450 Artisan Way

Building Performance Exchange

MASS CLEAN ENERGY CENTER

This case study is part of the MassCEC Building Electrification and Transformation Accelerator (BETA): Project Planning program, committed to helping a representative selection of commercial building types in Massachusetts reach net zero emissions by 2050. This MassCEC funded resource and more are available via the Building Performance Exchange.

Building type	Office
Location	Somerville
Year built	2014
Stories	4
Square footage	137,952 SF
Energy use intensity (EUI)*	63.2 kBtu/sf/yr [w/ PV]
Carbon emission intensity (CEI)*	4.0 CO2e kg/sf/yr
Decarbonization goals	Lower utility costs, corporate ESG targets, align upgrades with equipment end of life

The 450 Artisan Way building, located in Somerville, MA, is a LEEDv3 Gold certified mixed-use office and retail facility. The ground floor has retail stores and restaurants, while the upper floors consists of commercial office use.

Existing Conditions

Enclosure	**Walls**	**Roof**	**Windows**
	Good	Good	Good
Heating	Natural gas boilers		
Cooling	Direct expansion (DX) cooling system		
Ventilation	Air handling units (AHUs) with heating coils and DX cooling to fan power boxes (FPBs). FPBs have secondary hot water coils.		
Hot water	Electric domestic hot water (DHW) system, consiting of an 80-gal DHW tank per floor (for offices)		
Lighting	Approximately 85% LED lighting. Remaining lighting is fluorescent		
Controls	No demand control ventilation (DCV) or lighting controls		
Other	Commercial retail kitchen in the restaurants with natural gas appliances, commercial electrical appliances and refrigeration units		
Renewable energy	Existing 100+ kW solar PV system installed in 2014 (owned), which represents 6.7% of existing annual energy use		

*EUI represents the annual energy usage of the building divided by the total area. CEI is the amount of greenhouse gas (GHG) emissions divided by the total area.

Key Challenges & Solutions

Relatively new building with limited upgrades planned

With newer systems from 2014 construction, planning is based on equipment end of life and feasible energy efficiency upgrades

Corporate ESG targets

The owner’s corporate carbon reduction plan targets a 46% reduction by 2030 and net zero emissions by 2050. The proposed strategic decarbonization plan will help meet these reduction targets

Renewable energy

Existing Solar PV system, with limited area to expand. No feasible site area for energy storage

Core Decarbonization Strategy

- Energy efficiency and load reduction include upgrading the remaining lighting system with LEDs and lighting controls, DCV, enclosure air sealing, and weather proofing
- Electrification of heating systems includes replacing the boilers with an air to water heat pump (AWHP) system, heat recovery and a heat pump DHW system upgrade
- A roof replacement may be best aligned with the HVAC systems upgrades

Retrofit Measures and Energy Impacts

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Measures

Energy Efficiency & Load Reduction

Foundational Energy Efficiency and Load Reduction:

- LED lighting system controls upgrade
- DCV system
- Air sealing and weather proofing

System Electrification

Electrification Enablers: Electrical service upgrade assessment required

System Electrification:

- AWHP system
- Heat recovery for space heating and cooling
- DHW electrification

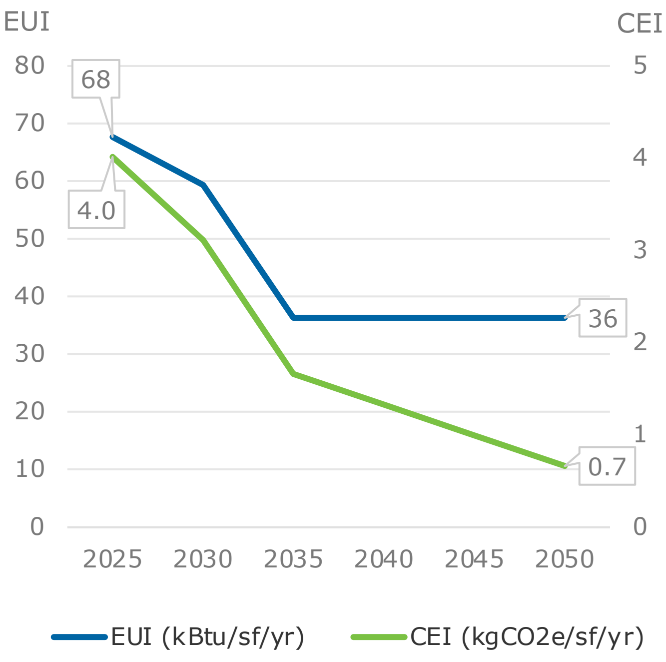
Renewable Energy

Solar:

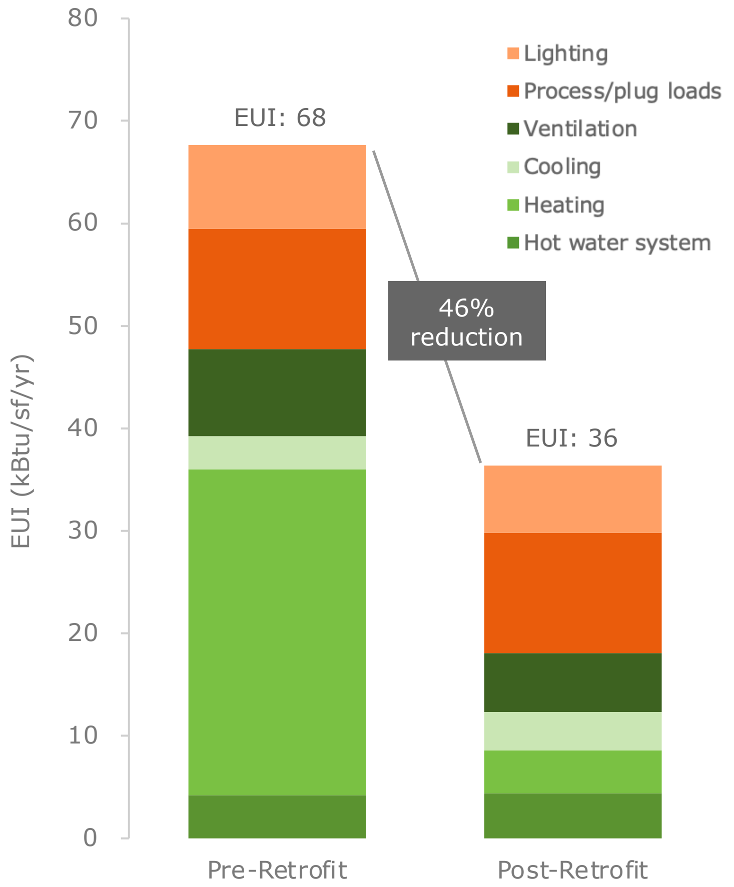
- Existing solar PV array to remain (producing about 180,000 kWh/yr)

Performance Targets

The decarbonization approach prioritizes immediate energy efficiency measures and enclosure air sealing, while looking at an all-electric mechanical system replacement at end-of-life, including heat recovery. These efforts would yield the following results over time:



Annual Energy Use Impacts*



*The performance targets and annual energy use impacts graphics illustrate the before and after once all recommended measures are implemented, except for any renewable energy. The existing PV system production could not be fully verified and was not included in the EUI or CEI results. The existing solar PV system serves approximately 6.7% of the existing electrical load demand. The existing solar PV system will serve an estimated 3.5% of the the higher post-retrofit load after full system electrification.

Project Planning

The graphic below presents a decarbonization pathway, organizing measures into bundled actions that are best implemented together. The expected cumulative carbon reduction potential from each bundle is noted on the right. The strategy to reach zero GHG emissions by 2050 focuses on maximizing energy efficiency, electrifying on-site combustion systems within a cleaner grid, and cost-effective on-site renewables. Key considerations or triggers are listed along a timeline to support informed decision-making, with bolded dates indicating recommended implementation years.

Triggers

2027: Foundational energy efficiency improvements to address immediate operational savings benefits

2030-35: While not time dependent, the enclosure air infiltration reduction measure will enable the electrification of heating systems, while reducing HVAC sizing

2030-35: Existing mechanical equipment to be replaced, based on equipment end of life, with full implementation of electrification of heating systems, and associated cooling and ventilation systems' upgrades

2035: Removal of existing HVAC infrastructure to be combined with new AWHP installation, allowing roof and mechanical room space requirements. DHW heat pump system will require room expansion into the tenant space

The natural gas connection may be required to remain for the retail restaurant, pending on lease timelines, and impacting the timing of the kitchen electrification

Order of Implementation

Cumulative Carbon Reduction Potential*

LED Lighting Upgrade
LED light fixture and lighting controls

DCV System

16%

Air Sealing and Weather Proofing
Enclosure air infiltration reduction

AWHP System
Install new AWHP system and new AHUs with heat recovery for space heating and cooling

DHW Electrification
Install new heat pump DHW heater

Solar PV System
Reconfigure or reinstall solar PV system as needed

Existing Boiler
Remove existing natural gas boiler

Existing HVAC Infrastructure
Remove existing AHUs and DX cooling

Kitchen Electrification
partial replacement of natural gas commercial kitchen equipment, pending tenant leases

41%

Zero on-site fossil fuel combustion
(With the exception of any backup power)

*GHG calculations are based on BERDO Version 2.3 emissions factors. Full decarbonization is dependent on statewide renewable energy adoption. GHG calculations include direct onsite combustion (Scope 1) and purchased electricity (Scope 2). For any renewable energy measures included in this plan, it is assumed that the owner will retain the Renewable Energy Credits (RECs) to claim the GHG reduction for reporting.

Annual Utility Impacts

Measure description	Changes in annual utility costs		
	Electricity	Fossil fuel	Net total changes
Lighting	($22,525)		($22,525)
Process/plug loads	$66	($2,792)	($2,726)
Ventilation	($38,230)		($38,230)
Cooling	$7,080	-	$7,080
Heating	$53,468	($64,991)	($11,523)
Hot water system	$2,792		($2,792)
Total from recommended measures	**($2,651)**	**($67,783)**	**($65,131)**

The existing Solar PV System utility costs savings are not included in the utility cost saving analysis, as the utility costs savings' data (and other financial benefits) was not available. It is expected that they further improve the annual utility savings.

Lifecycle Costs*

Realizing the full value of decarbonization requires a long-term outlook that weighs upfront investments, operating costs, and financial incentives. BETA assessments identify the retrofit pathway that most effectively reduces emissions, maintains comfort, and improves performance relative to upgrades an owner would already make (the business-as-usual (BAU) scenario). This comparison highlights long-term avoided costs and risks, as well as opportunities—such as incentives—that support pursuing the optimized pathway.

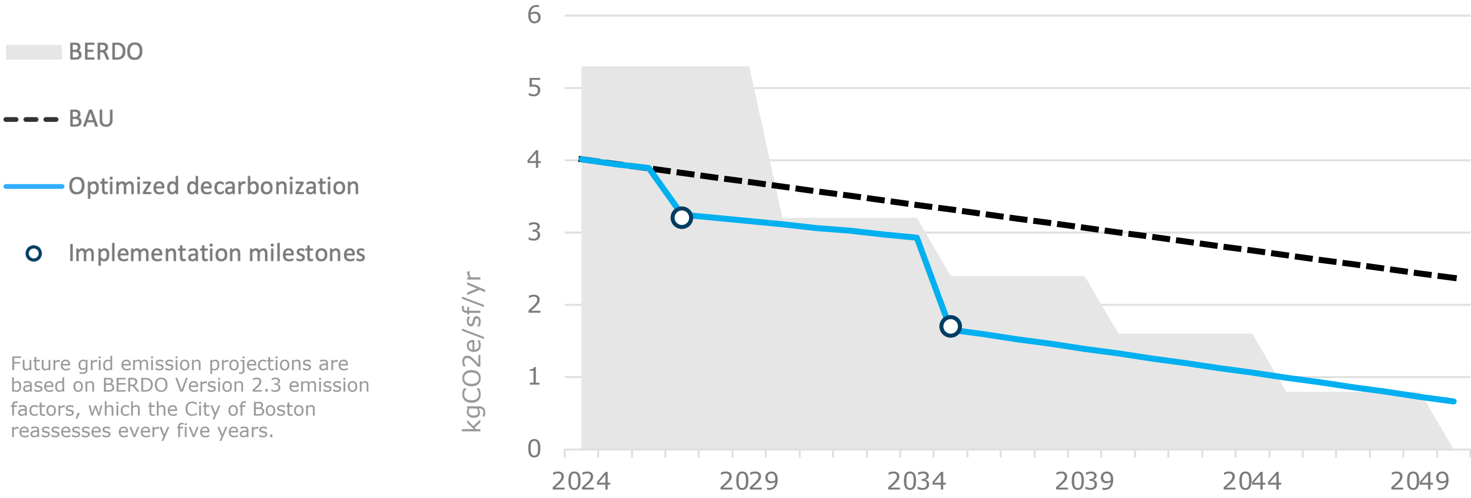
Costs	BAU retrofit	Optimized decarbonization pathway	
Base building and envelope costs	$330,000	$413,000	Foundational efficiency and load reduction
		$0	Advanced load reduction
Mechanical costs	$5,710,000	$0	Electrification enablers
		$5,651,000	System electrification
Renewable energy costs	$0	$0	Renewable energy
Soft costs	$1,812,000	$1,820,000	
Total upfront costs	**$7,852,000**	**$7,883,000**	
Utility incentive opportunities	$0	($268,000)	
25-year total accrued utility costs	$20,208,000	$17,638,000	
25-year accrued total operating costs	$26,558,000	$23,588,000	
25-year LCCA	**$34,410,000**	**$31,203,000**	

BAU scope:
- Gas-fired condensing boiler replacement
- AHU with DX cooling replacement
- DHW replacement per floor

*All cost and incentive values are estimated based on industry data and rounded to the nearest $1,000. All incentives values are based on currently available programs and are subject to change over time. Forecasted operating costs include utility costs, maintenance costs, and noncompliance fees if relevant. Utility and maintenance costs reflect a 3% annual escalation rate. The BAU approach assumes necessary repairs and replacements that meet code compliance. In this case study, BAU represents the conventional gas or code-compliant versions of the decarbonization measures listed.

Emissions Goals and Benchmarking

Boston's Building Emissions Reduction and Disclosure Ordinance (BERDO) applies to large existing buildings in the city and, outside Boston, serves as a useful benchmark for owners to proactively align upgrades with statewide goals. As Massachusetts targets net-zero emissions by 2050, similar policies may be adopted statewide. Achieving "zero" depends on the pace of statewide renewable energy adoption, with any remaining gaps addressed through RECs or clean electricity aggregation programs.



Resiliency Considerations

Part of the building has a 1% annual chance of flooding an average of less than one foot, per the FEMA National Risk Index, which may increase in the future or pending the occurrence of extreme weather events. The City of Somerville has a combined sewer system, which is vulnerable in times of flooding. There are no current plans to improve the sewer system around the building. The city-owned drains, both onsite and east of the building, are in the low-risk flood zone, as part of the Mystic River watershed. Consideration for floodproofing and a vulnerability assessment are recommended.

Next Steps and Best Practices

There are many potential strategies to reduce the operational GHG emissions of buildings. As a starting point, owners are encouraged to have a solid understanding of base building information, including current energy use, carbon emissions, and long-term property goals through 2050. The data and scoping developed through this assessment can be used by design teams, including architects and engineers, to begin shaping project plans and construction timelines, while also strengthening financing strategies and incentive applications. To move from assessment to action and ensure a clear, strategic path toward decarbonization, the following next steps are recommended.

- [x] Existing building conditions
- [x] Decarbonization assessment
- [ ] Supplemental assessments
  - Existing service capacity evaluation
  - Climate vulnerability assessment
- [ ] Emergency protocols
- [ ] Assemble project team
- [ ] Structure financing stack