Municipal Decarbonization Roadmap

Shutesbury

November 2025

Purpose and Acknowledgements

Shutesbury is committed to taking action to mitigate climate change. Shutesbury aims to lead by example and reduce emissions from facilities, equipment, and operations to support climate and sustainability goals and make operations more efficient. As a participant in the Massachusetts Green Communities program, Shutesbury 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.

In 2022, the Shutesbury Select Board created the Energy and Climate Action Committee (ECAC) to guide the Town in identifying needs and solutions for climate change mitigation and resilience. As part of this, ECAC is tasked with coordinating with other town committees and boards to reduce GHG emissions and increase electrification in municipal buildings. This Decarbonization Roadmap provides a framework for Shutesbury to further their efforts towards carbon neutrality and to implement clean energy strategies to eliminate the use of fossil fuels on-site by 2050.

List of Contributors

Support for the production of this Roadmap came from the DOER Green Communities Division.

Shutesbury

Select Board:

- Melissa Makepeace-O'Neil, Chair
- Eric Stocker, Vice Chair
- Rita Farrell

Energy and Climate Action Committee:

- Michael DeChiara, Chair
- Greg Day
- Gail Fleischaker
- Nate Heard

Buildings Committee:

- Frank McGinn, Chair

Town Administrator:

- Hayley Bolton

Other Partners

Christopher Mason – DOER

ICF

Deb Harris
Kaitlyn Cyr
George Voigt
Angus Dillon

Executive Summary

This Decarbonization Roadmap[1] describes Shutesbury's municipal buildings portfolio and covers the various aspects of municipal emissions from building construction, operation, and maintenance as well as vehicle fleet emissions. This Roadmap covers five out of the six buildings that are included for Shutesbury in the Mass Energy Insight (MEI) platform. Overall, the Roadmap covers 99.7% of municipal building emissions and 64.8% of total municipal emissions in fiscal year 2022 (FY22). The Old Town Hall[2], which is excluded from the Roadmap, accounts for 0.3% of municipal building emissions in FY22, while municipal non-building assets, such as vehicles and streetlights, contribute to the remaining 34.9% of total FY22 emissions. For estimating the municipal emissions over time, these non-building assets will be assumed to uniformly reduce emissions over the twenty-eight years covered in the Roadmap.

The goal of this Roadmap is to identify Energy Conservation Measures (ECMs) to achieve complete fossil fuel elimination for municipal buildings and vehicles, and to reduce overall energy use intensity by the year 2050. This Roadmap considers how emissions are generated throughout Shutesbury's facilities and vehicles and the potential costs associated with the ECMs necessary to achieve decarbonization by the target year. Shutesbury's staff and volunteers worked closely with their technical assistance team to identify the scope of the Roadmap, incorporate stakeholder feedback, develop municipal goals, and identify implementation processes and roles to achieve the strategies outlined in the Roadmap.

The Shutesbury Energy and Climate Action Committee (ECAC) in collaboration with the Shutesbury Buildings Committee will be the lead implementer of energy management strategies and programs impacting building operations and maintenance. Support will be provided by other town committees including the Select Board, Finance Committee, and Capital Planning Committee.

Summary of Shutesbury

Shutesbury has been an active Green Community since the Town's designation in 2011 and has been awarded over $365,526 in Green Communities grants. The Town is enthusiastic about the new Climate Leader program and hopes to be one of the initial communities to receive this designation.

Shutesbury has a history of sustainability and is an engaged community that continues to push for actions that speed up the shift towards cleaner, greener technology and the preservation of the Town's natural resources. Highlighted below are recent actions the Town has undertaken to improve efficiency and reduce emissions in municipal and residential buildings.

- **2024**: With support from a second Green Community Grant Award (January 2023), the Town completed weatherization of the Shutesbury Elementary School, Fire Station, M.N.

[1] The decarbonization Roadmap is distinct from a community's Energy Reduction Plan (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.

[2] The Old Town Hall is excluded from the formal Roadmap, because the building consumes only a small amount of electricity and is no longer occupied by humans.

Spear Building, and Town Hall, and partial installation of an LED lighting system at Shutesbury Elementary School.

- **2025**: With support from a third Green Community Grant Award (March 2025), the Town is expected to complete 100% LED installation at the Shutesbury Elementary School by the end of 2025.
- **2025**: At its 2025 Annual Town Meeting, Shutesbury adopted several initiatives to support its Climate Leader Community status. This included 1) a Municipal Decarbonization Resolution committing to the elimination of fossil fuel use in municipal buildings and vehicles by 2050, in accordance with state climate goals; 2) a Zero Emission First Vehicle Policy and 3) Specialized Stretch Energy Code bylaw.
- **2025**: Shutesbury began construction on the fully electrified library building, which is expected to finish construction and open officially in fall/winter 2025. The building will be paired with a rooftop solar array.
- **2025**: In December 2025, Town residents will begin participating in the newly established Community Choice Aggregation program.

In addition to Shutesbury's building decarbonization initiatives, there is work underway across other economic sectors to mitigate and adapt to the impacts of climate change, such as:

- **2020**: Creation of the 2020 Municipal Vulnerability Plan, which includes a comprehensive assessment of the Town's baseline climate-change and natural hazard vulnerability, with a list of priority actions to be taken by the Town.
- **2021**: Shutesbury adopted an updated Hazard Mitigation Plan to identify specific actions for the Town to reduce or eliminate long-term risk to people and property from natural hazards. The updated plan was approved by FEMA in January 2022.
- **2022**: The Shutesbury Select Board established the Energy and Climate Action Committee (ECAC), as a reconfiguration of the previously existing Energy Committee, to address energy policies and programs that could help mitigate the effects of climate change through municipal and community efforts.
- **2023-2025**: The Shutesbury Buildings Committee undertook a town-wide buildings inventory and assessment to identify infrastructure lifecycle trajectories and opportunities to improve energy efficiency.

Shutesbury is committed to building on this progress going forward, including but not limited through the actions identified in this Roadmap. The Roadmap includes the following buildings. These facilities are a critical part of Shutesbury's operations and services and provide key services for the community.

- Town Hall
- M.N. Spear Building
- Fire Station
- Highway Department Building
- Shutesbury Elementary School

Summary of Municipal Emissions and Emissions Reduction Potential

As shown in Table 1, Shutesbury's emissions profile is primarily comprised of buildings and the Town's vehicle fleet.

Table 1. Summary of FY22 Metric Tons of CO2 equivalent emissions ($MTCO_2e$)

Emission Category	Emissions in Baseline Year ($MTCO_2e$)	Ownership
Buildings	203.33	Municipality
Open Space	–	Municipality
Vehicle	107.04	Municipality
Water and Sewer	–	Municipality
Street Lighting	2.17	Municipality
Total	**312.54**	

Source: MEI (2025)

The recommendations laid out in this Roadmap represent the next steps that the Town of Shutesbury 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 and timeline to eliminating onsite fossil fuel usage while simultaneously reducing overall energy consumption through building management strategies and system and equipment changes.

Based on the analysis detailed in this Roadmap, the potential for Shutesbury to reduce their overall emissions to net-zero by 2050 follows a path of consistent work and incremental improvements over the coming 25 years. Recent decarbonization efforts, such as the construction of the all-electric library building set to open in early 2026 and the HVAC control upgrade completed at the school in 2023, demonstrate a strong commitment to decarbonizing the Town's facilities. Continuing projects like these will be crucial to achieving the milestones set out in this Roadmap. As shown by the projects in Table 2, it is possible for Shutesbury to meet the onsite fossil fuel elimination by 2050 goal and also adopt strategic Energy Use Intensity (EUI) reduction projects 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%**	**17%**	**81%**	**94%**	**100%**
Zero-emission vehicles (ZEVs) in light-duty fleet adoption (% of fleet)	**0%**	**10%**	**25%**	**80%**	**100%**
Zero-emission vehicles (ZEVs) in medium-/heavy-duty fleet adoption (% of fleet)	**0%**	**0%**	**10%**	**25%**	**100%**
Energy Use Intensity reduction (deep energy retrofits/retro commissioning)	**EUI****	**15%**	**67%**	**88%**	**97%**
Total Emissions Reduction Goals (% of 2022 emissions)	**0%**	**15%**	**68%**	**88%**	**97%**

Shutesbury has a long track record of participating in DOER's programs to achieve energy efficiency, reduction, and decarbonization. Over the coming 25 years, the Town will commit to continuing that record by pushing for more efficient building systems to mitigate overall energy consumption.

Table of Contents

List of Figures

List of Tables

Introduction and Scope

The Shutesbury Municipal Decarbonization Roadmap provides facility specific decarbonization plans for five out of the six municipal facilities classified under the buildings category in MassEnergyInsight (MEI). The only building with data on MEI not formally included in the Roadmap process is the Old Town Hall which only consumes electricity and is currently only used for file storage. Emissions from the Old Town Hall in the baseline year of FY22 only accounted for 0.3% of total municipal building emissions, therefore this Roadmap covers 99.7% of the municipal building emissions reported in MEI for Shutesbury. Emissions from vehicles are discussed in the Vehicle section of the Roadmap. The Roadmap does not cover municipal emissions from non-building assets such as streetlights and open spaces.

As Shutesbury 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, Shutesbury will adopt them and add that transition to their decarbonization Roadmap. These considerations to maintain self-sufficiency for 72 hours are not incorporated in this Roadmap. All buildings in this Roadmap are assumed to eliminate on-site fossil fuel use by 2050.

Data Collection and Baseline

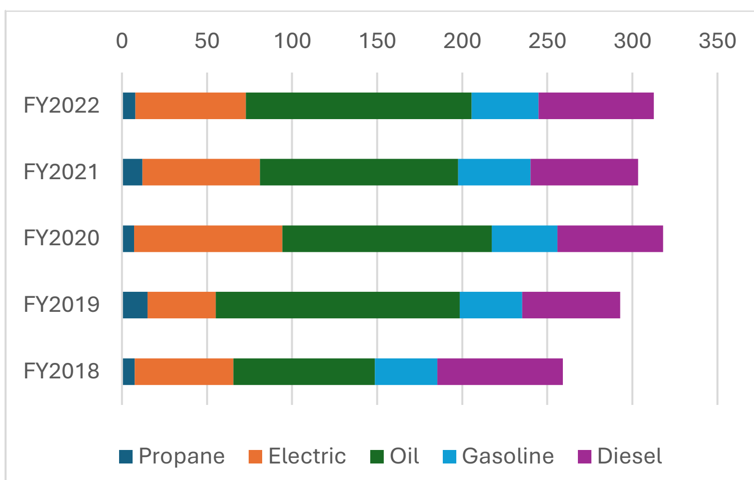
The first step in developing this decarbonization Roadmap was to assess the current greenhouse gas (GHG) emissions trends for the Shutesbury buildings. The baseline assessment provides a year-by-year view of GHG emissions. This section provides an overview of the methodology used to develop the emissions baseline, the municipal level emissions trends, and the facility level emissions for the baseline year of FY22. The fuel consumption and emissions baseline used for Shutesbury's municipal buildings was obtained from MassEnergyInsight (MEI). Emission factors utilized by MEI are reported on the DOER Decarbonization Roadmap Guidance Document and summarized in the Technical Appendix.

In addition to MEI's fuel consumption and emissions baseline data, Shutesbury used buildings inventory information from site visits to assess baseline building conditions and estimate expected equipment retrofit dates. Specifically, Shutesbury leveraged building condition information from a 2023 buildings assessment conducted internally by the Town and a 2025 site visit conducted separately by ICF.

Municipal Emissions Over Time

As shown in Figure 1, Shutesbury's municipal emissions increased from FY18 to FY22, primarily due to a 60% increase in emissions from heating oil consumption and a 12% increase in emissions from electricity consumption from FY18 to FY22. Emissions from propane and gasoline consumption each increased by 7% from FY18 to FY22, while emissions from diesel consumption decreased by 8% over the same period. As a Green Community, Shutesbury has been continually engaging in ECMs and EUI reduction strategies.

Figure 1. Shutesbury Municipal Emissions, $MTCO_2e$ (FY18 - FY22)



During the baseline year of FY22, Shutesbury's municipal emissions were composed of 42% heating oil, 22% diesel, 21% electricity, 13% gasoline, and 3% propane. Because Shutesbury does not have natural gas service, there are no natural gas emissions to report in MEI.

Facility Specific Fuel Consumption and Emissions for the Baseline Year

Table 3 shows the summary of Shutesbury's emissions for the baseline year of 2022 by municipal facility and fuel type. The building with the greatest emissions in FY22 was the Shutesbury Elementary School (SES), followed by the Highway Department Building and the Fire Station.

Table 3. Summary of Municipal Emissions for FY22 ($MTCO_2e$) by Facility and Fuel Type

Name	Electricity	Natural Gas	Oil	Propane	Diesel	Gasoline	Total
Old Town Hall	0.7	0.0	0.0	0.0	0.0	0.0	**0.7**
Town Hall	8.1	0.0	11.0	0.0	0.0	0.0	**19.0**
M.N. Spear	1.8	0.0	0.0	1.4	0.0	0.0	**3.3**
Fire Station	1.2	0.0	0.0	6.5	0.0	0.0	**7.7**
Highway	2.4	0.0	9.6	0.0	0.0	0.0	**12.0**
SES	48.4	0.0	112.2	0.0	0.0	0.0	**160.6**
Open Space	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Street/Traffic Lights	2.2	0.0	0.0	0.0	0.0	0.0	**2.2**
Vehicles	0.0	0.0	0.0	0.0	67.8	39.3	**107.0**

Roadmap Implementation Areas

This Roadmap breaks down ECM 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 ECMs comprise most projects that facilities can implement to either reduce their EUI or transition away from fossil fuel usage. This Roadmap characterizes these six ECM 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 complete air sealing of 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 best practices and 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 setting occupancy, pre-set heating and cooling controls to reduce demand when areas are not 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:** 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:** Because of its ubiquitous wetlands and woodlands, Shutesbury's opportunities for installation of ground-mounted solar panels are severely limited. Although installation of rooftop solar panels can reduce onsite electricity usage from the grid, the practicability of installing rooftop solar panels cannot be so easily assured. Shutesbury's municipal buildings are old, therefore roof integrity and weight-bearing capacity must be taken into account, as well as costs calculated for any roof being brought to standard, before rooftop installation can be recommended for a facility. While the grid continues to decarbonize, rooftop solar arrays will mitigate some emissions from building electricity consumption. For facilities with relatively flat or appropriately sloped roofs, solar arrays can be a beneficial investment.

[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.

Decarbonization Roadmap Narrative

Shutesbury's buildings portfolio presents multiple opportunities to implement decarbonization strategies and meet Shutesbury's decarbonization goals. The following section describes the key strategies that Shutesbury 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 Shutesbury 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 Shutesbury's planning and procurement processes and advancing building standards and equipment requirements in addition to the specific strategies described in this Roadmap.

This section provides a high-level overview and facility-specific recommendations for decarbonization strategies to be implemented by the Town. These actions are presented in four distinct time categories (2027, 2030, 2040, and 2050) to capture and effectively distribute fiscal and technical capacity of the Town. This time horizon also ensures 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).

Summary of Decarbonization Goals

Due to the electrical grid becoming cleaner over time, the overarching strategy of the Roadmap is to prioritize reducing overall energy needs at municipal facilities before investing in electrified HVAC and water heating equipment. This approach ensures that when building electrification occurs, cost-effectiveness is maximized. In line with Shutesbury's fossil fuel policy, as equipment reaches the end of life, electric alternatives for replacement will be considered and when technically and financially viable they will be selected for upcoming replacements. Similarly, as ZEVs become viable (both technically and financially) for medium-duty and heavy-duty fleet replacements, Shutesbury will invest further in decarbonizing their municipal fleet.

Overview of Goals for Implementation through 2030

Shutesbury has already begun implementing significant ECM and EUI reduction actions and is committed to continuing this progress through 2030. For example, Shutesbury is finalizing the construction of a new, fully electric library building in early 2026 and has made heat pump retrofits in multiple municipal buildings in recent years, including Town Hall and the Shutesbury Elementary School.

The Shutesbury Elementary School should be prioritized for ECMs in the short term in particular, due to the building's high fuel and electricity use relative to other facilities and the age of the oil boiler (it is over thirty years old). Additionally, weatherization air sealing was already completed at the School in 2012 and the building already has modern insulation, so the building is well set up to begin investing in electrified HVAC and water heating equipment.

Due to aging equipment, HVAC retrofits are also expected to be made at the Highway Department building by 2030.

Overview of Goals for Implementation from 2030 to 2050

As Shutesbury progresses further down the path of decarbonization, low-cost high impact opportunities will become less available as the Town achieves these more accessible actions, and significant equipment replacement will be required to complete decarbonization efforts for facilities. By delaying investments in electrified HVAC and water heating equipment, when possible, Shutesbury can leverage the existing time and goals outlined through 2030 to reduce overall energy demand. In addition, equipment alternatives by 2040 will likely be significantly cheaper than they are today. Major HVAC electrification projects at the large emitting buildings in Shutesbury, besides the Elementary School and Highway Department Building which require earlier retrofits for aging equipment, will likely occur in the 2030-2040 time period to minimize wasted lifespan on expensive equipment, when applicable.

Areas of Highest Emissions and Greatest Opportunity for Impact

The top three highest emitting buildings, in FY22, in Shutesbury's municipal portfolio are listed below.

1. Shutesbury Elementary School: 160.6 $MTCO_2e$ of emissions in FY22.
2. Town Hall: 19.0 $MTCO_2e$ of emissions in FY22.
3. Highway Department Building: 12.0 $MTCO_2e$ of emissions in FY22.

Decarbonizing the Shutesbury Elementary School will have the highest emissions reduction potential for the Town, followed by decarbonizing Town hall and the Highway Department Building. Each of these three buildings currently utilizes a combination of electric heat pump and heating oil boiler HVAC systems. Shutesbury will experience the greatest emissions reductions once fossil fuel use is eliminated entirely at these buildings and the electricity grid becomes cleaner.

In addition to these three buildings, the Fire Station and M.N. Spear Building present modest opportunities for emissions reduction, with these buildings emitting 7.7 $MTCO_2e$ and 3.3 $MTCO_2e$, respectively, in the baseline year FY22.

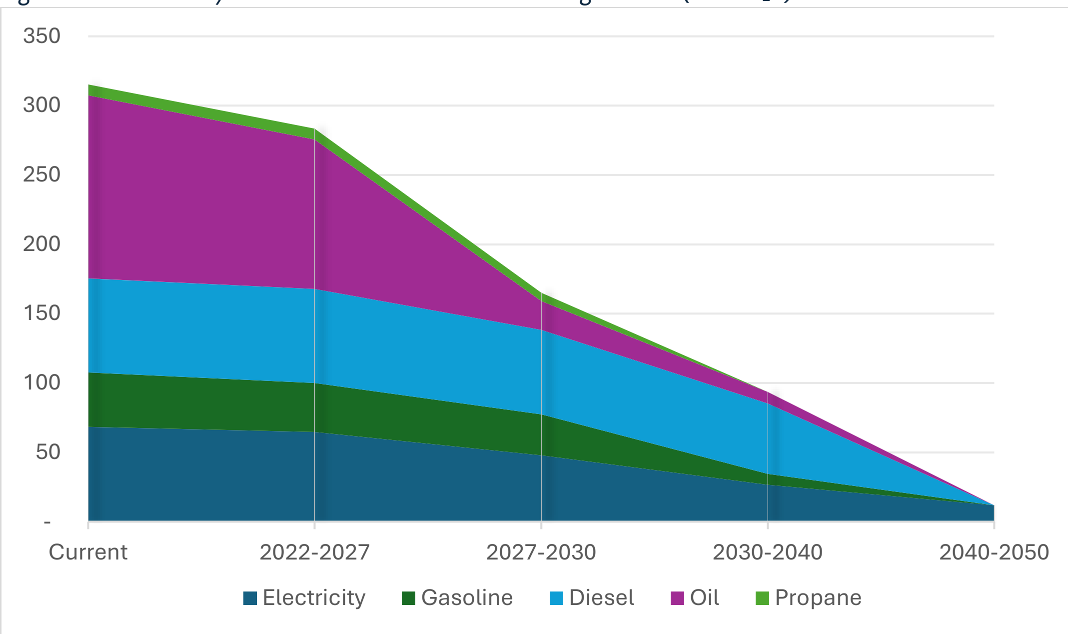
All of the buildings in this roadmap had an EUI (in kBTU/sf) and total energy usage (MMBtu) below the state median for their respective building category type in FY22 according to MEI, illustrating that Shutesbury buildings are already fairly energy efficient relative to other municipal buildings in Massachusetts.

Due to recent investments in the new, all-electric library building and the need to retrofit aging boiler systems in the near term at Elementary School and Highway Department Building, there may be limited capacity for additional significant projects early in this Roadmap. The re-purposing of the M.N. Spear Building is currently under consideration, and depending on its intended use and the extent of retrofits or renovations required, it could potentially represent the first decarbonization opportunity addressed. As a result, the proposed implementation timeline delays most equipment replacements for other buildings in the Shutesbury portfolio to the 2030-2040 or 2040-2050 periods. As funding is available, rightsizing should be conducted before electrification projects to minimize the required size of systems when they are replaced.

Achieving Elimination of Onsite Fossil Fuel Use by 2050

The proposed implementation of ECMs over the coming two and a half decades charts a path to net-zero by 2050, as shown in Figure 2. Shutesbury has consistently invested in energy reduction strategies as part of their participation in the Green Communities program. The next steps require continued commitment to decarbonizing municipal emissions, not only by converting existing on-site fossil fuel usage to electricity by 2050 but also by investing in facility energy reduction strategies to achieve EUI reduction targets.

Figure 2. Shutesbury Emissions Forecast 2022 through 2050 (MTCO$_2$e)



Major Trigger Events to Achieve Onsite Fossil Fuel Elimination

Trigger events are an important planning tool for portfolio level management and decarbonization. They identify key actions necessary for both the maintenance and upgrading of a facility. DOER has created a larger planning tool for municipalities to identify both regular energy audit timing, as well as end of life and capital planning for larger equipment[4]. For the purposes of this section, regular energy audits are excluded from Figure 3, however, they should be planned at a regular interval for each facility to ensure that equipment is functioning properly, and the facility is in adequate condition.

This section lays out the timelines for major equipment replacements and retrofits categorized as greater than $50,000 along the timeline for 2022 – 2050. The goal of this timeline is to distribute major events over the full span of the Roadmap to eliminate the occurrence of overlapping projects which may increase the risk of deviating from the Roadmap. Over this time, fleet electrification will continue to occur as retirements and replacements are available.

[4] The DOER municipal trigger event workbook is listed under additional resources here - https://www.mass.gov/info-details/climate-leader-communities

Figure 3. Major Trigger Event Timeline for Shutesbury's Inventoried Buildings

	2022	2027	2030 - 2040		2040 - 2050	
Shutesbury Elementary School	Lighting	HVAC	Water Heating			
Highway	Insulation	HVAC and Roof				
Fire Station		Insulation	HVAC			
Town Hall				Insulation	HVAC	
M.N. Spear[5]	Insulation	HVAC				

Shutesbury Elementary School

The most capital intensive ECMs in the Shutesbury portfolio are HVAC electrification and water heating electrification at the Shutesbury Elementary School (SES), due to the high energy consumption at the school relative to other municipal buildings. HVAC replacement is expected to occur by 2030 to align with the expected lifetime of the building's oil-fired boilers that are over thirty years old and need to be replaced soon. Water heating system replacement is expected by 2040, as the school recently installed a new oil-fired water heater and expansion tank in 2020 and 2023, respectively. This water heating equipment has an expected lifetime of 8-15 years, so Shutesbury would likely not want to replace the water heater until 2030-2035. Due to the SES's large square footage, lighting retrofits are also expected to be relatively capital intensive.

Highway Department Building

HVAC replacement projects at the Highway Department Building and the Fire Station are expected to be more capital intensive, relative to other ECMs in the Roadmap. Shutesbury is also planning to replace the back roof of the Highway Department Building by 2027.

Town Hall

The Roadmap delays electrifying the HVAC until at least 2040 to align with the expected lifetime of the oil boiler, which is a 2016 model with a 30-50 year life. Insulation upgrades are proposed to occur by 2040, prior to HVAC electrification.

Fire Station

The Roadmap delays electrifying the HVAC until at least 2030 to align with the expected lifetime of the building's propane gas furnaces, which are expected to require replacement between 2032 to 2039. Insulation upgrades are proposed to occur by 2030, prior to HVAC electrification.

M.N. Spear Building

The development of the new net-zero library building means that the future use of the M.N. Spear Building, which has hosted the library since 1904, is being explored. Given the opportunity to repurpose this building, there is the possibility for ECMs to be implemented in the near-term even though the energy consumption of this building does not make it a priority.

[5] Note that the M.N. Spear Building does not have any expected major equipment replacements (classified as greater than $50,000) from 2022 to 2050 but is included here for completeness. Re-purposing of the M.N. Spear Building is currently under consideration, and depending on its intended use and the extent of retrofits or renovations required, it could potentially represent the first decarbonization opportunity addressed.

Co-Benefit Considerations

In addition to supporting decarbonization goals, the strategies in this Roadmap can also provide co-benefits to the local and greater regional community by improving buildings resilience, human health, energy cost savings, and economic development. The decarbonization strategies identified in this Roadmap can deliver the following co-benefits as investments in Shutesbury's community.

Building ECM Potential Co-Benefits:

- **Human Health**: Reduces indoor air pollution by eliminating fossil fuel and wood burning stoves and furnaces.
- **Buildings Performance and Community Resilience**: Enhances comfort and performance during extreme heat or cold and power outages through better insulation and heat pumps.
- **Energy Cost Savings**: Lowers utility bills with efficient appliances and improved building envelopes.
- **Regional Economic Development**: Supports regional jobs in HVAC, insulation, and energy auditing industries.

Vehicle Electrification Co-Benefits:

- **Human Health**: Improves local and regional air quality by reducing tailpipe emissions, especially in higher traffic areas.
- **Energy Cost Savings**: Reduces fuel and maintenance costs for electric vehicle owners.
- **Grid Resilience**: Enables vehicle-to-grid technology to support the grid during peak demand.
- **Regional Economic Development**: Boosts regional growth in electric vehicle manufacturing, battery production, and charging infrastructure.

Program Management Plan for Implementation, Monitoring and Oversight

Lead Implementers

With the support of stakeholders, funding, and this Roadmap, Shutesbury 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 Shutesbury Town government and residents. The Roadmap provides a strategic, portfolio-level approach to prioritize and implement decarbonization measures at Shutesbury's buildings. Shutesbury committees will work collaboratively to oversee and coordinate facility operations and maintenance, budget approvals, and energy management — to include the Select Board, Finance Committee, Buildings Committee, Energy and Climate Action Committee, and the Capital Planning Committee, as well as Highway Department and Town Administrator.

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 and/or volunteer resources will also be necessary to support the implementation of these actions. Over time, as implementation progresses and technologies and policies evolve, Shutesbury will also update this 2025 Roadmap to reflect accomplishments and new opportunities.

Roadmap Maintenance

As Shutesbury embarks on the 25-year road of implementing this Roadmap, it will require participation and coordination by multiple parts of Town Government. The Energy and Climate Action Committee, the Buildings Committee, the Capital Planning Committee, the Finance Committee, the Select Board, and the Town Administrator all contribute to the planning and implementation of town functions related to ECMs. This will include contributing to tracking progress and making modifications to this Roadmap over time. Staff and volunteer leadership, combined with continued support from residents via Town Meeting, will ensure that progress toward the 2050 goal of net-zero and updating MEI with ECM implementation and associated emission reductions information is achieved.

Facility Level Decarbonization Plans

The following facility profiles outline the recommended ECMs for each facility and a proposed timeline to avoid unrealistic implementation timing based on logistic and financial constraints. The goal of these profiles is to describe what types of projects should be implemented and in what order to best match the needs of the facility with the decarbonization steps required.[6] At the core of each facility's recommendation is the goal of reducing overall energy consumption for the facility through weatherization and insulation projects to an efficient level before investing in electrified replacement equipment.

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 end of lifespan. By maintaining the Roadmap with implemented projects and planned replacements, Shutesbury 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.

[6] The building condition of each facility is categorized as poor, fair, or 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).

Town Hall

Baseline

The Town Hall's baseline FY22 emissions were 19.0 $MTCO_2e$, representing 9.4% of the Town's buildings portfolio included in this roadmap. Figure 4 presents emissions by fuel type for the baseline year. The Town Hall utilizes an oil boiler for heating but uses a heat pump water heater and additional heat pumps for cooling. Additionally, the Town Hall has insulated glass windows and all-LED lighting. The Town Hall has already undertaken significant decarbonization actions, including installing a 10kW solar system behind the building, installing a heat pump water heater system in 2018, and installing two new heat pumps in 2020, but there is still room for improvement. Despite these decarbonization actions, emissions at the Town Hall have stayed fairly constant from FY18 to FY22.

Building Characteristics	
Year Built/Major Renovation	1950
Building Condition	Good
Square Footage	4,200
Future Plans	Keep
GHG FY22 ($MTCO_2e$)	19.0
EUI FY22 (kBtu/sf)	73.6

Improvement Goals

The facility consumes electricity and heating oil in the baseline year of FY22. This Roadmap proposes implementing weatherization and envelope projects by 2040 to reduce the overall building's energy usage while allowing time for capital improvement plans to be developed for the HVAC upgrades. The water heating system at the Town Hall is already electrified, so there is no assumed water heating retrofit. Similarly, the building already has all-LED lighting, so there is no lighting strategy proposed.

Figure 4. Town Hall Emissions, $MTCO_2e$ (FY22)

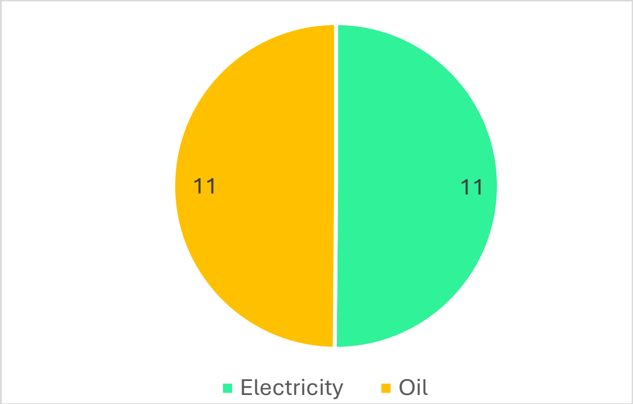


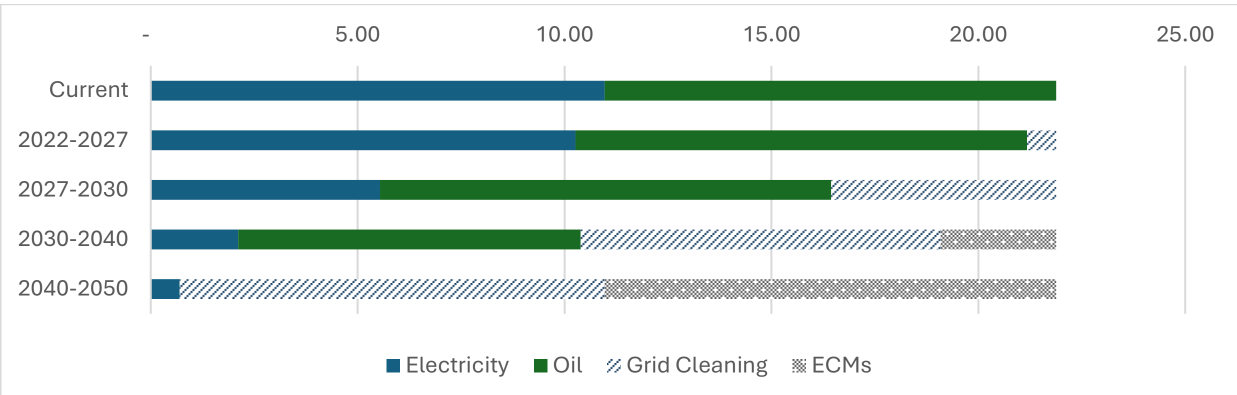
Table 4. Town Hall Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2040	**Weatherization Measures**	$	14.0
FY2040	**Envelope/Insulation Improvements**	$$	33.0
FY2050	**HVAC Electrification and Controls Retrofit**	$$	102.7

Note: Estimated costs determination is detailed in the Technical Appendix, and values are based on national averages for building categories and sizes. These estimates are not intended to replace actual project cost estimations.

By implementing the proposed decarbonization plan in Table 4, the projected building emissions reductions for the Town Hall are described in Figure 5 . The proposed timeline delays electrifying the HVAC until at least 2040 to allow sufficient time to reduce EUI for the facility prior to investing in significant equipment, and to align with the expected lifetime of the oil boiler, which is a 2016 model with a 30-50 year life. The water heating system at the Town Hall is already electrified, so there is no assumed water heating retrofit. The proposed timeline involves weatherization and envelope upgrades occurring during the 2030 – 2040 period, and the HVAC system being electrified in the 2040 – 2050 period. Additional emission reductions within these periods are the result of the lower emission factors for electricity, presented as Grid Cleaning in the below figure.

Figure 5. Town Hall Estimated Future Building Emissions based on the Building Plan ($MTCO_2e$)



Note: As the emission factor for electricity decreases over time, baseline electricity usage generates fewer emissions. As a result, the emission forecast for the decarbonization of the Town Hall shows a combination of both ECM implementation and grid cleaning to result in the decarbonized facility by 2050.

In addition to the proposed EUI reduction and system electrification projects, the Town Hall already has a 10 kW solar array behind the building. The Town Hall roof could be a potential candidate for an additional rooftop solar array that would add to the facility's decarbonization path. An estimated 20 kW array could be installed on the roof, which would generate an estimated 26,000 kWh of electricity annually.

M.N. Spear Building

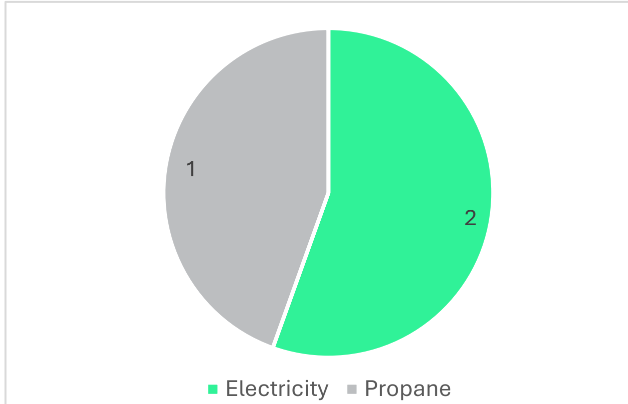
Baseline

Building Characteristics	
Year Built/Major Renovation	1902
Building Condition	Good
Square Footage	768
Future Plans	Repurpose
GHG FY22 ($MTCO_2e$)	3.3
EUI FY22 (kBtu/sf)	62.9

The M.N. Spear Building's baseline FY22 emissions were 3.3 $MTCO_2e$, representing 1.6% of the Town's buildings portfolio included in this roadmap. Figure 6 presents emissions by fuel type for the baseline year. The building utilizes a propane water heater (although currently there is no running water in the building) and a combination of a propane furnace and a mini-split heat pump system for heating and cooling. Additionally, the building has all-LED lighting. The building has already undertaken some decarbonization actions, including installing a heat pump system in 2020. Despite recent decarbonization actions, emissions at the M.N. Spear Building have slightly increased from FY18 to FY22.

Improvement Goals

Figure 6. M.N. Spear Emissions, $MTCO_2e$ (FY22)



The M.N. Spear Building consumes electricity and propane in the baseline year of FY22. Shutesbury is finalizing the construction of the new, all-electric Shutesbury Public Library, which is expected to be completed by early 2026. After construction is complete, the M.N. Spear Building, which has hosted the library since 1904, will be repurposed. This Roadmap assumes that the M.N. Spear Building will still be in use in the future and the timing of decarbonization actions at the building will revolve around the expected propane HVAC and water heater replacement dates. This Roadmap proposes implementing weatherization and envelope projects by 2030 to reduce the overall building's energy usage while allowing time for capital improvement plans to be developed for the HVAC upgrades. Decarbonization at the M.N. Spear Building could occur sooner if the Town repurposes it as a community space and secures a Climate Leader grant; however, short-term funding may be prioritized for buildings with greater decarbonization potential, like the Shutesbury Elementary School.

Table 5. M.N. Spear Decarbonization Plan

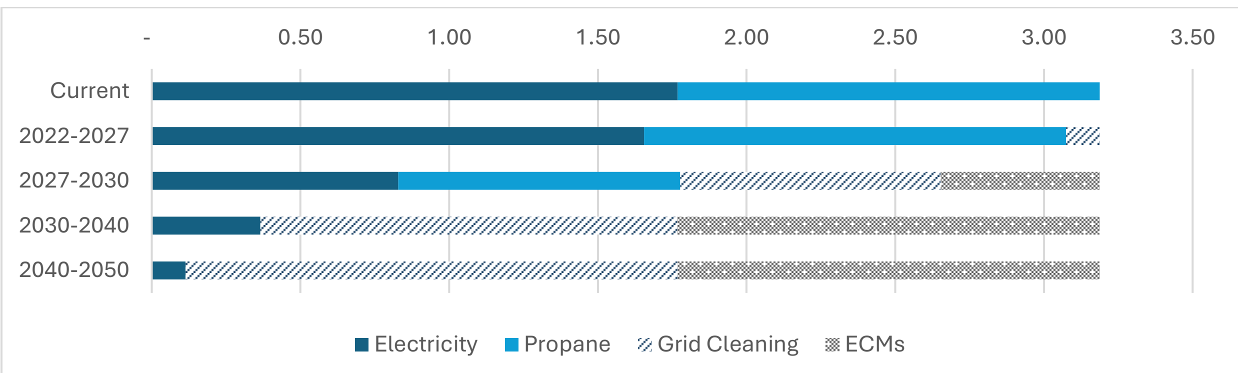
Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2030	**Weatherization Measures**	$	2.7
FY2030	**Envelope/Insulation Improvements**	$$	6.7
FY2040	**HVAC Electrification and Controls Retrofit**	$$	12.1
FY2040	**Water Heating Electrification**	$	1.2

Note: Estimated costs determination is detailed in the Technical Appendix, and values are based on national averages for building categories and sizes. These estimates are not intended to replace actual project cost estimations.

By implementing the proposed decarbonization plan in Table 5, the projected building emissions reductions for the M.N. Spear Building are described in Figure 7. The proposed timeline delays electrifying the HVAC until at least 2040 to allow sufficient time to reduce EUI for the facility prior to investing in significant equipment, and to align with the estimated replacement timing for the propane furnace and water heater. The proposed timeline involves weatherization and envelope upgrades occurring during the 2027 – 2030 period, and the HVAC system being electrified in the 2030 – 2040 period. The building already has all-LED lighting, so there is no lighting strategy proposed. Additional emission reductions within these periods are the result of the lower emission factors for electricity, presented as Grid Cleaning in the below figure.

It is important to note that this Roadmap assumes that the M.N. Spear Building will continue to be in use in the future, and therefore benefit from decarbonization actions, despite the construction of the separate, new library building. The new library building (expected to be completed in early 2026) is not formally included in this Roadmap as it will be fully electric when built, so no ECMs will be applicable.

Figure 7. M.N. Spear Estimated Future Building Emissions based on the Building Plan (MTCO$_2$e)



Note: As the emission factor for electricity decreases over time, baseline electricity usage generates fewer emissions. As a result, the emission forecast for the decarbonization of the M.N. Spear Building shows a combination of both ECM implementation and grid cleaning to result in the decarbonized facility by 2050.

The new, all-electric library building will include a rooftop 47 kW solar array when construction is finalized. The M.N. Spear Building could be a potential candidate for an additional rooftop solar array if the electricity produced is consumed on-site. In other words, if the M.N. Spear Building is expected to consume enough electricity after it is re-purposed, it would make sense to install a rooftop solar array. If applicable, an estimated 8 kW array could be installed on the M.N. Spear Building roof, which would generate an estimated 10,000 kWh of electricity annually.

Fire Station

Baseline

The Fire Station's baseline FY22 emissions were 7.7 $MTCO_2e$, representing 3.8% of the Town's buildings portfolio included in this roadmap. Figure 8 presents emissions by fuel type for the baseline year. The Fire Station utilizes a combination of propane furnaces and mini-split heat pumps for heating and cooling, along with a propane water heater. Additionally, the Fire Station is weatherized/air sealed and has all-LED lighting. The Fire Station has already undertaken some decarbonization actions, including installing a 15 kW pole-mounted solar system behind the building, and installing mini-split heat pumps in the building's office rooms, but there is still room for improvement. Overall, emissions at the Fire Station have stayed fairly constant from FY18 to FY22.

Building Characteristics	
Year Built/Major Renovation	1972
Building Condition	Good
Square Footage	4,600
Future Plans	Keep
GHG FY22 ($MTCO_2e$)	7.7
EUI FY22 (kBtu/sf)	40.4

Improvement Goals

The Fire Station consumes electricity and propane in the baseline year of FY22. This Roadmap proposes implementing envelope/insulation projects by 2030 to reduce the overall building's energy usage while allowing time for capital improvement plans to be developed for the HVAC and water heater upgrades. The Fire Station has already been weatherized, so there is no assumed weatherization retrofit. Similarly, the building already has all-LED lighting, so there is no lighting strategy proposed.

Figure 8. Fire Station Emissions, $MTCO_2e$ (FY22)

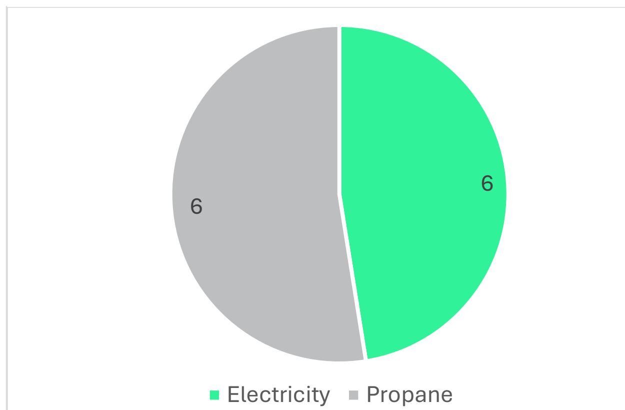


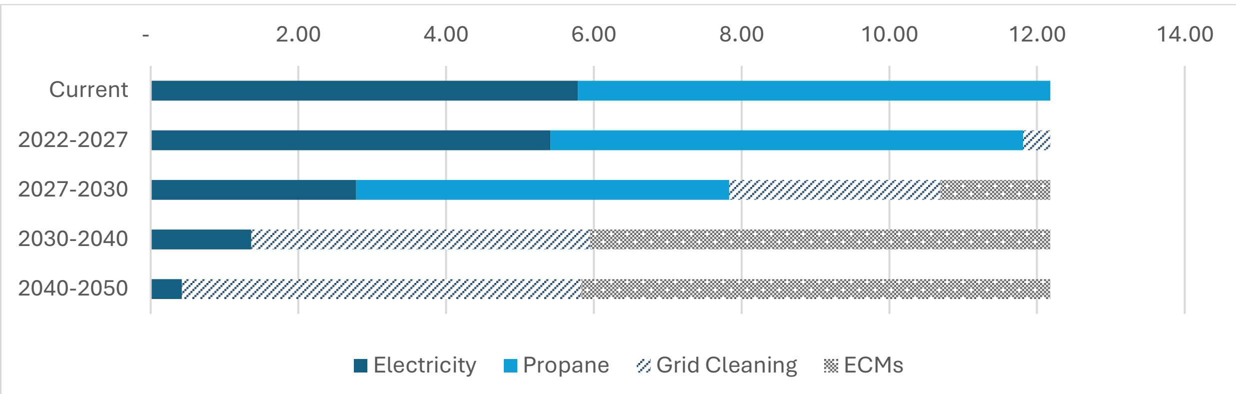
Table 6. Fire Station Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2030	**Envelope/Insulation Improvements**	$$	25.4
FY2040	**HVAC Electrification and Controls Retrofit**	$$	51.8
FY2040	**Water Heating Electrification**	$	13.0

Note: Estimated costs determination is detailed in the Technical Appendix, and values are based on national averages for building categories and sizes. These estimates are not intended to replace actual project cost estimations.

By implementing the proposed decarbonization plan in Table 6, the projected building emissions reductions for the Fire Station are described in Figure 9. The proposed timeline delays electrifying the HVAC until at least 2030 to allow sufficient time to reduce EUI for the facility prior to investing in significant equipment, and to align with the expected lifetime of the building's propane gas furnaces, which are expected to require replacement between 2032 to 2039, according to the 2023 Shutesbury buildings assessment. The proposed timeline involves envelope upgrades occurring during the 2027 – 2030 period, and the HVAC and water heating systems being electrified in the 2030 – 2040 period. Additional emission reductions within these periods are the result of the lower emission factors for electricity, presented as Grid Cleaning in the below figure.

Figure 9. Fire Station Estimated Future Building Emissions based on the Building Plan ($MTCO_2e$)



Note: As the emission factor for electricity decreases over time, baseline electricity usage generates fewer emissions. As a result, the emission forecast for the decarbonization of the Fire Station shows a combination of both ECM implementation and grid cleaning to result in the decarbonized facility by 2050.

In addition to the proposed EUI reduction and system electrification projects, the Fire Station already has a 15 kW pole-mounted solar array behind the building. Identified wetlands likely preclude additional ground-mounted solar behind the building. The Fire Station roof could be a potential candidate for an additional rooftop solar array that would add to the facility's decarbonization path, although the building does have a fairly steep roof. An estimated 29 kW array could be installed on the roof, which would generate an estimated 37,000 kWh of electricity annually.

Highway Department Building

Baseline

Building Characteristics	
Year Built/Major Renovation	1973
Building Condition	Good
Square Footage	3,200
Future Plans	Keep
GHG FY22 ($MTCO_2e$)	12.0
EUI FY22 (kBtu/sf)	51.5

The Highway Building's baseline FY22 emissions were 12.0 $MTCO_2e$, representing 5.9% of the Town's buildings portfolio included in this roadmap. Figure 10 presents emissions by fuel type for the baseline year. The Highway Building utilizes an oil-fired furnace for heating and a mini-split heat pump for additional heating and cooling, along with an electric water heater. Additionally, the Highway Building has all-LED lighting. The Highway Building has already undertaken some decarbonization actions, including installing a mini-split heat pump and an electric water heater, but there is still room for improvement. Overall, emissions at the Highway Building have decreased slightly from FY18 to FY22.

Improvement Goals

The Highway Building consumes electricity and heating oil in the baseline year of FY22. This Roadmap proposes implementing weatherization and envelope projects by 2027 to reduce the overall building's energy usage while allowing time for capital improvement plans to be developed for the HVAC and water heater upgrades. The Highway Building already has an electric water heater, so there is no water heater electrification strategy proposed. Similarly, the Highway Building already has all-LED lighting, so there is no lighting strategy proposed.

Figure 10. Highway Emissions, $MTCO_2e$ (FY22)

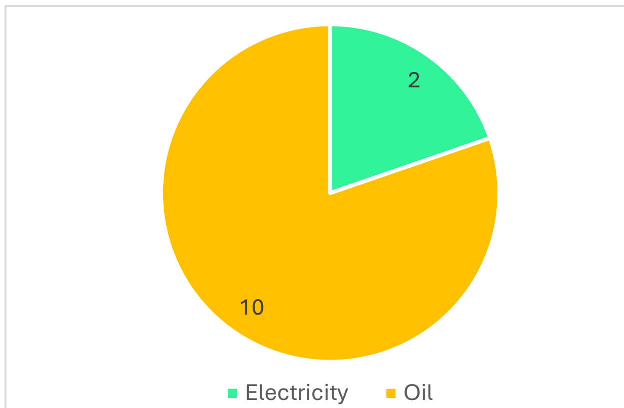


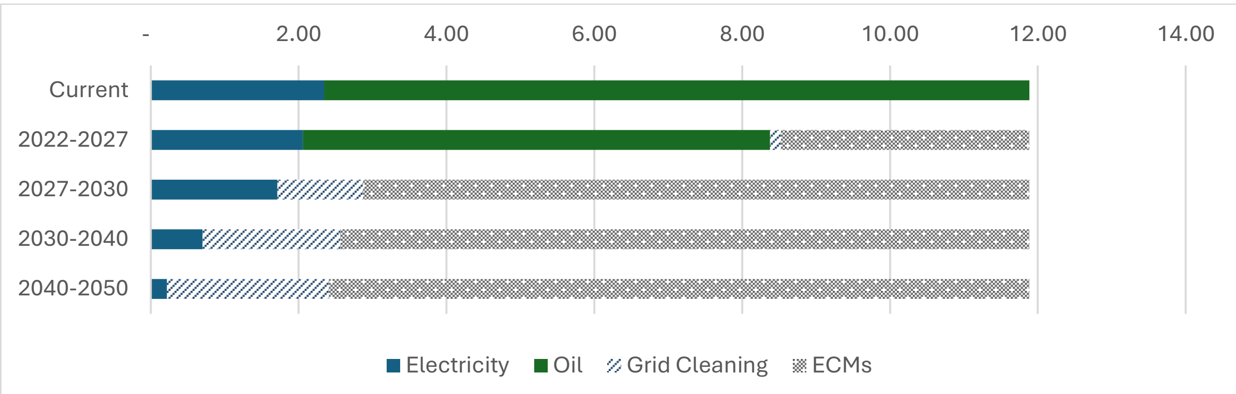
Table 7. Highway Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2027	**Weatherization Measures**	$	15.3
FY2027	**Envelope/Insulation Improvements**	$$	30.9
FY2030	**HVAC Electrification and Controls Retrofit**	$$	69.2

Note: Estimated costs determination is detailed in the Technical Appendix, and values are based on national averages for building categories and sizes. These estimates are not intended to replace actual project cost estimations.

By implementing the proposed decarbonization plan in Table 7, the projected building emissions reductions for the Highway Building are described in Figure 11. The proposed timeline suggests electrifying the HVAC by 2030 to allow some time to reduce EUI for the facility prior to investing in significant equipment, and to align with the expected lifetime of the building's oil-fired furnace, which is around thirty years old and needs to be replaced soon. The proposed timeline involves envelope upgrades occurring during the 2022 – 2027 period, and the HVAC and water heating systems being electrified in the 2027 – 2030 period. Additional emission reductions within these periods are the result of the lower emission factors for electricity, presented as Grid Cleaning in the below figure.

Figure 11. Highway Estimated Future Building Emissions based on the Building Plan (MTCO₂e)



Note: As the emission factor for electricity decreases over time, baseline electricity usage generates fewer emissions. As a result, the emission forecast for the decarbonization of the Highway Building shows a combination of both ECM implementation and grid cleaning to result in the decarbonized facility by 2050.

In addition to the proposed EUI reduction and system electrification projects, the Highway Building could be a potential candidate for a rooftop solar array that would add to the facility's decarbonization path. An estimated 16 kW array could be installed on the roof, which would generate an estimated 20,000 kWh of electricity annually. Please note that this estimate assumes solar installation only on the main structure roof of the Highway Building (the structure closest to Leverett Road).

Shutesbury Elementary School

Baseline

Building Characteristics	
Year Built/Major Renovation	1974
Building Condition	Good
Square Footage	32,557
Future Plans	Keep
GHG FY22 ($MTCO_2e$)	160.6
EUI FY22 (kBtu/sf)	67.9

The Shutesbury Elementary School (SES) baseline FY22 emissions were 160.6 $MTCO_2e$, representing 79.0% of the Town's buildings portfolio included in this roadmap. Figure 12 presents emissions by fuel type for the baseline year. The SES uses two oil boilers for heating and an oil-fired water heater, along with mini-split heat pumps for additional cooling. Additionally, the SES has modern insulation, is weatherized/air sealed, and will have 100% LED lighting by the end of 2025. The SES has already undertaken some decarbonization actions, including installing mini-split heat pumps for cooling and upgrading the HVAC control system in 2023, but there is still room for improvement. Overall, emissions at the SES increased by 66% from FY18 to FY22, although emissions in FY18 were abnormally low relative to other historical years.

Improvement Goals

The SES consumes electricity and heating oil in the baseline year of FY22. This Roadmap proposes implementing lighting projects by 2027 to reduce the building's overall energy usage while allowing time for capital improvement plans to be developed for the HVAC and water heater upgrades. The SES is already weatherized and well insulated, so there are no weatherization or envelope strategies proposed.

Figure 12. SES Emissions, $MTCO_2e$ (FY22)

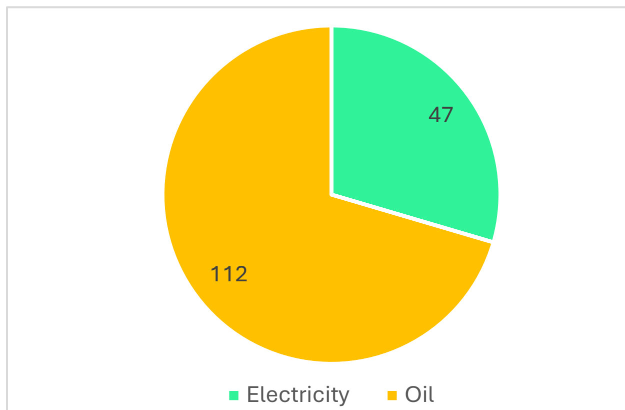


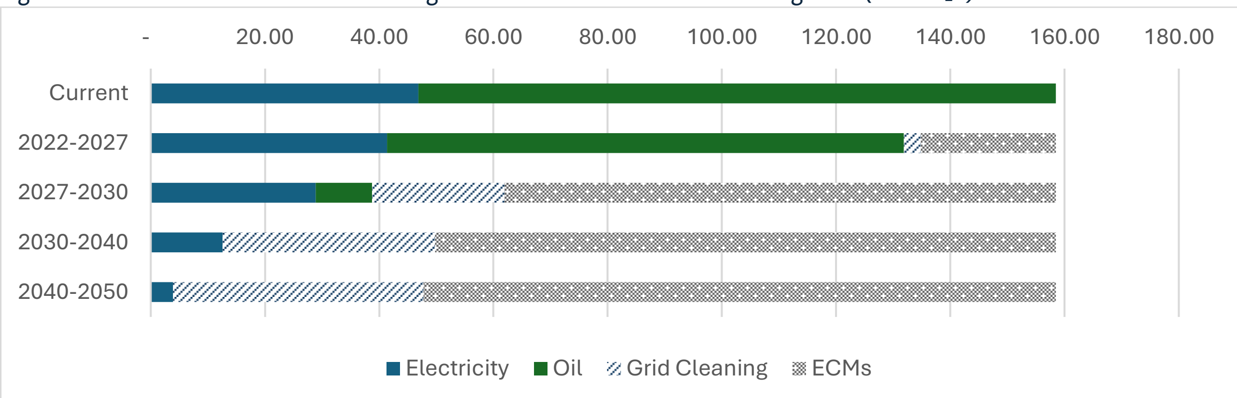
Table 8. SES Decarbonization Plan

Implemented By	Proposed Strategy	Estimated Cost	Energy Savings (MMBTU)
FY2027	**Lighting**	$	38.7
FY2030	**HVAC Electrification and Controls Retrofit**	$$$	914.8
FY2050	**Water Heater Electrification**	$$	81.1

Note: Estimated costs determination is detailed in the Technical Appendix, and values are based on national averages for building categories and sizes. These estimates are not intended to replace actual project cost estimations.

By implementing the proposed decarbonization plan in Table 8, the projected building emissions reductions for the SES are described in Figure 13. The proposed timeline suggests electrifying the HVAC by 2030 to align with the expected lifetime of the building's oil-fired boilers that are over thirty years old and need to be replaced soon. Additionally, as the SES is by far the largest emitting building in the municipal portfolio, Shutesbury should prioritize investing in decarbonizing this building as much as possible. Furthermore, the SES is already weatherized and well insulated, so it has an efficient EUI that makes near-term electrification feasible. The proposed timeline suggests electrifying the water heating system by 2040, as the school recently installed a new oil-fired water heater and expansion tank in 2020 and 2023, respectively. This water heating equipment has an expected lifetime of 8-15 years, so Shutesbury would likely not want to replace the water heater until 2030-2035. Given this, the proposed timeline involves lighting upgrades occurring during the 2022 – 2027 period, HVAC electrification in the 2027 – 2030 period, and water heating electrification in the 2030 – 2040 period. Additional emission reductions within these periods are the result of the lower emission factors for electricity, presented as Grid Cleaning in the below figure.

Figure 13. SES Estimated Future Building Emissions based on the Building Plan ($MTCO_2e$)



Note: As the emission factor for electricity decreases over time, baseline electricity usage generates fewer emissions. As a result, the emission forecast for the decarbonization of the SES shows a combination of both ECM implementation and grid cleaning to result in the decarbonized facility by 2050.

In addition to the proposed EUI reduction and system electrification projects, the SES could be a prime candidate for a canopy solar array and EV chargers in the parking lot that would significantly add to the facility's decarbonization path. An estimated 90 kW canopy solar array could be installed in the SES parking lot, which would generate an estimated 105,000 kWh of electricity annually. If the canopy is paired with two dual-port level two EV chargers, approximately 10% of its annual energy production would be allocated to EV charging, with the remaining energy offsetting grid electricity consumption at the SES.[7] Please note that these high-level estimates do not account for battery storage or potential curtailment of excess electricity. Without storage, some solar energy may not be utilized during periods of low on-site demand. Shading of the school roof from surrounding trees on neighboring properties makes rooftop solar installation impractical for the SES, despite the large rooftop area and the recent roof replacement at the school gymnasium.

[7] These estimates assume the solar canopy is paired with two dual-port Level two EV chargers that each draw 7.2 kW of power. It is assumed that each of the four charging ports is used for one charging session per day, for two hours, for 180 days annually (the average number of school days per year). This results in approximately 10,358 kWh in total annual electricity consumption for the EV chargers.

Other Buildings

Baseline

As mentioned at the beginning of the Municipal Building Portfolio section, this Roadmap includes most of Shutesbury's municipal emissions. However, there are other buildings not included in the formal Roadmap process that are included here for completeness.

These buildings are excluded from the Roadmap because they consume little to no energy and are not regularly occupied. Their minimal energy use and lack of human occupancy make them outside the scope of decarbonization planning. None of these buildings, as shown in Table 9, consume any power except for the Old Town Hall and the Fiber Optic Building which shares a propane tank backup with the Town Hall. As a result, excluding these buildings from the formal Roadmap modeling has a minimal impact on modeling the elimination of fossil fuel use in Shutesbury municipal buildings by 2050. Additionally, as mentioned earlier in this Roadmap, the new library building (expected to be completed in fall 2025) is not formally included in this Roadmap as it will be fully electric when built, so no ECMs will be applicable.

Table 9. Other Buildings Excluded from the Roadmap

Building Name	Fuels Used	Plans
Old Town Hall	Electricity	Keep, primarily for file storage
West Schoolhouse #2	No Power	Keep
Dam House	No Power	Keep
Hearse Building	No Power	Keep
Fiber Optic Building	Electricity and Propane	Keep
Elliot Park Shed	No Power	Keep

Improvement Goals

These buildings should be regularly assessed to make sure equipment is functioning properly and receiving appropriate repairs. As discussed before, emphasizing the weatherization and insulation of a facility where necessary prior to the retrofitting of central HVAC or water heating systems is key to achieving EUI targets outlined in this roadmap. In addition to the proposed EUI reduction and system electrification projects, where roof aspects are favorable, Shutesbury could consider implementing rooftop arrays at their other facilities.

Vehicle Fleet Decarbonization Plan

In FY22, the municipal fleet of Shutesbury generated about 34% of overall municipal emissions. This section overviews the Town's vehicle fleet and baseline emissions and provides a decarbonization plan by vehicle type. Although Shutesbury does not currently have any EVs in the municipal fleet, the Town is actively engaged in discussions to install public EV charging infrastructure to support the future build out of EVs in the Town.

Fleet Composition and Emissions

Light-Duty Vehicles

Light-duty vehicles comprise 43.8% of Shutesbury's municipal fleet. The targeted percentage of light-duty ZEV vehicles in the fleet is detailed in Table 10, with a consistent adoption of vehicles as they reach retirement age. In FY22, Shutesbury did not have any light-duty ZEV vehicles in their municipal fleet.

Table 10. Light-duty ZEV adoption targets

Targets	2022	2027	2030	2040	2050
Zero-emission vehicles (ZEVs) in light-duty fleet adoption (% of fleet)	**0%**	**10%**	**25%**	**80%**	**100%**

Medium- and Heavy-Duty (MHD) Vehicles

Medium-duty vehicles comprise 6.3% of Shutesbury's municipal fleet; heavy-duty vehicles comprise 50.0% of the fleet. The targeted percentage of MHD ZEV vehicles in the fleet is detailed in Table 11. Due to the current lack of technically feasible electric vehicles that fit MHD functions, transitioning of the MHD fleet will be slower than the light-duty fleet. An updated replacement plan will be developed when current limitations on available heavy-duty vehicles are less restrictive.

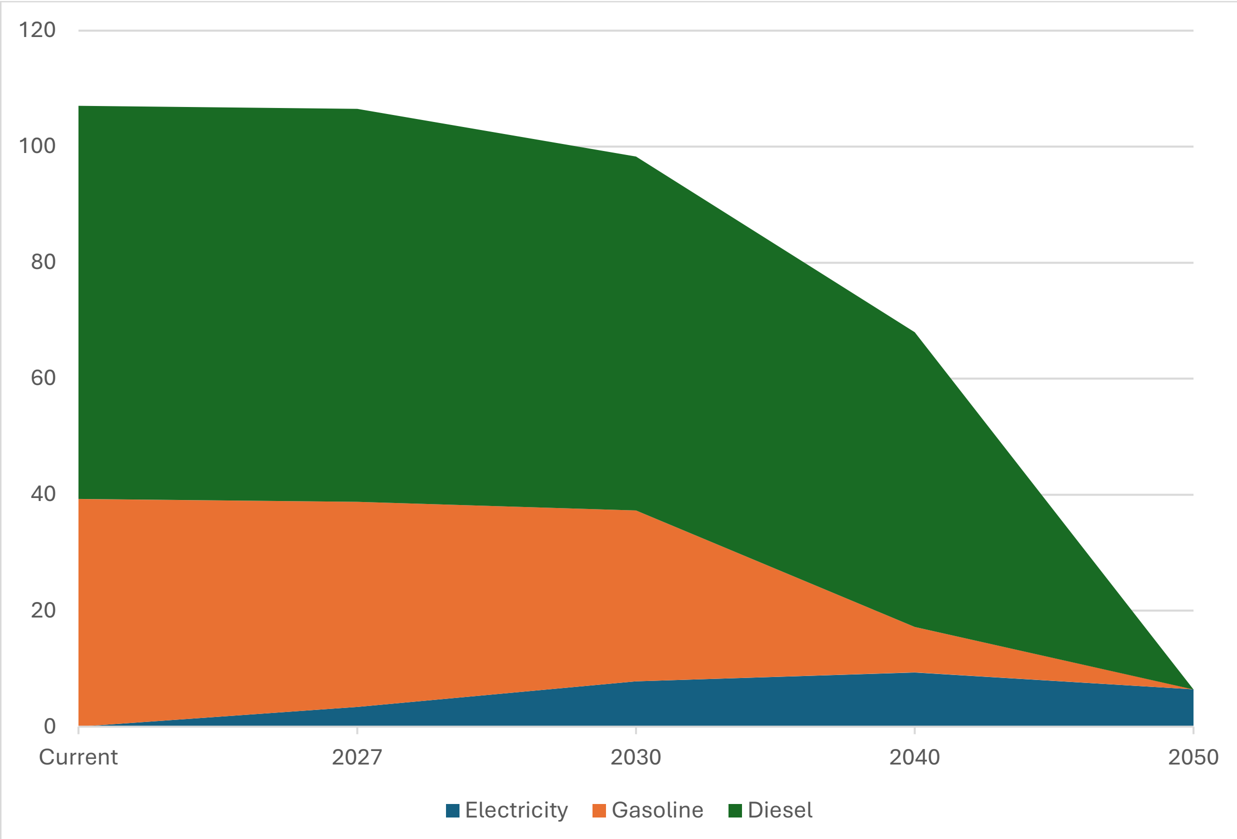
Table 11. MHD ZEV adoption targets

Targets	2022	2027	2030	2040	2050
Zero-emission vehicles (ZEVs) in medium-/heavy-duty fleet adoption (% of fleet)	**0%**	**0%**	**10%**	**25%**	**100%**

Estimated Municipal Fleet Emissions

By transitioning the municipal fleet based on Table 10 and Table 11, estimated municipal fleet emissions are shown in Figure 14 below.

Figure 14. Emissions Profile of Electric Vehicle Adoption ($MTCO_2e$)



Technical Appendix

Shutesbury 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 (FY22), 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 emission factors in Table 12 (in $MTCO_2e$ per fuel unit type) from MA EEA's forecasting for each fuel type. These estimates were produced as part of the MA 2050 Decarbonization Roadmap and were forecast 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. The Roadmap acknowledges that local emission factors for Shutesbury may differ from these state average emission factors.

Table 12. Emission Factors Applied in Tool ($MTCO_2e$/fuel unit)

	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 consisted of FY22 totals for electric, gas, oil, propane, and total fuel use for each building. The fuel-costs-by-type data were also FY22 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.[8] 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 (plus 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. Table 12summarizes each building's eligibility for additional ECMs.

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

Table 12. Energy Conservation Measure (ECM) Eligibility by Building

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
Town Hall	309	309,011	74	4,200	0%	80%	100%	70%	70%	0%
M.N. Spear	48	48,301	63	768	0%	100%	100%	100%	50%	100%
Fire Station	186	185,874	40	4,600	0%	0%	100%	70%	70%	100%
Highway	165	164,756	51	3,200	0%	100%	100%	80%	80%	0%
SES	2,211	2,210,581	68	32,557	50%	0%	0%	80%	80%	100%

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[9]) 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	$/sq ft

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[10]) 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[11]	$/sq ft

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

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

[10] 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

[11] 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[12]	$/sq ft

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 pumps 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[13]. 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[14]	$/sq ft
HVAC Electrification	$17.87[15]	$/sq ft

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

---

[12] 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.

[13] ACEEE Electrifying Space Heating in Existing Commercial Buildings

[14] Energy Information Administration (EIA)- Commercial Buildings Energy Consumption Survey (CBECS) Data

[15] Energy Home, DEP, Montgomery County, MD (montgomerycountymd.gov)

Water Heating Electrification

To estimate energy savings from electrifying existing propane- and oil-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 a 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[16]	$/sq ft

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.[17] This calculator estimates the energy production of grid-connected photovoltaic (PV) energy systems throughout the world based on a rooftop area size estimator using aerial images of the facility. It is important to note that the solar capacity estimates from PVWatts are based solely on rooftop area derived from aerial imagery and do not account for other factors that affect installation viability, such as roof condition, shading, slope, and structural integrity. These estimates also do not account for battery storage or potential curtailment of excess electricity. Without storage, some solar energy may not be utilized during periods of low on-site demand.

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 the Town Hall), or the rooftop had irregularities, obstacles, and slope type that would alter solar PV feasibility, judgment 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[18]	$/W

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

---

16 Energy Home, DEP, Montgomery County, MD (montgomerycountymd.gov)

17 PVWatts Calculator (nrel.gov)

18 https://www.masscec.com/resources/commercial-solar-information-hub

Energy Consumption Projections

After an ECM eligibility assumption was established for each building, 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 impacts of ECM implementation through 2050. 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 by fuel type over time.