20 Charlesgate West

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	Multifamily housing
Location	Boston, MA
Year built	1899; 1980s Renovation
Stories	6
Square footage	64,441
Energy use intensity (EUI)*	74.5 kBtu/sf/yr
Carbon emission intensity (CEI)*	3.96 CO2e kg/sf/yr
Decarbonization goals	Occupant comfort, thermal comfort, lower utility costs

20 Charlesgate West was originally constructed in 1899. The building was used as a hotel until the 1980s when it underwent a renovation and change of occupancy. The building was then used as a nunnery and now acts as transitional housing. During the 1980s renovation, thermal improvements were made to the original enclosure (roofs & windows). The façade is load-bearing brick in fair condition for its age.

Existing Conditions

Enclosure	Walls	Roof	Windows
	Poor	Poor	Poor
Heating	Natural gas-sourced hydronic system with steam radiators. AHU heating (with natural gas furnace) for the chapel/community space.		
Cooling	No central cooling in dwelling units. Window A/C units for 25-30% of dwelling units upon request. AHU DX cooling for the Chapel/Community space.		
Ventilation	Natural ventilation through operable windows in dwelling units. Mechanical AHU ventilation for Chapel/community space.		
Hot water	Natural gas boiler plan: (3) 120 gal tanks (80% efficiency). (1) Lead and (2) stand-by tanks.		
Lighting	Fluorescent lighting throughout, no lighting controls		
Controls	None		
Other	(1) Full commercial kitchen with gas appliances with smaller kitchenettes on every floor		
Renewable energy	No on-site renewable energy systems		

*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

Reported thermal comfort concerns in warm weather.

Replace existing boilers with centralized ASHP/VRF (adding whole building cooling) as part of planned building renovation.

Reported electrical capacity issues

In-depth electrical capacity assessments and upgrades to the electrical infrastructure will be required prior to electrification.

Reported draftiness from windows and air infiltration in cold weather

Prioritize air sealing around windows and add additional wall insulation on the interior side of exterior walls during the planned building renovation to reduce heating loads.

Core Decarbonization Strategy

- The owner's planned building renovation allows for large scale interior disruptions to allow all-electric new HVAC infrastructure.
- Air sealing, exterior wall insulation (interior side), and new windows will support lower energy use and addresses reported draftiness and air leakage, while minimizing costly enclosure upgrades and maintaining the historical character of the of the building.

Retrofit Measures and Energy Impacts

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Measures

Energy Efficiency & Load Reduction

Foundational efficiency:
- LED lighting upgrades and controls
- Demand Control Ventilation (DCV) in AHU

Foundational load reduction:
- Air sealing and Weatherstripping

Advanced load reduction:
- Roof replacement with added insulation
- Wall insulation upgrade
- Window replacement

System Electrification

Electrification Enablers:
- Electrical distribution panel upgrade

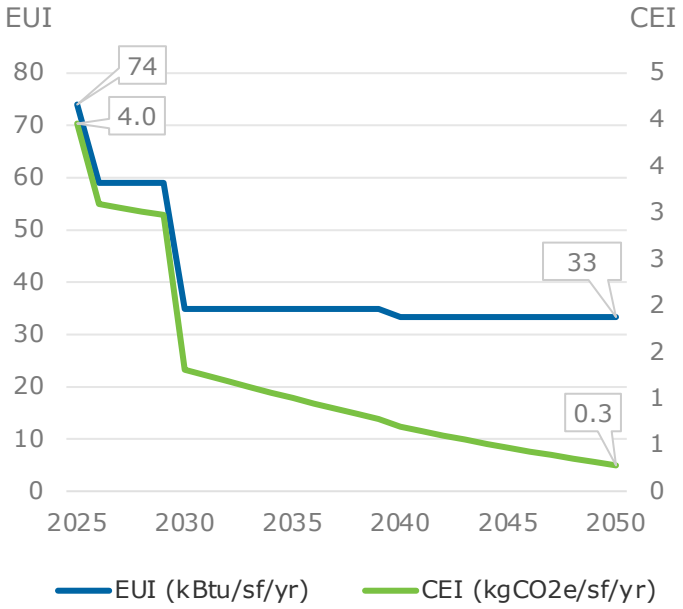
System electrification:
- Air Source Heat Pump (ASHP)/ VRF
- DOAS Ventilation with heat recovery (or ERVs)
- Heat pump domestic water heater (DHW)

Renewable Energy

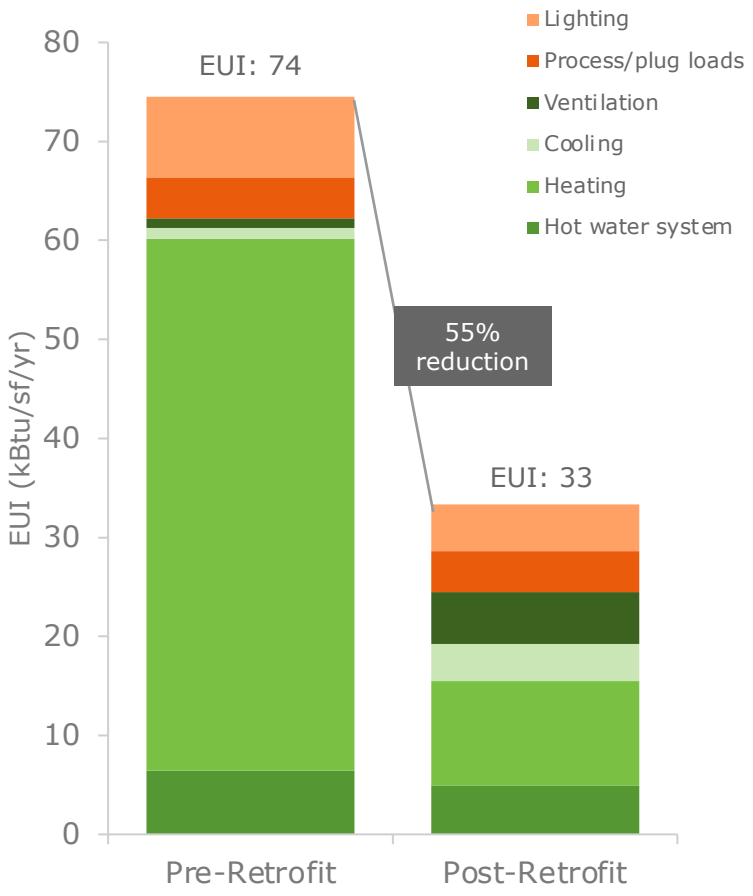
Renewable Energy:
- Not feasible *(limited roof space/structural)*

Performance Targets

The decarbonization approach prioritizes an all-electric mechanical system over a 15-year timeline (2025-2040). The recommended measures enable the property to reach a 55% EUI reduction and up to an 82% GHG reduction by 2040 to align with impending BERDO regulations. These efforts would yield the following results over time:



Annual Energy Use Impacts*



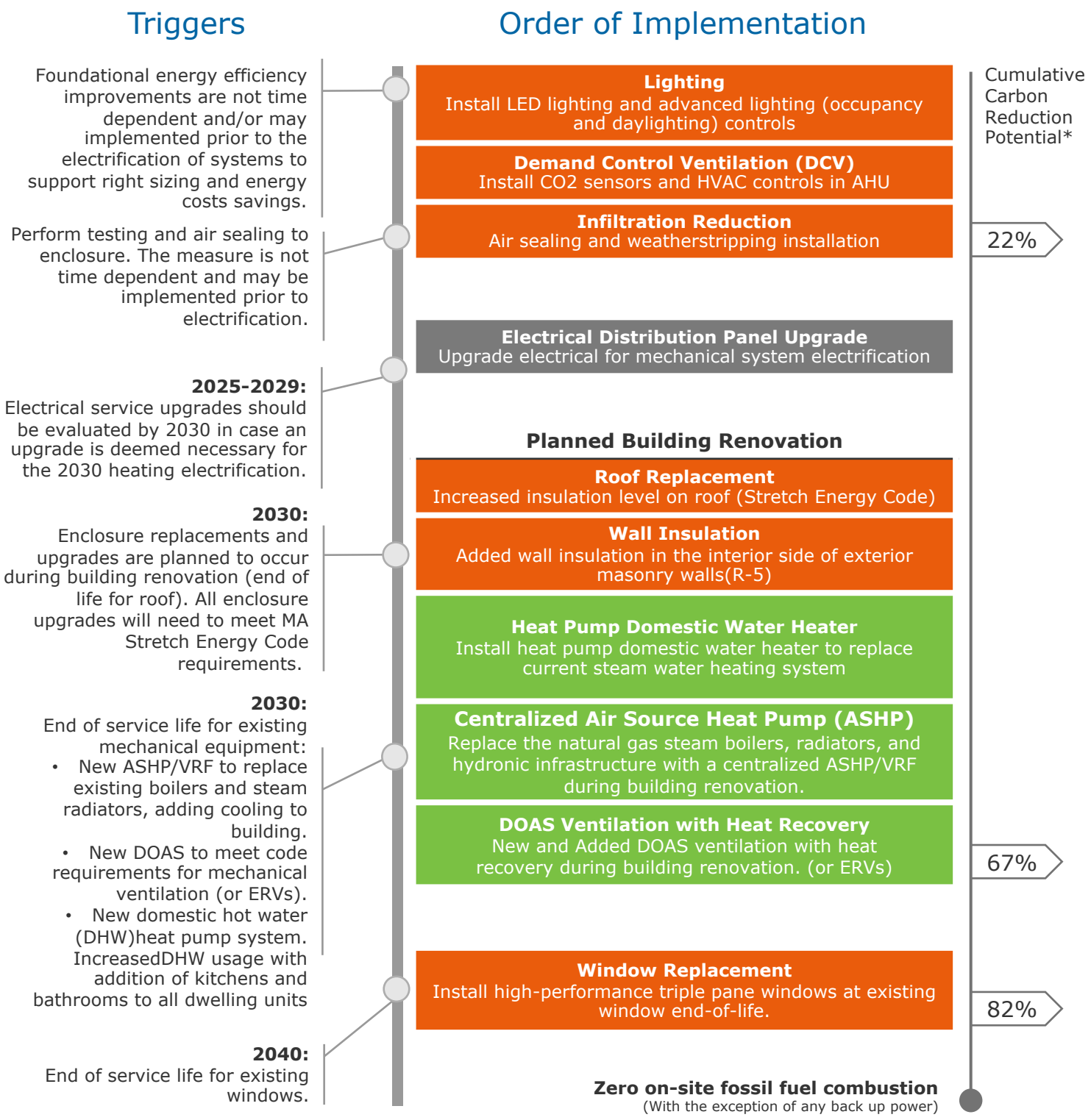
*The Post-Retrofit EUI represented in the graph above does not include additional energy use reductions from renewable energy systems.

*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	($27,900)	-	($27,900)
Process/plug loads	($12,200)	-	($12,200)
Ventilation	$19,500	-	$19,500
Cooling	$10,700	-	$10,700
Heating	$50,800	($62,600)	($11,800)
Hot water system	$26,200	($7,600)	$18,600
Total from recommended measures	**$67,100**	**($70,200)**	**($3,100)**
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 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	$1,367,000	$394,000	Foundational efficiency and load reduction
		$1,816,000	Advanced load reduction
Mechanical costs	$1,297,000	$644,000	Electrification enablers
		$2,671,000	System electrification
Renewable energy costs	$0	$0	Renewable energy
Soft costs	$932,000	$1,933,000	
Total upfront costs	**$3,596,000**	**$7,458,000**	
Utility incentive opportunities	$0	($419,000)	
25-year total accrued utility costs	$7,463,000	$6,633,000	
25-year accrued total operating costs	$8,700,000	$7,216,000	
25-year LCCA	**$19,759,000**	**$20,888,000**	

BAU scope:

- Roof replacement in 2030.
- Mechanical Ventilation added in 2030.
- Boiler and radiator replacement in 2030.
- Replacement of A/C window units in 2030.
- Window replacement in 2040.
- Electrification ready infrastructure based on code requirements (fossil fuels are maintained as the primary heat source).

Note:The 25-yr. LCCA optimized decarbonization pathways costs account for new and added MEP systems serving the space planning improvements as part of the owner's upcoming needed renovations (cooling, kitchens, bathrooms), while the BAU does not include the systems associated with the renovations.

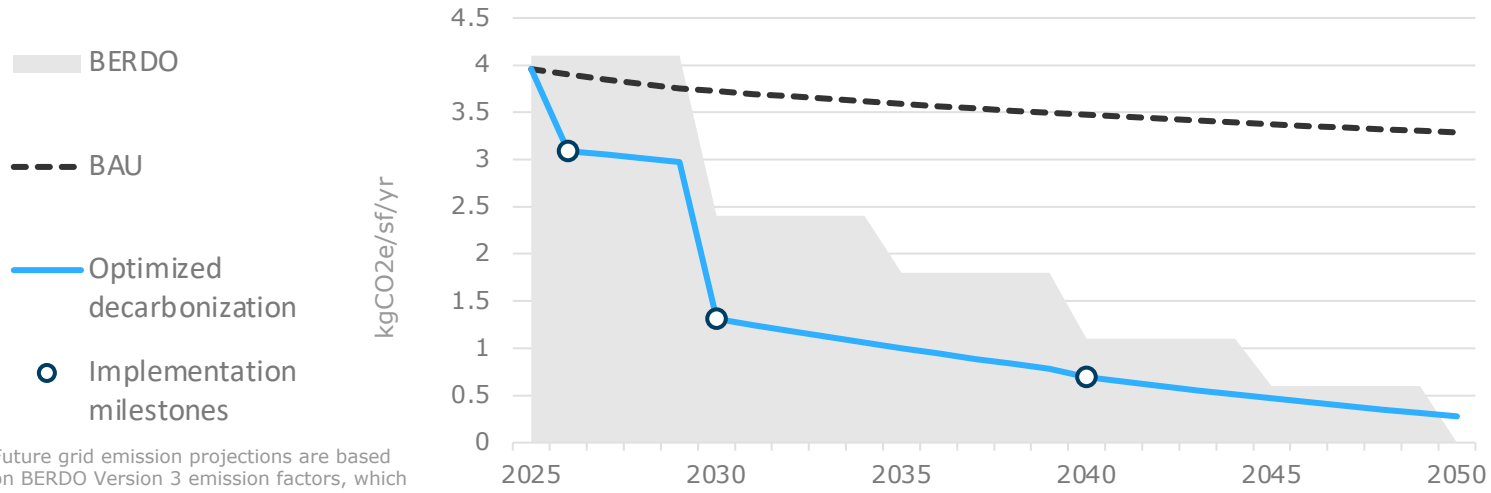
*All cost and incentive values are estimated based on industry data and rounded to the nearest $1,000. All incentives values are based on currently available programs and are subject to change over time. Forecasted operating costs include utility costs, maintenance costs, and noncompliance fees if relevant. Utility and maintenance costs reflect a 3% annual escalation rate. The BAU approach assumes necessary repairs and replacements that meet energy code compliance. In this case study, BAU represents the conventional gas or energy 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 across the city 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 facility is located outside of the current FEMA flooding zones but is near the affected area of the Muddy River Flood Plain. Considering the potential for intense weather events, including extreme rainfalls in short timeframes, a climate change vulnerability assessment may be recommended. As temperatures are projected to rise by 2050, analysis indicates that heating demand could decrease by approximately 8%, while cooling loads may increase by about 38% (considering not current cooling at units). In the event of extreme weather, building enclosure improvements are expected to help moderate energy demand during periods of extreme heat and extreme cold.



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.

- ☑ Existing building conditions
- ☑ Decarbonization assessment
- ☑ Supplemental assessments
  - Electric load study (initiated)
  - Resiliency and vulnerability assessment (TBD)
- ☑ Assemble project team
- ☐ Structure financing stack