FR and Wildwood ESs. The project is targeting to meet an energy use intensity (EUI) of 25 kBtu/sf-year for Mass Save Path 1. The project goals also include meeting LEED School v4 Gold certification and complying with the thermal energy demand intensity (TEDI) requirement in 225 CMR 23 Massachusetts Stretch Energy Code, Section C401.2.1.

Figure 19. Estimated Future Building Emissions based on the Building Plan



Wastewater Treatment Facility

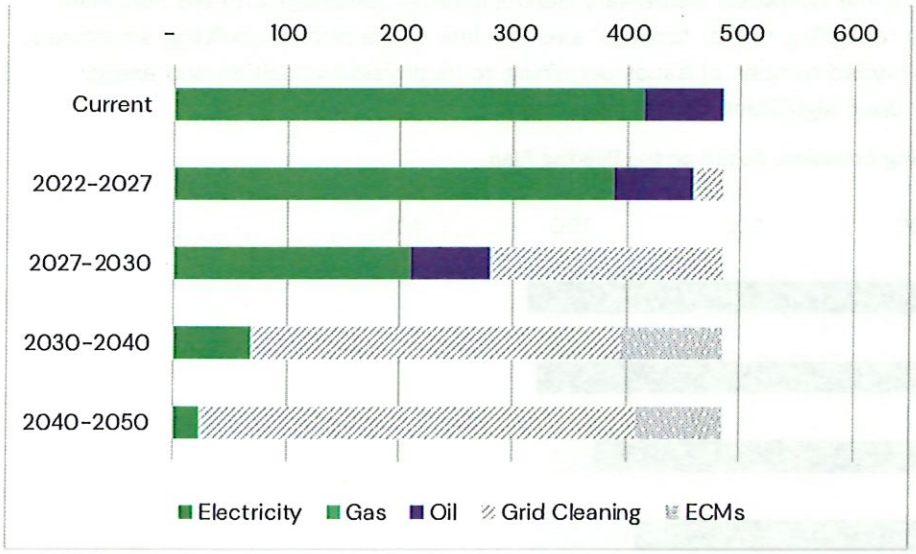
As noted in the baseline inventory, the Wastewater Treatment Facility utilizes electricity and oil, with a small amount of gas in the baseline year of FY2022. Due to the large degree of electrical usage stemming from motor operation, the majority of emission reduction stems from grid cleaning. ECM implementation is targeted for 2038 and 2043 to the right size the facility prior to replacing the HVAC equipment.

Table 6. Wastewater Treatment Facility Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2038	**Lighting**	$78,750	126.6
FY2038	**Weatherization Measures**	$125,000	216.8
FY2038	**Envelope/Insulation Improvements**	$487,500	542.0
FY2043	**HVAC Electrification and Controls Retrofit**	$521,750	277.3

By implementing the proposed decarbonization plan in Table 6, the projected building emissions for the Wastewater Treatment Facility are described in Figure 20. Some anticipated challenges for the Wastewater Treatment Facility include that there has been a long discussion of relocating this facility. As a result there has been little incentive to invest extensively in modifications or retro-fits..

Figure 20. Estimated Future Building Emissions based on the Building Plan



Wildwood Elementary School

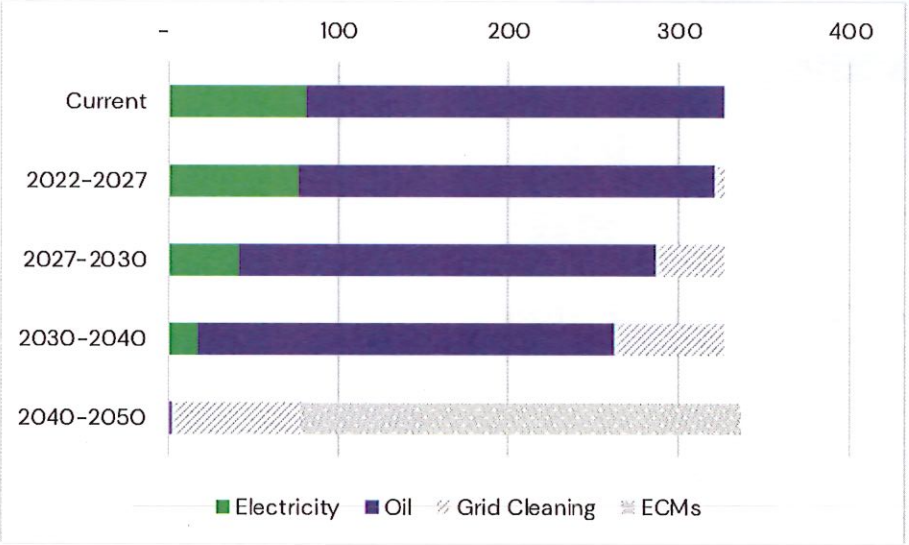
As noted in the baseline inventory, the Wildwood Elementary School utilizes oil and electricity in the baseline year of FY2022. The proposed implementation will prepare the facility through Lighting, Weatherization, and Insulation measures prior to replacing the HVAC and Water Heating measures in the 2041– 2042 period. As discussed earlier, the Wildwood school will be vacated when the new Fort River Elementary School opens. The facility will remain in the town's portfolio and could be used as a resilience hub, community center, or other uses to benefit the community.

Table 7. Wildwood Elementary School Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2041	**Lighting**	$124,945	67.4
FY2041	**Weatherization Measures**	$237,990	205.6
FY2041	**Envelope/Insulation Improvements**	$1,546,935	856.8
FY2042	**HVAC Electrification and Controls Retrofit**	$1,655,617	590.0
FY2042	**Water Heating Electrification**	$499,779	178.2

By implementing the proposed decarbonization plan in Table 7, the projected building emissions for the Wildwood Elementary School are described in Figure 21. Some anticipated challenges for the Wildwood Elementary School include: that the Wildwood Elementary School is being combined with the Fort River Elementary School and will be relocating to that facilities' site, The fate of the physical building structure is uncertain and remains with a myriad number of issues pertaining to its physical condition and energy efficiency. Future use will rely upon significant capital investment.

Figure 21. Estimated Future Building Emissions based on the Building Plan



Crocker Farm Elementary School

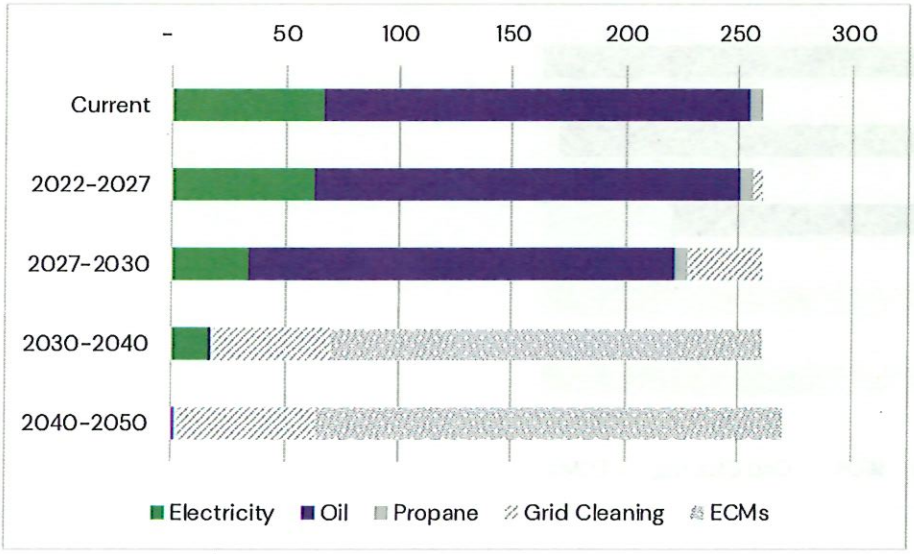
As noted in the baseline inventory, the Crocker Farm Elementary School utilizes oil and electricity, with some propane in the baseline year of FY2022. The proposed implementation will prepare the facility through Weatherization and Insulation measures prior to replacing the HVAC and Water Heating measures in the 2037 – 2038 period.

Table 8. Crocker Farm Elementary School Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2037	**Weatherization Measures**	$208,188	163.95
FY2037	**Envelope/Insulation Improvements**	$1,353,222	683.13
FY2038	**HVAC Electrification and Controls Retrofit**	$1,260,925	1,519.94
FY2038	**Water Heating Electrification**	$437,195	141.76

By implementing the proposed decarbonization plan in Table 8, the projected building emissions for the Crocker Farm Elementary School are described in Figure 22. Some anticipated challenges for the Crocker Farm Elementary School include that the Crocker Farm School is listed in the state's Mass Energy Insight database for FY'24 as one of the town's top three municipal building energy users and for building emissions. It is one of the targeted facilities for a complete assessment to address physical improvements and decarbonization opportunities. Capital funding remains one of the largest obstacles to addressing its needs..

Figure 22. Estimated Future Building Emissions based on the Building Plan



Water Treatment Plants

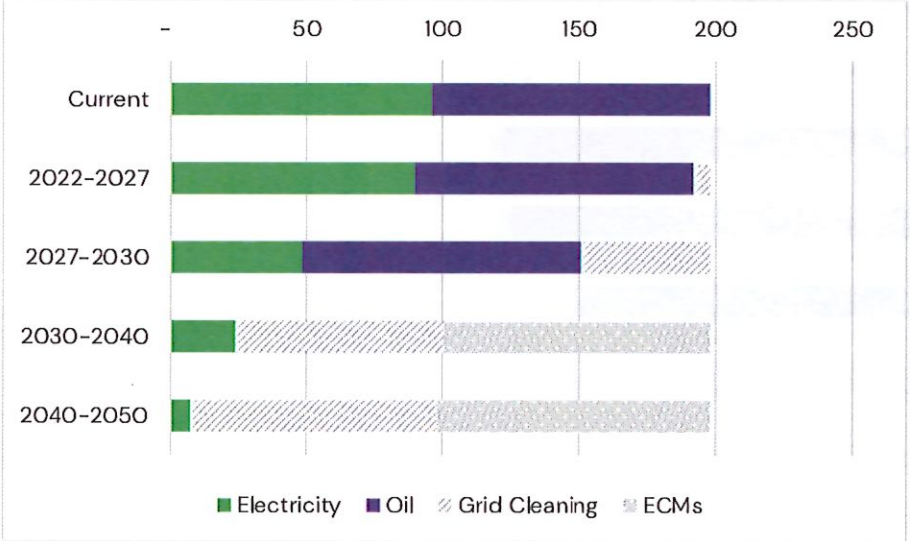
As noted in the baseline inventory, the Water Treatment Plants utilizes electricity and oil in the baseline year of FY2022. Due to the large degree of electrical usage stemming from motor operation, the majority of emission reduction stems from grid cleaning. ECM implementation is targeted for 2035 and 2036 to right size the facility prior to replacing the HVAC equipment.

Table 9. Water Treatment Plants Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2035	**Lighting**	$31,500	28.8
FY2035	**Weatherization Measures**	$50,000	182.02
FY2035	**Envelope/Insulation Improvements**	$195,000	455.06
FY2036	**HVAC Electrification and Controls Retrofit**	$208,700	200.90

By implementing the proposed decarbonization plan in Table 9, the projected building emissions for the Water Treatment Plants are described in Figure 23. Some anticipated challenges for the Water Treatment Plants include that the Atkins Water Treatment Plant is targeted as one of the buildings being assess for its physical and efficiency conditions, Capital funding is likely to be one of the largest challenges in order to address repairing and decarbonizing this structure.

Figure 23. Estimated Future Building Emissions based on the Building Plan



Amherst Police Station

As noted in the baseline inventory, the Amherst Police Station utilizes electricity and gas in the baseline year of FY2022. ECM implementation is targeted for 2046 and 2047 to right size the facility prior to replacing the HVAC equipment as it reaches end of life during the 2040 – 2050 period.

Table 10. Amherst Police Station Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2046	**Lighting**	$99,927	269.0
FY2046	**Weatherization Measures**	$95,169	105.2
FY2046	**Envelope/Insulation Improvements**	$618,599	438.2
FY2047	**HVAC Electrification and Controls Retrofit**	$566,890	140.0
FY2047	**Water Heating Electrification**	$199,855	216.2

By implementing the proposed decarbonization plan in Table 10, the projected building emissions for the Amherst Police Station are described in Figure 24. Some anticipated challenges for the Amherst Police Station include: that the building envelope must be completely addressed in order to advance to decarbonizing this facility. Insulation was installed in 2024 and a chiller which will provide some heating as well was recently installed. Funding to retrofit the system to full electrification will require a significant capital investment.

Figure 24. Estimated Future Building Emissions based on the Building Plan

Water Pumping Stations

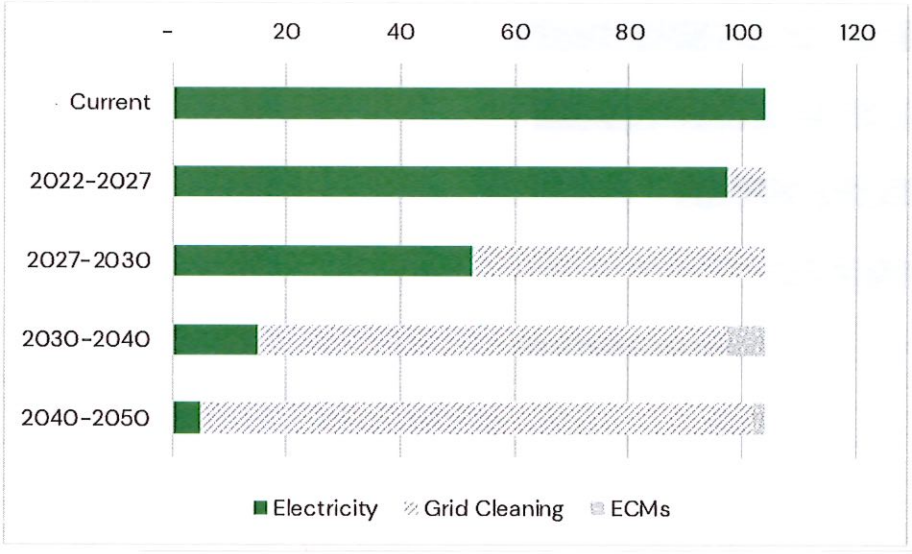
As noted in the baseline inventory, the Water Pumping Stations utilizes electricity in the baseline year of FY2022. Due to the large degree of electrical usage stemming from motor operation, the majority of emission reduction stems from grid cleaning. ECM implementation is targeted for 2033 and 2034 to right size the facility. The HVAC Electrification and Controls Retrofit ECM for the Water Pumping Stations is exclusively a controls retrofit as the current HVAC system is electric, and should be replaced with an electric system when it reaches end of life.

Table 11. Wastewater Pumping Stations Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2033	**Lighting**	$2,520	31.0
FY2033	**Weatherization Measures**	$4,000	26.8
FY2033	**Envelope/Insulation Improvements**	$15,600	67.1
FY2044	**HVAC Electrification and Controls Retrofit**	$16,696	40.9

By implementing the proposed decarbonization plan in Table 11, the projected building emissions for the Water Pumping Stations are described in Figure 25. Some anticipated challenges for the Water Pumping Stations include: that the age and condition of pumping stations as well efficiency all present challenges to move towards decarbonization of pumping facilities. A reliable form of a back up system is critical when moving to convert systems to full electrification,. Back up generation must be readily available and for an extended period of time in the case of a power outage..

Figure 25. Estimated Future Building Emissions based on the Building Plan



Amherst Bangs Senior Center

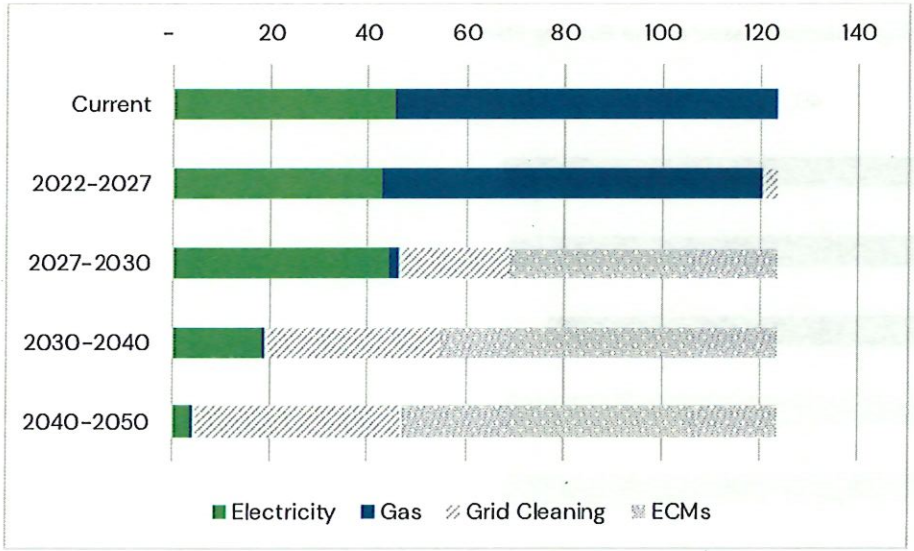
As noted in the baseline inventory, the Amherst Bangs Senior Center utilizes gas and electricity in the baseline year of FY2022. ECM implementation is targeted for 2027 and 2028 to right size the facility prior to replacing the HVAC equipment as it reaches end of life during the 2027 – 2030 period.

Table 12. Amherst Bangs Senior Center Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2027	**Lighting**	$82,111	56.4
FY2027	**Weatherization Measures**	$78,201	94.7
FY2027	**Envelope/Insulation Improvements**	$508,307	394.4
FY2028	**HVAC Electrification and Controls Retrofit**	$544,018	269.4
FY2028	**Water Heating Electrification**	$164,222	18.3

By implementing the proposed decarbonization plan in Table 12, the projected building emissions for the Amherst Bangs Senior Center are described in Figure 26. Some anticipated challenges for the Amherst Bangs Senior Center include: that the Bangs Center is one of the targeted facilities for an extensive physical condition and efficiency assessment. Due to its age, size and design it will require extensive capital investment to address the buildings numerous issues..

Figure 26. Estimated Future Building Emissions based on the Building Plan



Public Works Building

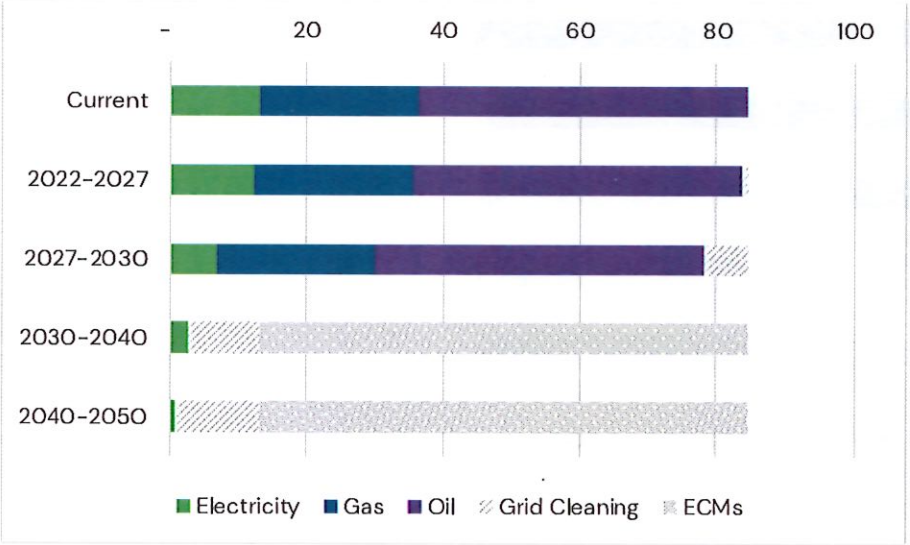
As noted in the baseline inventory, the Public Works Building utilizes oil, gas, and electricity in the baseline year of FY2022. ECM implementation is targeted for 2038 and 2039 to right size the facility prior to replacing the HVAC equipment as it reaches end of life during the tail end of the 2030 – 2040 period.

Table 13. Public Works Building Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2038	**Lighting**	$28,775	39.3
FY2038	**Weatherization Measures**	$27,405	76.3
FY2038	**Envelope/Insulation Improvements**	$178,133	317.9
FY2039	**HVAC Electrification and Controls Retrofit**	$190,647	138.9

By implementing the proposed decarbonization plan in Table 13, the projected building emissions for the Public Works Building are described in Figure 27. Some anticipated challenges for the Public Works Building include: that the DPW facility is an old structure that is targeted to be replaced with a new facility. It is one of four major capital projects prioritized in the coming years. Due to the town's net zero building policy for construction projects over $2,000,000, it will require a net zero design. The main challenge for this project is locating a suitable site for its construction. The existing structure is extremely inefficient and would require extensive capital investment to improve the envelope, physical structure and decarbonization of its HVAC systems.

Figure 27. Estimated Future Building Emissions based on the Building Plan



Amherst North Fire Station

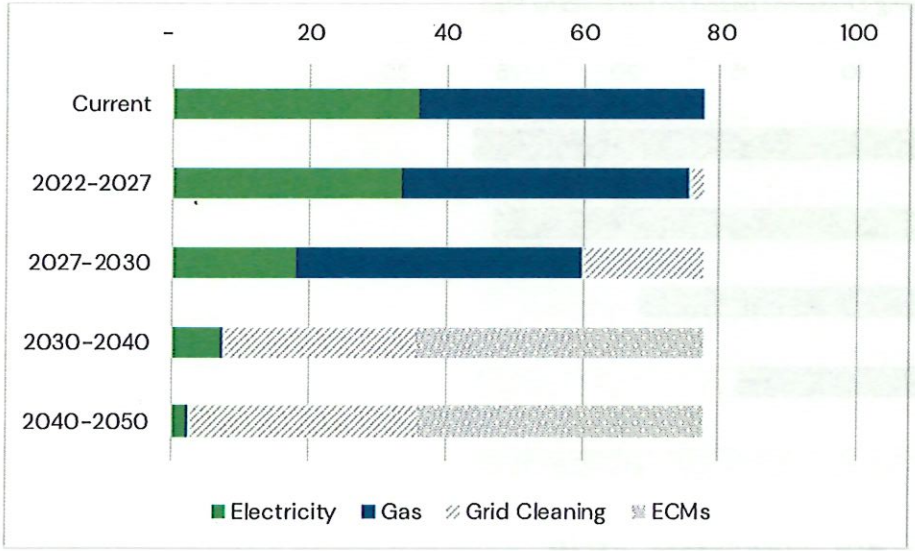
As noted in the baseline inventory, the Amherst North Fire Station utilizes electricity and gas in the baseline year of FY2022. ECM implementation is targeted for 2038 and 2039 to right size the facility prior to replacing the HVAC equipment as it reaches end of life during the tail end of the 2030 – 2040 period.

Table 14. Amherst North Fire Station Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2038	**Lighting**	$39,640	81.9
FY2038	**Weatherization Measures**	$37,752	59.4
FY2038	**Envelope/Insulation Improvements**	$245,388	247.5
FY2039	**HVAC Electrification and Controls Retrofit**	$224,876	(334.2)
FY2039	**Water Heating Electrification**	$79,279	23.5

By implementing the proposed decarbonization plan in Table 14, the projected building emissions for the Amherst North Fire Station I are described in Figure 28. Some anticipated challenges for the Amherst North Fire Station include: that the North Fire Station is also in need of physical repairs to the structure as well as addressing the efficiency of the building envelope prior to any decarbonization efforts. AS with all projects – significant capital investment is required to move this project work forward.

Figure 28. Estimated Future Building Emissions based on the Building Plan



Central Fire Station

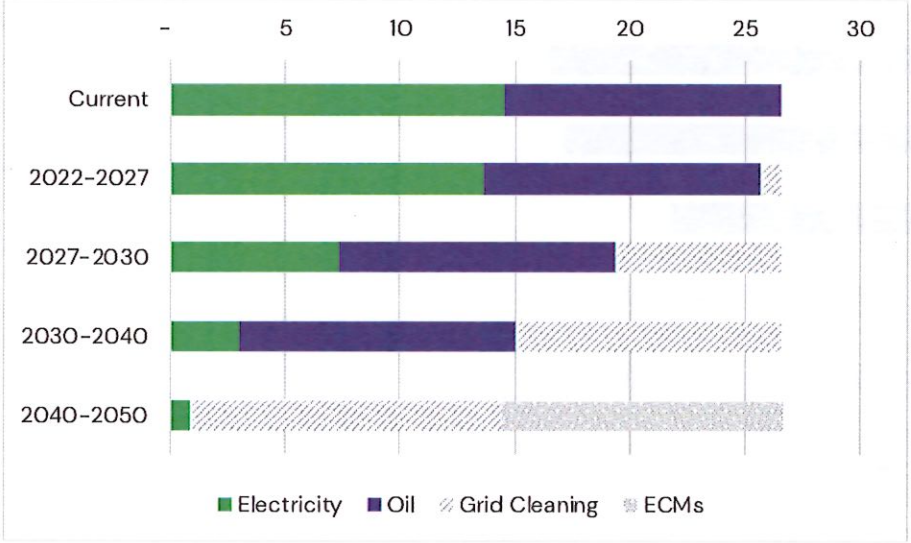
As noted in the baseline inventory, the Central Fire Station utilizes electricity and oil in the baseline year of FY2022. ECM implementation is targeted for 2044 and 2045 to right size the facility prior to replacing the HVAC equipment as it reaches its anticipated end of life towards the middle of the 2040 – 2050 period.

Table 15. Central Fire Station Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2044	**Lighting**	$20,125	33.3
FY2044	**Weatherization Measures**	$19,167	10.8
FY2044	**Envelope/Insulation Improvements**	$124,586	44.9
FY2045	**HVAC Electrification and Controls Retrofit**	$133,338	28.8
FY2045	**Water Heating Electrification**	$40,251	21.1

By implementing the proposed decarbonization plan in Table 15, the projected building emissions for the Central Fire Station are described in Figure 29. Some anticipated challenges for the Central Fire Station include: that the Central Fire Station is an old and inefficient structure that is targeted for replacement as one of four approved capital projects. Siting the facility has been its greatest challenge. The fate of the existing structure is uncertain and would require extensive capital investment to adequately address its numerous issues.

Figure 29. Estimated Future Building Emissions based on the Building Plan



Munson Library

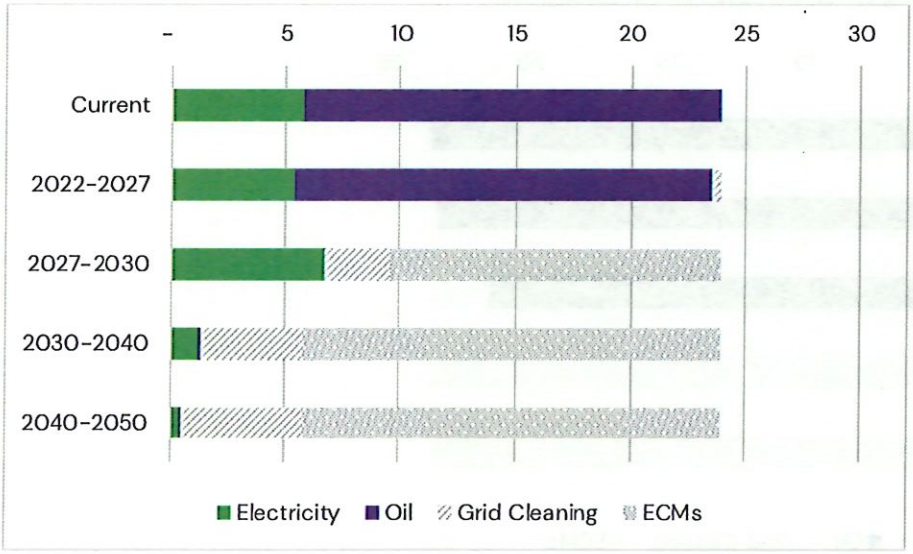
As noted in the baseline inventory, the Munson Library utilizes oil and electricity in the baseline year of FY2022. ECM implementation is targeted for 2029 to right size the facility prior to replacing the HVAC equipment as it reaches its anticipated end of life towards the end of the 2027 – 2030 period.

Table 16. Munson Library Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2029	**Weatherization Measures**	$24,546	16.8
FY2029	**Envelope/Insulation Improvements**	$159,549	69.9
FY2029	**HVAC Electrification and Controls Retrofit**	$170,758	50.9
FY2029	**Water Heating Electrification**	$51,547	2.8

By implementing the proposed decarbonization plan in Table 16, the projected building emissions for the Munson Library are described in FIgure 30. Some anticipated challenges for the Munson Library include: that the Munson Library is an old structure that like all other targeted facilities suffers from deferred maintenance and structural inefficiencies. Building envelope improvements will need to be made prior to HVAC system conversion. AS with the other projects, this will require significant capital investment..

Figure 30. Estimated Future Building Emissions based on the Building Plan



Amherst Landfill

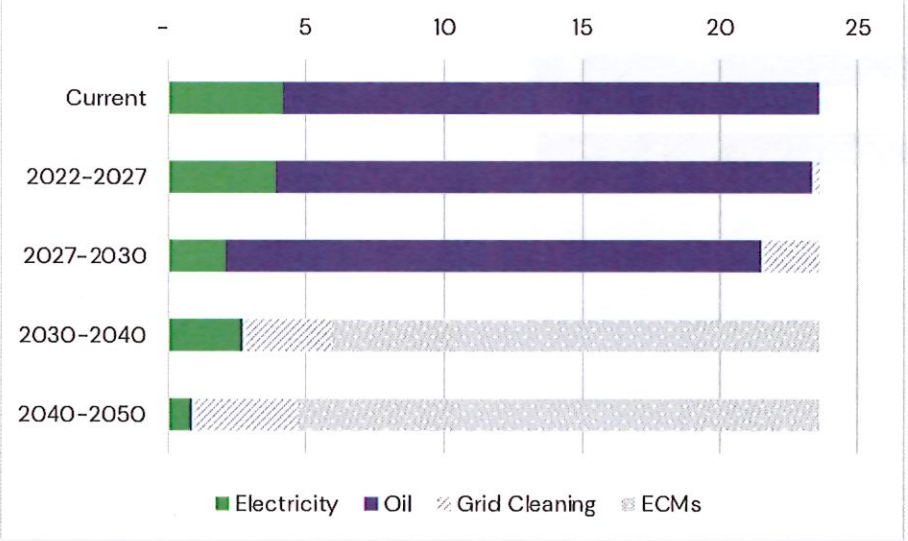
As noted in the baseline inventory, the Amherst Landfill utilizes oil and electricity in the baseline year of FY2022. ECM implementation is targeted for 2030 and 2031 to right size the facility prior to replacing the HVAC equipment as it reaches its anticipated end of life at the end of the 2027 – 2030 period.

Table 17. Amherst Landfill Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2030	**Lighting**	$6,098	12.4
FY2030	**Weatherization Measures**	$5,808	18.6
FY2030	**Envelope/Insulation Improvements**	$37,752	77.6
FY2031	**HVAC Electrification and Controls Retrofit**	$40,404	33.0

By implementing the proposed decarbonization plan in Table 17, the projected building emissions for the Amherst Landfill are described in Figure 31. Some anticipated challenges for the Amherst Landfill include: that the landfill office is an extremely inefficient facility that needs to be addressed prior to any decarbonization efforts. Like other projects it is a matter of prioritization and when funds may be allocated to address its system inefficiencies.

Figure 31. Estimated Future Building Emissions based on the Building Plan



Other Buildings

As noted in the baseline inventory, the timeline for proposed adoption will assume a uniform decrease in building emissions over time, resulting in decarbonization by 2050. These ECM adoptions will be structured so that lighting, weatherization, and insulation projects are completed prior to the replacement of HVAC and domestic water heating equipment.

Vehicles

In FY2022, the municipal fleet of Amherst generated a significant proportion of overall municipal emissions.

Light-Duty Vehicles

Within the municipal fleet of Amherst, 39.61% is comprised of light-duty vehicles. Amherst has no current plans to add or reduce the number of vehicles in their light-duty fleet. The targeted percentage of light-duty ZEV vehicles in the fleet is detailed in Table 2.

Medium-Duty Vehicles

Within the municipal fleet of Amherst, 34.42% is comprised of medium-duty vehicles. Amherst has no current plans to add or reduce the number of vehicles in their medium-duty fleet. The targeted percentage of medium-duty ZEV vehicles in the fleet is detailed in Table 2.

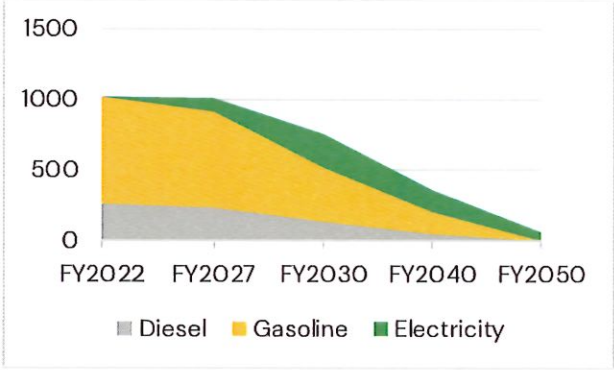
Heavy-Duty Vehicles

Within the municipal fleet of Amherst, 25.97% is comprised of heavy-duty vehicles. Amherst has no current plans to add or reduce the number of vehicles in their heavy-duty fleet. The targeted percentage of heavy-duty ZEV vehicles in the fleet is detailed in Table 2.

Estimated Municipal Fleet Emissions

By transitioning the municipal fleet based on the Table 2, estimated municipal fleet emissions are shown in Figure 32.

Figure 32: Amherst Vehicle Emission Forecast 2022-2050



Co-Benefit Considerations

In addition to supporting emissions reductions and decarbonization goals, these strategies can also provide co-benefits to the community by improving human health, economic development opportunities, and increased building resilience. Energy efficiency upgrades and the deployment of on-site renewable resources can help to mitigate impacts from extreme heat or cold and power outages. The decarbonization strategies identified in this Roadmap can deliver co-benefits as investments in Amherst's community.

Program Management Plan for Implementation, Monitoring and Oversight

Lead Implementers

Amherst engaged a Fellow from the University of New Hampshire's Sustainability Institute Fellow's Program to develop a Town Amherst Fleet GHG Inventory and Transition Timeline in the summer of 2024. Recommended measures within the plan along with the adoption of a Zero Emission Vehicle Fleet Policy will guide the decarbonization of its vehicle fleet.

With the support of stakeholders, funding, and this guiding Roadmap, Amherst will begin implementing actions and strategies to achieve the town's decarbonization goals. Implementation of this multi-year roadmap will require support and action from the Amherst government, businesses, and residents. The roadmap provides a strategic, portfolio-level approach to prioritize and implement decarbonization measures at Amherst's buildings. Within Amherst, Department Heads are responsible for complying with town fleet procurement policies. Capital requests are reviewed by the Town Manager, Join Capital Planning Committee and ultimately approved by the Town Council.

The actions identified in this Roadmap will require ongoing evaluation and strategic planning to incorporate building upgrades into existing budget processes or to identify additional funding sources where needed. Staff resources will also be necessary to support the implementation of these actions. Over time, as implementation progresses and technologies and policies evolve, Amherst will also update this 2024 Roadmap to reflect accomplishments and new opportunities.

Roadmap Maintenance

Amherst's Town Manager is responsible in collaboration with Department Heads will be primarily responsible for maintaining this Roadmap and monitoring progress toward the 2050 goal.

Technical Appendix

Amherst utilized a modeling tool developed for the purposes of this Roadmap to estimate the emissions reduction potential from a range of potential energy conservation measures (ECMs). The tool incorporated existing building characteristics data and business-as-usual (BAU) fuel use and costs from Fiscal Year 2022 (FY2022), in addition to known information about retrofit and upgrades completed to date for each building, to estimate the impact of implementing a range of ECMs. The tool inputs and assumptions are described in this Appendix.

Data Sources and Assumptions

The baseline emissions profile for the town's portfolio and by building was sourced from MEI. The tool used the below emission factors from MA EEA's forecasting for each fuel type. These estimates were produced as part of the MA 2050 Decarbonization Roadmap and were forecasted for every 5 years from 2020 to 2050. For estimating emissions in this roadmap, the 2025 emission factor for electricity is being applied to the 2027 period.

	2022	2025	2030	2040	2050
Electricity (kWh)	0.000235	0.00022	0.000118	0.0000485	0.000015
Gas (therms)	0.00531	0.00531	0.00531	0.00531	0.00531
Oil (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

Building Characteristics & Energy Consumption

The tool used building characteristics data from MEI including total fuel use, EUI, and square footage for each building. The fuel use by type data included FY2022 totals for electric, gas, oil, propane, and total fuel use for each building. The fuel costs by type were also FY2022 totals for each applicable fuel type. For each building, the MEI building category was mapped to an EIA building category to apply the most appropriate building assumptions for each facility type.

MEI	EIA Match
Administration	Office
Indoor Recreation	Public Assembly
Library	Public Assembly
Public Safety	Public Order and Safety
Public Works	Service
School	Education
Other	Other

The tool used Commercial Building Energy Consumption by End Use factors from the U.S. Energy Information Administration (EIA) Commercial Buildings Energy Consumption Survey to estimate each

facility's energy consumption by end use to estimate reductions from each ECM.[4] These factors provided the percentage of total consumption for each end-use by energy source.

Energy Conservation Measures

ECM implementation timelines aligned with the Roadmap timeline structure (2022-2027, 2027-2030, 2030-2040, 2040-2050) and enabled short-, medium-, and long-term assumptions for each ECM type based on available facility data and cost estimations.

Existing ECMs information in MEI, and additional resources and information sources where applicable, were used to determine each building's eligibility for additional Energy Conservation Measures (ECMs) with 100% being fully eligible, i.e. having not implemented the ECM to any extent, and 0% being ineligible, i.e. having already fully implemented that ECM or the ECM is not applicable or appropriate for that building. Where no data was available, the tool assumed 100% eligibility for that ECM.

Note: As the commercial EIA factors did not include an end-use energy value for pump equipment used in water and wastewater treatment plants, the lighting ECM for these facilities overcounts for the impact of lighting retrofits (i.e., assumes that all electricity end-use consumption is from lighting and not other equipment). For these facilities, the eligibility assumptions for the lighting ECMs were reduced by 90% to account for the overrepresentation of lighting end-use in the savings calculations.

[4] Table E5 and E7, Commercial Buildings Energy Consumption Survey (CBECS), 2018
https://www.eia.gov/consumption/commercial/data/2018/index.php?view=consumption

Building Name	Fuel Use Total	Fuel Use Total	EUI	Building Square Footage	Eligibility for Additional Energy Conservation Measures (100%=Eligible, 0%=Not Eligible. Percentages indicate amount already completed.)						
	MMBtu	kBtu	kBtu/sf	sq. ft.	Lighting	Weatherization	Envelope/Insulation	HVAC Controls	HVAC Electrification	Water Heating Electrification	Solar
Amherst Town Hall	1961.8	1,961,800	99.16	19,784.0	0%	0%	100%	0%	100%	50%	0%
Cherry Hill Golf Course	105.59	105,590	16.26	6,493.0	0%	0%	100%	100%	100%	100%	0%
Jones Library	2008.8	2,008,800	53.13	37,807.0	100%	0%	100%	100%	100%	100%	0%
Munson Library	332.52	332,520	40.64	8,182.0	0%	0%	100%	100%	100%	100%	0%
North Amherst Library	27.24	27,240	14.72	1,850.0	100%	0%	100%	100%	100%	100%	0%
Amherst Bangs (Senior Ctr.)	2061.26	2,061,260	79.08	26,067.0	100%	0%	100%	100%	100%	100%	0%
Conservation Dept Shop	9.12	9,120	32.93	277.0	100%	0%	100%	100%	100%	100%	0%
East St School	5.79	5,790	0.06	101,930.0	100%	0%	100%	100%	100%	100%	0%
Heartland Farm	6.68	6,680	0.9	7,408.0	100%	0%	100%	100%	100%	100%	0%
Amherst North Fire Station	1286.79	1,286,790	102.26	12,584.0	100%	0%	100%	0%	100%	100%	0%
Amherst Police Station	3240.45	3,240,450	102.15	31,723.0	100%	0%	100%	0%	100%	100%	0%
Central Fire Station	383.39	383,390	60.01	6,389.0	100%	0%	100%	100%	100%	100%	0%
Amherst Landfill	302.23	302,230	156.11	1,936.0	100%	0%	100%	100%	100%	100%	0%
DPW Parks and Rec garage	363.36	363,360	108.08	3,362.0	100%	0%	100%	100%	100%	100%	0%
Public Works Building	1199.4	1,199,400	131.3	9,135.0	100%	0%	100%	100%	100%	100%	0%
Red Shed	15.63	15,630	7.82	2,000.0	100%	0%	100%	100%	100%	100%	0%
Ruxton	15.01	15,010	4.19	3,584.0	100%	0%	100%	100%	100%	100%	0%
Amherst High School	11270	11,270,000	47.14	249,750.0	100%	0%	100%	100%	100%	100%	0%
Amherst Middle School	11264	11,264,000	56	196,382.0	100%	0%	100%	100%	100%	100%	0%
Crocker Farm ES	3513.78	3,513,780	50.63	69,396.0	0%	0%	100%	10%	100%	100%	0%

Fort River ES	4359.06	4,359,060	54.95	79,330.0	0%	0%	100%	100%	100%	100%	0%
Wildwood ES	4172.34	4,172,340	52.59	79,330.0	50%	0%	100%	100%	100%	100%	0%
WWTP	6,007.60	6,007,600	240.30	25,000.0	100%	100%	100%	100%	100%	100%	0%
Atkins Water Treatment Plant	2,798.40	2,798,400	279.84	10,000.0	100%	100%	100%	100%	100%	100%	0%
Stanley Street Pump Stations	1,510.10	1,510,100	1,887.63	800.0	100%	100%	100%	100%	0%	100%	0%

*Greyed rows indicate no available ECM data on MEI.

The eligibility assumptions were incorporated into the ECM calculations for each building, using the assumptions and factors described below. **Note:** the HVAC Electrification and Controls Retrofit calculations use the estimated energy consumption following implementation of the Weatherization and Envelope/Insulation Improvements. This assumption requires a phased approach where all weatherization and envelope/insulation measures are implemented prior to any electrification measures.

Lighting Retrofits

To estimate lighting end-use consumption reductions from lighting retrofits, the tool used the matched building type, building square footage, and electricity usage to estimate the lighting end-use consumption. The estimated lighting end-use consumption was multiplied by an Expected Electricity Savings assumption of 66% (based on Averaged PNNL Study based on Design Lights Case Studies[5]) to estimate the total reduction potential from lighting retrofits.

To estimate total implementation costs per facility, the tool applied the following cost per unit assumption:

Description	Cost	Unit
LED retrofit w/ photocells	$3.15	$/sqft

Cost estimates do not account for prevailing wage requirements in Massachusetts.

Weatherization

To estimate energy savings from weatherization measures, the tool used the matched building type, building square footage, and applicable fuel usage to estimate the HVAC end-use consumption. For each applicable fuel type per building, the estimated HVAC end-use consumption was multiplied by an Expected Electricity Savings assumption of 8% (ICF assumption[6]) and an Expected Gas/Fuel Savings assumption of 12% (ICF assumption) to estimate the total reduction potential from weatherization measures.

To estimate total implementation costs per facility, the tool applied the following cost per unit assumption:

Description	Cost	Unit
Weatherization Measures	$5.00[7]	$/sqft

Cost estimates do not account for prevailing wage requirements in Massachusetts.

[5] https://www.designlights.org/our-work/networked-lighting-controls/lighting-controls-case-studies/

[6] Weatherization and Envelope/Insultation improvement energy reduction potentials were derived from ICF industry experience in alignment with recent studies completed and reduction potentials from commercial buildings. Since reduction potentials of building envelope vary based on investment, higher cost and reductions potentials were used for the Envelope/Insulation Improvements. https://www.insulate.org/ICFStudy2022.pdf

[7] ICF assumption.

Envelope/Insulation Improvements

To estimate energy savings from envelope/insulation improvements, the tool used the matched building type, building square footage, and applicable fuel usage to estimate the HVAC end-use consumption. For each applicable fuel type per building, the estimated HVAC end-use consumption was multiplied by an Expected Electricity Savings assumption of 20% (ICF assumption) and an Expected Gas/Fuel Savings assumption of 30% (ICF assumption) to estimate the total reduction potential from envelope/insulation improvements.

To estimate total implementation costs per facility, the tool applied the following cost per unit assumption:

Description	Cost	Unit
Building Envelope Retrofit	$19.50[8]	$/sqft

Cost estimates do not account for prevailing wage requirements in Massachusetts.

HVAC Electrification and Controls Retrofit

To estimate energy savings from HVAC electrification and controls retrofits, the tool used the matched building type, building square footage, and applicable fuel usage (using the projected reduced fuel usage following implementation of any weatherization and envelope/insulation improvements) to estimate the HVAC end-use consumption. For each applicable fuel type per building, the estimated HVAC end-use consumption was multiplied by an Expected Electricity Savings assumption of 10% (ICF assumption) and an Expected Gas/Fuel Savings assumption of 10% (ICF assumption) to estimate the total reduction potential from HVAC electrification and controls retrofits.

Energy savings from increased efficiency of heat pump are estimated using a coefficient of performance (COP) of 2.5. This results in a 60% reduction in HVAC energy demand for a building after the HVAC retrofit has occurred. Current data on realized COP values is limited for non-residential properties. The COP of 2.5 used in this model is based on a range of values from 1.00 – 3.50 based on heating degree days, with lower COPs occurring in high heating degree day regions[9]. The value of 2.5 is associated with 7,000 heating degree days, which provides a conservative estimate.

To estimate total implementation costs per facility, the tool applied the following cost per unit assumption:

Description	Cost	Unit
Building Automation System	$3.00[10]	$/sqft
HVAC Electrification	$17.87[11]	$/sqft

Cost estimates do not account for prevailing wage requirements in Massachusetts.

[8] Based on an average cost between $11.00-28.00 provided in Transformative Building Envelope Retrofit Using Insulation-Inflatable Walls Assisted by Automation, 2021. Source: info.ornl.gov/sites/publications/Files/Pub172058.pdf.
[9] ACEEE Electrifying Space Heating in Existing Commercial Buildings
[10] Energy Information Administration (EIA)- Commercial Buildings Energy Consumption Survey (CBECS) Data
[11] Energy Home, DEP, Montgomery County, MD (montgomerycountymd.gov)

Water Heating Electrification

To estimate energy savings from electrifying existing natural gas-fired water heaters, the tool used the matched building type, building square footage, and applicable fuel usage to estimate the water heating end-use consumption. For each applicable fuel type per building, the estimated water heater end-use consumption in fossil fuels was estimated using building characteristic data and then transformed to electricity use assuming an existing hot water heater with an Uniform Efficiency Factor (UEF) efficiency of 80% and new heat pump water heater with a UEF of 2 to estimate the total energy change from water heater electrification.

To estimate total implementation costs per facility, the tool applied the following cost per unit assumption:

Description	Cost	Unit
Water Heater Electrification	$6.30[12]	$/sqft

Cost estimates do not account for prevailing wage requirements in Massachusetts.

Solar PV

To estimate solar eligibility and system size, the tool used estimates from NREL's PVWatts® Calculator.[13] This calculator estimates the energy production of grid-connected photovoltaic (PV) energy systems throughout the world based on a rooftop size estimator using aerial images of the facility. Each facility was searched on PVWatts® to determine whether it was a good candidate for a PV system and, if determined to be an eligible candidate, the simulated outputs from PVWatts® were integrated into the tool. These outputs included the estimated DC system capacity (KW) and estimated solar generation annually (kWh). In addition to the results provided from the PVWatts® calculator, eligibility assumptions were determined by judging the feasibility of solar on the rooftop based on the aerial imagery. I.e., if a facility was historic (such as a Town Hall), or the rooftop had irregularities, obstacles and slope type that would alter solar PV feasibility, judgement was used to determine a percentage from 0% (not eligible) to 50% (eligible), with these rooftop irregularities in mind.

The tool used an average of Mass CEC costs to establish a cost estimation. To estimate total implementation costs, the tool applied the following cost per unit assumption:

Description	Cost	Unit
PV	$3.11[14]	$/W

Cost estimates do not account for prevailing wage requirements in Massachusetts.

Energy Consumption Projections

After an ECM eligibility assumption for each building was established, the tool estimated the energy increases and/or decreases and costs associated with each ECM for each fuel type (electricity (kWh), natural gas (MMBTU), oil, (MMBTU), and propane (MMBTU)). These projections included the energy change over time for each Roadmap time period and cumulatively to demonstrate the

[12] Energy Home, DEP, Montgomery County, MD (montgomerycountymd.gov)
[13] PVWatts Calculator (nrel.gov)
[14] https://www.masscec.com/resources/commercial-solar-information-hub

impacts of ECM implementation through 20250. The tool also projected the emissions change over time, using the projected energy changes and fuel emission factors provided above, to demonstrate the emission reductions over time and by fuel type.