125 Hartwell Ave

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	Commercial Health Service Center
Location	Lexington, MA
Year built	1976
Stories	2
Square footage	38,277
Energy use intensity (EUI)*	64.8 kBtu/sf/yr
Carbon emission intensity (CEI)*	4.0 CO2e kg/sf/yr
Decarbonization goals	Utility cost savings, regulatory compliance, equipment end of life replacement

125 Hartwell Avenue in Lexington, MA is a two-story facility (1976) currently operating as an office space and as a behavioral health service center for children, youth, adults, and families. Originally built as a research facility, it retains a robust electrical setup with plenty of service capacity for its new use type.

Existing Conditions

Enclosure	Walls	Roof	Windows
	Poor	Good	Fair
Heating	Includes multiple RTUs of varying input capacities and hydronic perimeter heat from gas boilers.		
Cooling	(2) 50-ton cooling-only VAV RTUs serve most of the building, supplying VAV boxes. Various constant volume RTUs serve training rooms and atrium.		
Ventilation	Ventilation is supplied by RTUs		
Hot water	50-gal direct-fired natural gas tank storage hot water heater		
Lighting	Majority LED lighting throughout		
Controls	Standalone thermostats		
Other	Office kitchenette and typical office equipment such as copy machines.		
Renewable energy	None		

*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

Funding Cycles & Equipment Life

End of life equipment should be replaced ahead of failure but in windows where funding cycles enable the upgrades.

Ventilation, Zoning, & Controls

Use of VRF and DOAS systems with new BMS controls to improve zone comfort, ventilation, & efficiency.

Envelope Losses

Weatherstripping, Window Replacement, and Window Film.

Core Decarbonization Strategy

- Implementation of Variable Refrigerant Flow (VRF) systems to replace existing gas-fired boilers and RTUs.
- Dedicated Outdoor Air Systems (DOAS) for improved ventilation and indoor air quality.
- Envelope upgrades to lower building heat load to reduce GHG emissions & implementation costs.
- Solar carports to generate on-site renewable electricity.

Retrofit Measures and Energy Impacts

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Measures

Energy Efficiency & Load Reduction

Foundational Efficiency and Load Reduction:

- Lighting Occupancy Sensors
- Supply Air Reset DCV
- Dual Enthalpy Economizer
- Optimal Start/Start
- VFD Pumps
- Weatherstripping

Advanced Load Reduction:

- Window Replacement
- Window Film in Atrium

System Electrification

Electrification Enablers:
Further assessment required

System Electrification:

- Variable Refrigerant Flow Installation
- Heat pump dedicated outdoor air system (DOAS)
- Heat pump DHW system

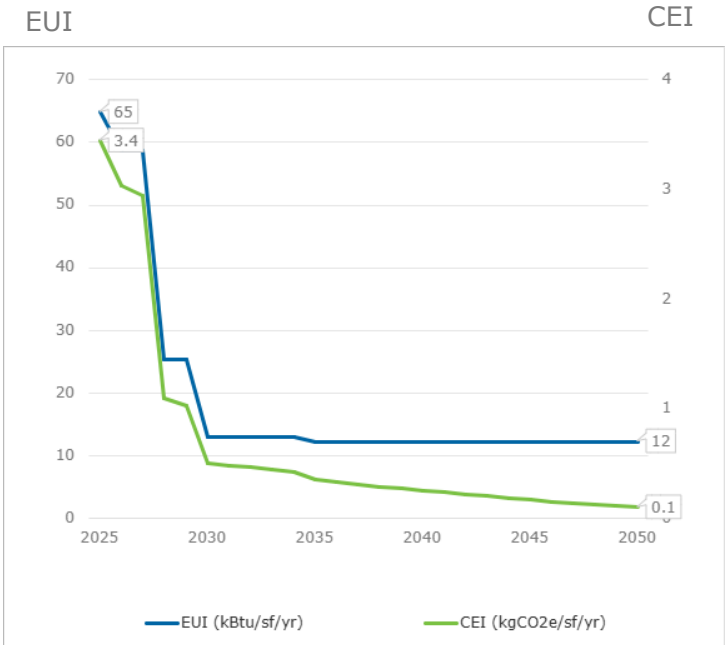
Renewable Energy

Solar:

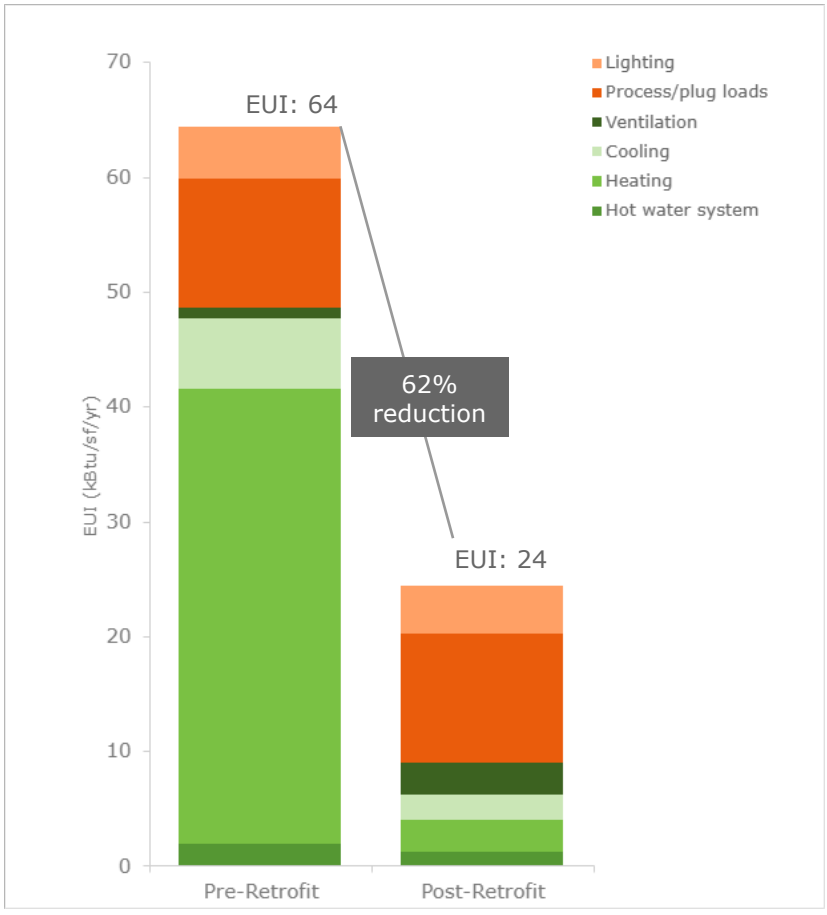
- Solar Car Port Installation estimated at 115kW
- Utilize rooftop solar if desired in future

Performance Targets

The decarbonization approach prioritizes immediate energy efficiency measures and heat recovery while looking long term at heat pumps and more efficient all-electric mechanical system replacement at end-of-life. These efforts would yield the following results over time:



Annual Energy Use Impacts*

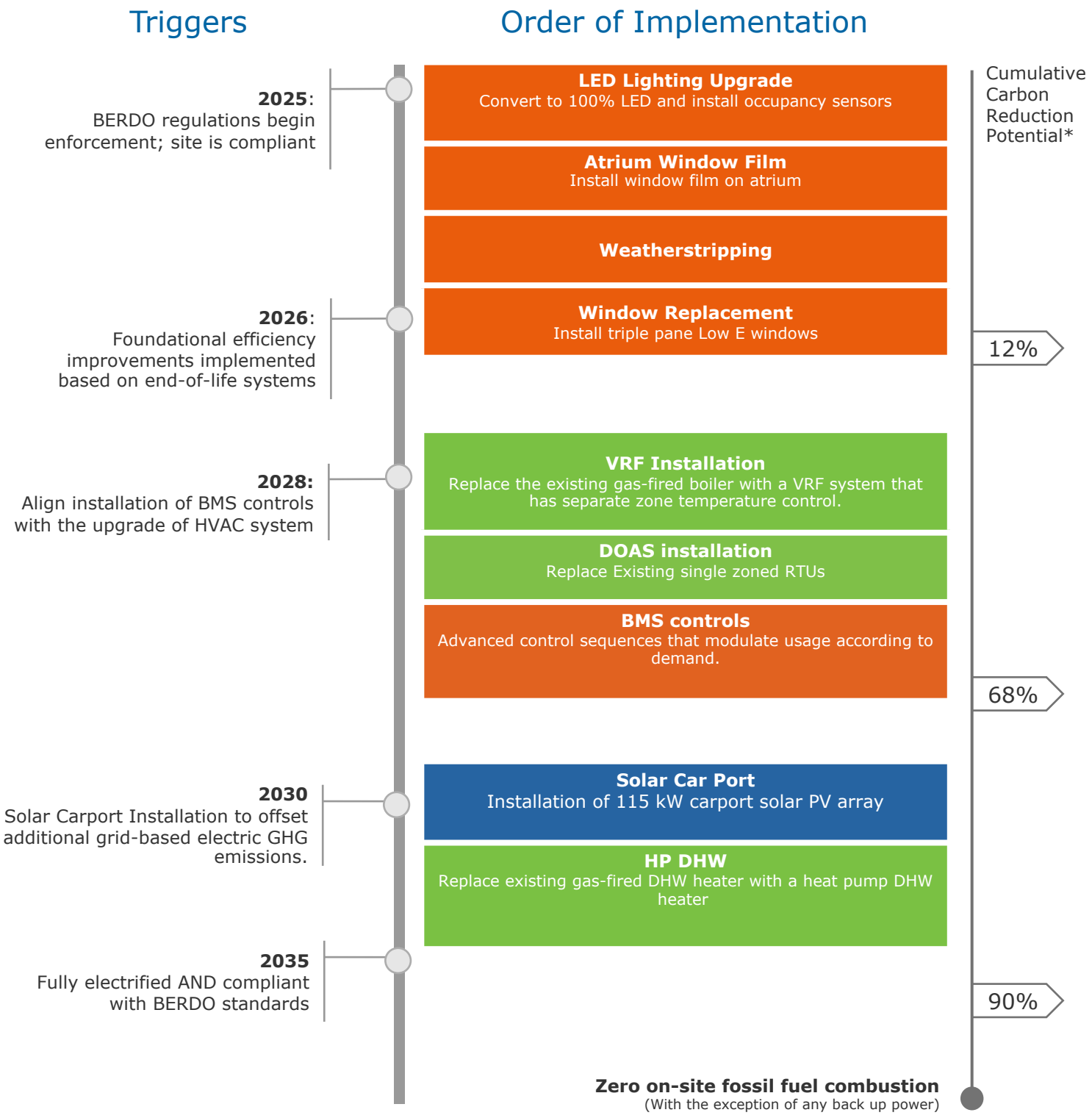


*The annual energy use impacts graphic illustrates an EUI before and after once all recommended measures are implemented, except for any renewable energy. The CEI and EUI shown in the performance targets account for the added benefits of renewable energy.

Project Planning

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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 cleaning 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.



*GHG calculations are based on BERDO Version 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.

Cost Analysis

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Annual Utility Impacts

Measure description	Changes in annual utility costs		
	Electricity	Fossil fuel	Net total changes
Lighting	-$1,100	$0	-$1,100
Process/plug loads	$0	$0	$0
Ventilation	$5,600	$0	$5,600
Cooling	-$12,000	$0	-$12,000
Heating	$6,400	-$24,400	-$18,000
Hot water system	$2,400	-$900	$1,500
Total from recommended measures	**$1,300**	**-$25,300**	**-$24,000**
Renewable energy	-$38,200		-$62,200

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	$403,000	$49,000	Foundational efficiency and load reduction
		$418,000	Advanced load reduction
Mechanical costs	$734,000	$0	Electrification enablers
		$2,897,000	System electrification
Renewable energy costs	$0	$454,000	Renewable energy
Soft costs	$114,000	$382,000	
Total upfront costs	**$1,251,000**	**$4,200,000**	
Utility incentive opportunities	$0	($341,000)	
25-year total accrued utility costs	$3,847,000	$1,703,000	
25-year accrued total operating costs	$4,851,000	$2,552,000	
25-year LCCA	**$6,102,000**	**$7,093,000**	

BAU scope:
- Window replacements
- Boiler replacement
- RTU replacements of various tonnages
- DHW heater replacement

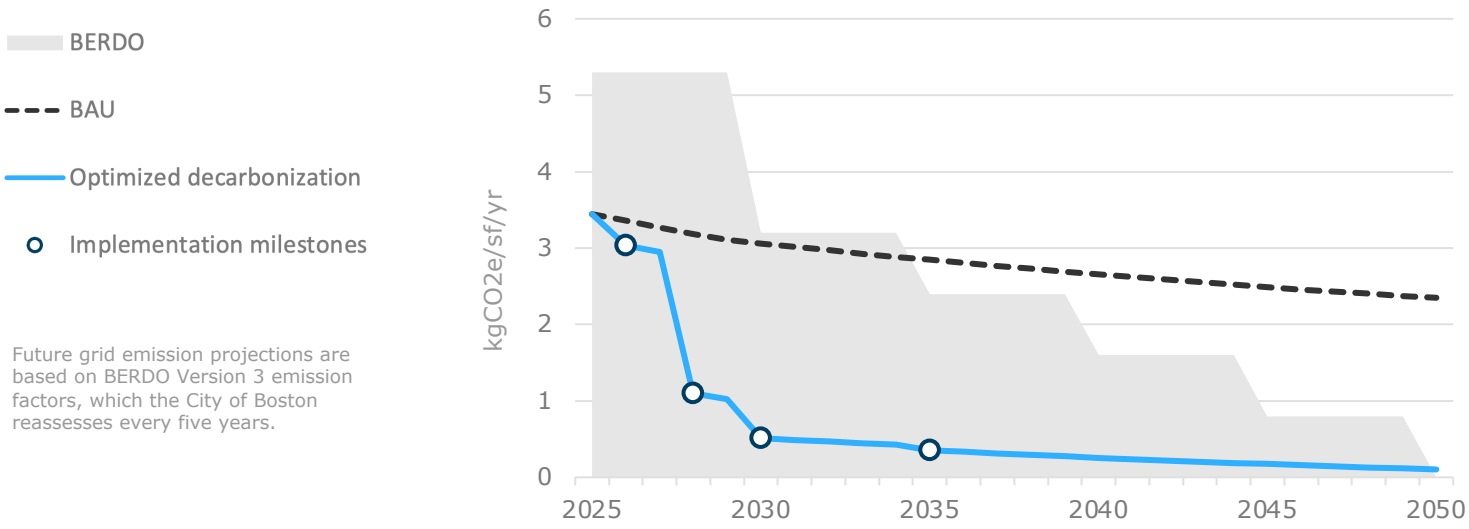
*All cost and incentive values are estimated based on industry data and rounded to the nearest $1,000. All incentives values are based on currently available programs and are subject to change over time. Forecasted operating costs include utility costs, maintenance costs, and noncompliance fees if relevant. 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.

Decarbonization Benefits

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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.



Future grid emission projections are based on BERDO Version 3 emission factors, which the City of Boston reassesses every five years.

Resiliency Considerations

The office is located outside of the current FEMA flooding zones and is listed as an "Area of Minimal Flood Hazard" according to Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map (FIRM). Though considering the potential for intense weather events, the site is located in Middlesex County which is indicated as a "relatively high" level of risk for various natural hazards, especially riverine flooding, ice storms, hurricanes, and lightning based on the Climate Mapping for Resilience and Adaptation (CMRA) data. Future Solar PV expansion (with battery storage) on site may be a consideration for additional resiliency.



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
  - Electric Load study
  - Resiliency & Vulnerability
- [ ] Emergency protocols
- [ ] Assemble project team
- [ ] Structure financing stack