West Hall at Olin College

This case study is part of the MassCEC BETA: Project Planning program, committed to helping a representative selection of commercial building types in Massachusetts reach net zero emissions by 2050.

Building type	Dormitory
Location	Needham
Year built	2000
Stories	5
Square footage	58,217
Energy use intensity (EUI)*	110 kBtu/sf/yr
Carbon emission intensity (CEI)*	5.85 CO2e kg/sf/yr
Decarbonization goals	Utility cost savings, regulatory compliance

West Hall, located in Needham, MA, is a 96-unit dormitory housing ~185 Olin College students. There are laundry rooms on each floor and one communal kitchen. Olin College is planning to decarbonize the central plant, so provisions for building specific HVAC decarbonization are not included.

Existing Conditions

	Walls	Roof	Windows
Enclosure	Fair	Flat portion: Good Curved portion: Poor	Fair
Heating	Central campus plant gas-boilers that provide hot water to radiant perimeter heaters		
Cooling	Central campus plant chillers that provide chilled water to fan coil units (FCUs)		
Ventilation	Ventilation is supplied by three energy recovery ventilators (ERVs)		
Hot water	Two 250-gal gas-fired water heaters, one 225-gallon storage tank		
Lighting	98% LEDs with plans to retrofit the remaining 2% to LEDs. Occupancy sensors in corridors and laundry rooms		
Controls	Centralized building management system (BMS), but no current temperature setbacks.		
Other	Gas oven in communal kitchen and gas dryers in laundry rooms on every floor		
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

Site is connected to a centralized gas fired boiler plant for heating

Focus on upgrading on-site combustion systems such as domestic hot water (DHW) and readying the building system to utilize low temperature heating hot water

Outdated heating hot water control

Install hot water demand control and heat pump hot water heaters to improve end use and reduce load

Reports of draftiness

Prioritize full-frame window replacements to reduce thermal bridging

Core Decarbonization Strategy

- Olin College is planning to decarbonize their central plant. Focus for this building is to decarbonize DHW and other end uses
- Gas-fired water heaters' end-of-life creates an opportunity for heat pump water heater replacements
- Air sealing, new windows, and partial roof replacement reduces heating loads and improves comfort

Retrofit Measures and Energy Impacts

Measures

Energy Efficiency & Load Reduction

Foundational Efficiency and Load Reduction:

- Smart thermostats
- Low-flow fixtures
- Hot water demand control
- Demand control ventilation (DCV)
- Variable speed fans in ERV
- Electronically communicated (EC) motors in FCUs
- Air sealing and weatherstripping
- Heat recovery wheels

Advanced Load Reduction:

- Window replacement
- Partial roof replacement

System Electrification

Electrification Enablers:
Thermal stress test for reduced hot water supply temperature and targeted existing heating infrastructure upgrades

System Electrification:

- Heat pump DHW system
- Electric laundry appliances
- Electric kitchen equipment
- Central plant boiler to ground source heat pump (GSHP)*

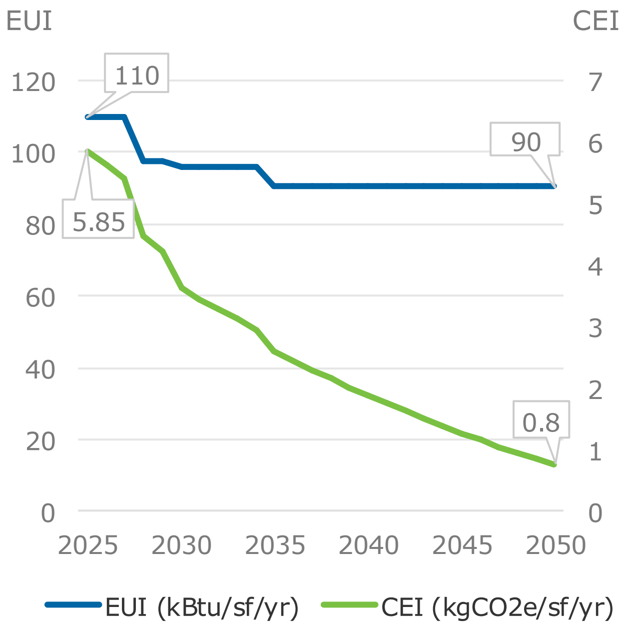
Renewable Energy

Solar:

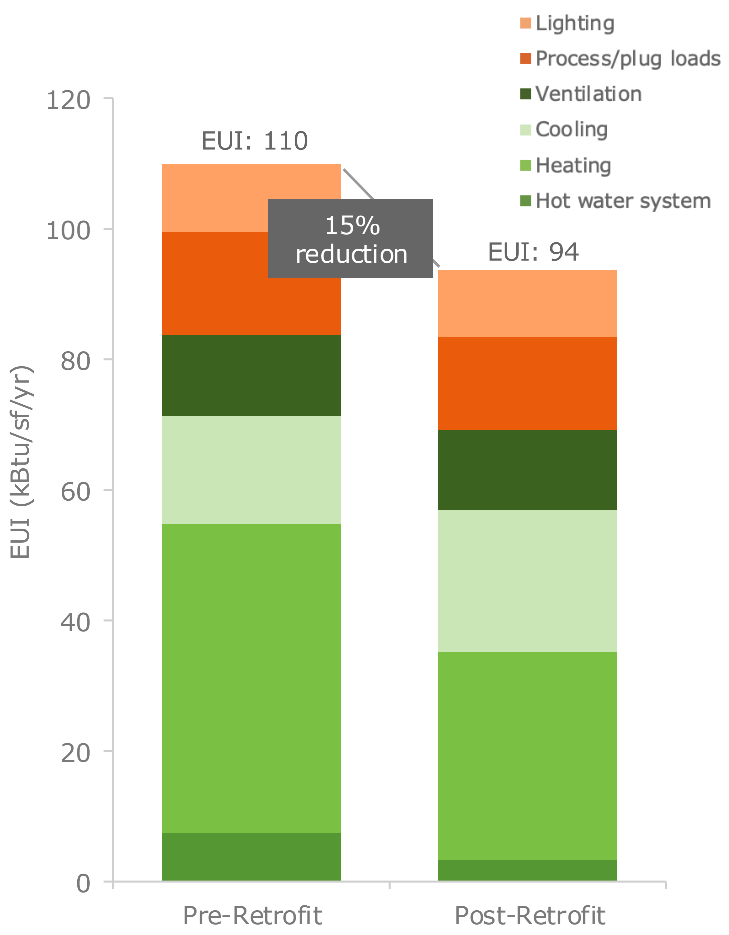
- Install ~50 kW rooftop solar system with thin film panels on curved roof

Performance Targets

The decarbonization approach prioritizes immediate energy efficiency measures and replacing the gas-fired water heaters at their end-of-life. The approach assumes the decarbonization of the campus plant within the timeline covered in this report. 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. The building is served by campus plant so its decarbonization is dependent on central plant decarbonization.

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.

Triggers

2026: Foundational efficiency improvements are not time dependent and may be based on the end-of-life of systems

Window replacement is not time dependent but earlier replacement could benefit HVAC sizing

2030: West Hall decarbonization depends on central plant decarbonization

2035: Replace kitchen and laundry appliances at end-of-life

Order of Implementation

Cumulative Carbon Reduction Potential*

- **Smart Thermostats**
- **Low-flow Showerheads**
- **Hot Water Demand Control**
- **Heat Recovery Wheels** – Replace the broken recovery wheels on ERVs
- **Window Replacement** – Increased U-factor value
- **Partial Roof Replacement** – Increased insulation level on curved portion
- **Thermal Stress Test** – Perform a thermal stress test on FCUs and radiators to determine temperature needs
- **DHW Electrification** – Install heat pump DHW heater to replace existing system

24%

- **Central Plant GSHP System** – Replace boiler and chiller system with GSHP
- **Variable Speed Fans in ERVs**
- **DCV System**
- **Infiltration Reduction** – Perform testing and air sealing to enclosure
- **EC Motors for FCUs**

38%

- **Kitchen and Laundry Electrification** – Replace gas oven with electric oven and gas dryers with electric dryers
- **Solar PV System** – Install new rooftop solar PV system

56%

Zero on-site fossil fuel combustion
(With the exception of 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.

Cost Analysis

Annual Utility Impacts

Measure description	Changes in annual utility costs		
	Electricity	Fossil fuel	Net total changes
Lighting	($3,700)	-	($3,700)
Process/plug loads	($1,700)	($1,800)	($3,500)
Ventilation	($4,500)	-	($4,500)
Cooling	$16,500	-	$16,500
Heating	$85,400	($27,000)	$58,400
Hot water system	$13,600	($5,500)	$8,100
Total from recommended measures	**$105,600**	**($34,300)**	**$71,300**
Renewable energy	($11,200)	-	($11,200)

Baseline utility costs were estimated due to lack of building-level metered data.

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	$1,590,000	$220,000	Foundational efficiency and load reduction
		$1,979,000	Advanced load reduction
Mechanical costs	$135,000	TBD**	Electrification enablers
		$290,000	System electrification
Renewable energy costs	$0	$152,000	Renewable energy
Soft costs	$173,000	$264,000	
Total upfront costs	**$1,898,000**	**$2,905,000**	
Utility incentive opportunities	$0	$4,000	
25-year total accrued utility costs	$9,015,000	$14,298,000	
25-year accrued total operating costs	$13,829,000	$18,654,000	
25-year LCCA	**$15,727,000**	**$21,554,000**	

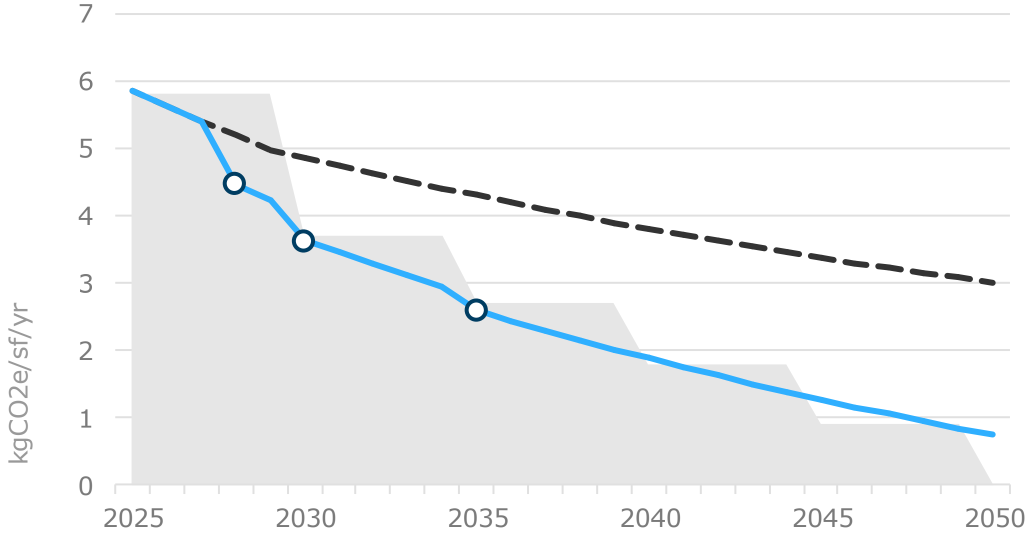
BAU scope:
- Roof replacement
- Lighting replacement
- Double-pane windows
- Gas DHW replacement

*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.
**Since Olin College intends to electrify heating and cooling at the campus plant, the extent and costs of building-level enabling measures depend on the campus plant design. The required extent of hydronic heating coil replacement will depend on the available hot water supply temperature from the plant.

Decarbonization Benefits

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 2.3 emission factors, which the City of Boston reassesses every five years.

Resiliency Considerations

West Hall is in an area of minimal flood hazard. Future weather patterns are likely to affect electricity consumption, system loads, and peak demand. As temperatures are projected to rise by 2050, analysis indicates that heating load could decrease by approximately 20%, while cooling loads may increase by about 50%. In the event of periods of extreme heat and extreme cold, building enclosure improvements and on-site solar generation are expected to help moderate energy demand.

Solar array simulated rooftop location. Areas on the wings have a curved roof, while the center location is a flat roof.

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
  - Thermal stress test
- [ ] Emergency protocols
- [ ] Assemble project team
- [ ] Structure financing stack