Dorchester Healthcare Facility

Building Performance Exchange

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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	Healthcare Facility
Location	Boston, MA
Year built	1996; 2014 Renovation
Stories	3
Square footage	23,000
Energy use intensity (EUI)*	155 kBtu/sf/yr
Carbon emission intensity (CEI)*	8.23 CO2e kg/sf/yr
Decarbonization goals	Occupant comfort, lower utility costs

The Dorchester Healthcare facility was built in 1996 and underwent a major renovation in 2014 that included an addition to the third floor. Since the third-floor addition, the facility has undergone a few smaller interior renovations that have had little impact to the overall performance and energy use of the building. The envelope is typical light gauge steel and concrete construction. The façade is in fair condition with an assumed air infiltration that aligns with the building's age and construction.

Existing Conditions

Enclosure	Walls	Roof	Windows
	Fair	Fair	Fair
Heating	Natural gas boiler sourcing hot water to rooftop RTUs and to VAVs for reheat. No heat recovery. Limited perimeter heating.		
Cooling	DX cooling provided by RTUs		
Ventilation	Ventilation air is supplied by RTUs		
Hot water	100-gal direct-fired natural gas tanks		
Lighting	LED lighting with occupancy sensors throughout		
Controls	Limited lighting controls (only occupancy ctrls.) temperature set back capabilities not in use (not optimized).		
Other	As a healthcare facility, the building maintains a large capacity for process and plug loads for equipment		
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

Staged electrification to align with emission reduction targets

Install an Air to Water Heat Pump (AWHP) to replace the natural gas sourced boiler/HW heating system (at end of equipment service life) prior to 2035 to align with BERDO emission targets.

Maximize energy reduction prior to delayed decarbonization implementation milestones

Prioritizing foundational energy efficiency and load reduction measures to reduce the energy demand for new mechanical equipment upgrades needed for electrification, improve occupant comfort and lowering utility costs, until enclosure end-of-life replacements for roof and windows.

Core Decarbonization Strategy

- A cost-effective air-to-water heat pump (AWHP) replacement for the existing natural gas boiler to support the existing terminal unit hydronic reheating, while minimizing intrusive interior renovations.
- New equipment replacement is phased over 15 years to align with systems' end-of-life and to manage upfront costs, with electrification planned between 2030-2040.
- Used advanced load reduction measures to minimize the building’s energy load.
- On-site renewable energy is not feasible.

Retrofit Measures and Energy Impacts

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Measures

Energy Efficiency & Load Reduction

Foundational efficiency:
- LED lighting and controls upgrades
- Demand Control Ventilation (DCV)
- Temperature Setbacks

Foundational load reduction:
- Air-sealing and Weatherstripping

Advanced load reduction:
- Roof replacement with added insulation
- Window replacement (triple glazing)
- Exterior wall insulation upgrades with added insulation

System Electrification

Electrification Enablers:
- Electrical distribution panel upgrade
- Low temperature hot water infrastructure testing

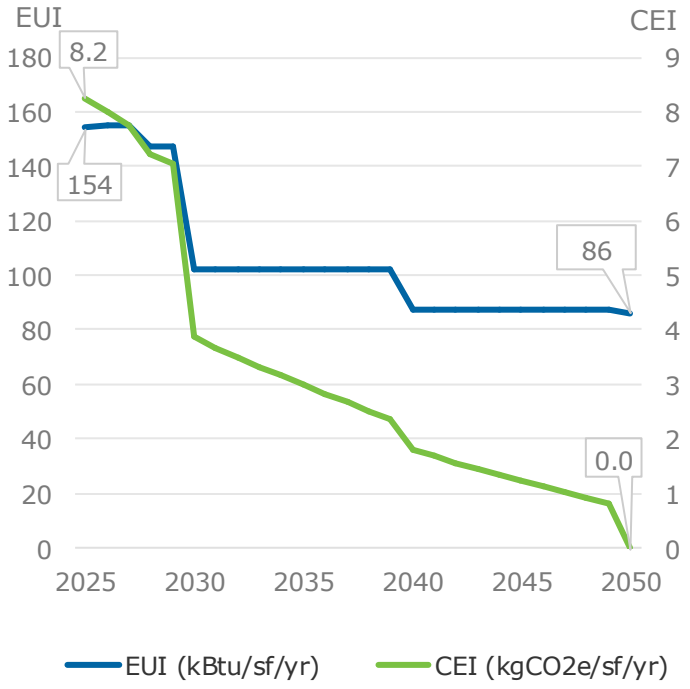
System electrification:
- Air-to-Water Heat Pump
- AHUs with Heat recovery
- Heat pump domestic water heater

Renewable Energy

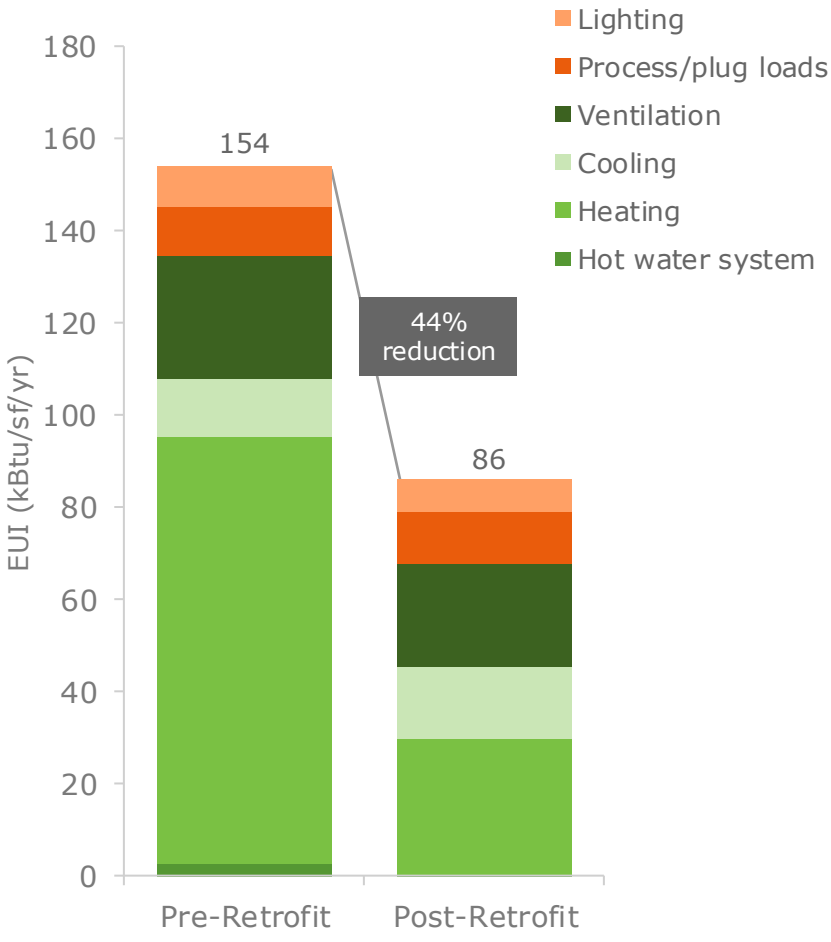
Renewable Energy:
- Not Feasible *(limited roof and site exposure)*

Performance Targets

The decarbonization approach prioritizes an all-electric mechanical system end of life replacement over a 15-year timeline (2025-2040). The recommended measures enable the property to reach an 44% EUI reduction and up to a 78% GHG reduction to align with impending BERDO regulations. 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 and electrifying on-site combustion systems within a cleaning grid. Key considerations or triggers are listed along a timeline to support informed decision-making, with bolded dates indicating recommended implementation years.

Triggers

Order of Implementation

2025-2029:
Foundational energy efficiency load reduction improvements, including whole building air infiltration testing and air sealing are not time dependent and/or may implemented prior to the electrification of systems to support right sizing and energy costs savings.

2025-2029:
Electrical service upgrades should be evaluated with consideration for the 2030 electrification of heating measures. The infrastructure design and sizing may account for the upcoming 2040 final envelope upgrades.

2030:
End of service life for existing mechanical equipment. All-electric heating and cooling.

2035-2039:
End of service life for major enclosure elements. Owner may want to plan for larger renovations or upgrades at this time.

2040:
End of service life for existing domestic hot water system . All-electric domestic hot water.

Lighting
Install advanced lighting controls [daylighting controls]

Demand Control Ventilation (DCV)/HVAC Controls
Install CO2 sensors and HVAC controls in RTUs. Implement temperature setbacks during unoccupied hours

Infiltration Reduction
Air sealing and weatherstripping testing and installation

Cumulative Carbon Reduction Potential*

12%

Electrical Distribution Panel Upgrade
Upgrade electrical for and mechanical system electrification

Low Temperature Hot Water Infrastructure
Evaluate existing heating infrastructure performance of unit ventilators for low hot water temp performance capacity. Upgrade VAVs for mechanical system electrification if necessary.

Air to Water Heat Pump
Replace natural gas boiler with an Air to Water heat pump (AWHP).

AHU Replacement
Replace current AHUs at electrification (end of service life) with AHUs including heat recovery.

53%

Wall Upgrades
Increased insulation level of exterior wall at time of siding replacement (R-30)

Roof Replacement
Increased insulation level on roof (R-50)

Window Replacement
Install high-performance triple pane windows at existing window end-of-life.

Heat Pump Domestic Water Heater
Install heat pump domestic water heater to replace current natural gas DHW heating system

78%

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

*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	($2,400)	-	($2,400)
Process/plug loads	-	-	-
Ventilation	($8,500)	-	($8,500)
Cooling	$4,800	-	$4,800
Heating	$35,100	($35,300)	($200)
Hot water system	$900	($1,200)	($300)
Total from recommended measures	**$29,900**	**($36,500)**	**($6,600)**
Renewable energy	-	-	-

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 GHG 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 decarbonization pathway.

Costs	BAU retrofit	Optimized decarbonization pathway	
Base building and envelope costs	$1,012,000	$84,000	Foundational efficiency and load reduction
		$1,223,000	Advanced load reduction
Mechanical costs	$1,346,000	$278,000	Electrification enablers
		$1,014,000	System electrification
Renewable energy costs	$0	$0	Renewable energy
Soft costs	$825,000	$910,000	
Total upfront costs	**$3,183,000**	**$3,509,000**	
Utility incentive opportunities	$0	$51,000	
25-year total accrued utility costs	$5,913,000	$5,907,000	
25-year accrued total operating costs	$7,971,000	$7,834,000	
25-year LCCA	**$11,154,000**	**$11,292,000**	

BAU scope:

- Roof, windows and DHW replacement in 2035-2040.
- Natural gas boiler and RTUs replacement in 2030.

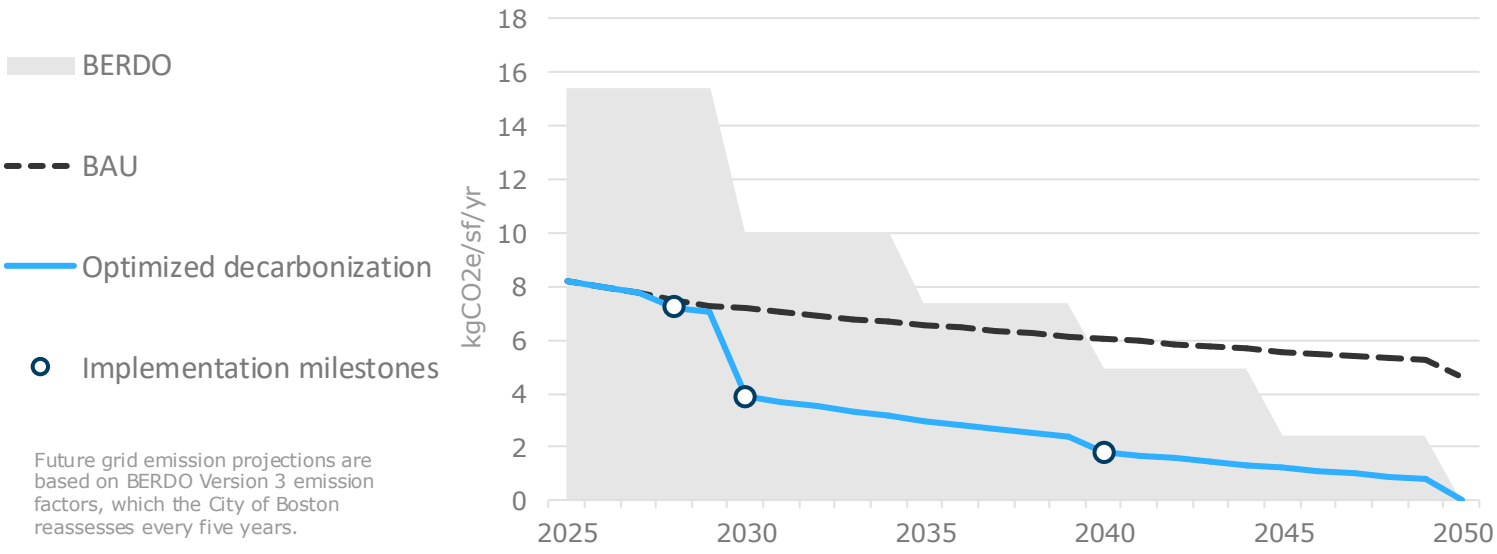
*All cost and incentive values are estimated based on industry data and rounded to the nearest $1,000. All incentives values are based on currently available programs and are subject to change over time. Forecasted operating costs include utility costs, maintenance costs, and noncompliance fees if relevant. 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 natural gas or code-compliant versions of the decarbonization measures listed.

Decarbonization Benefits

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GHG 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 GHG 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 facility is located outside of the current FEMA flooding zones but is near the affected area of the current FEMA flood zones with minimal risk of flooding hazards. However, there is the potential for intense weather events, including extreme rainfalls in short timeframes causing atmospheric rivers. A climate change vulnerability assessment may be recommended, including flood proofing measures for both the site and the facility, such as the electrical service, generator and other energy systems equipment located at ground level. Future peak load reduction measures such as on-site battery storage 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
  - Structural roof assessment
- [ ] Emergency protocols
- [ ] Assemble project team
- [ ] Structure financing stack