Salem Heights Apartments

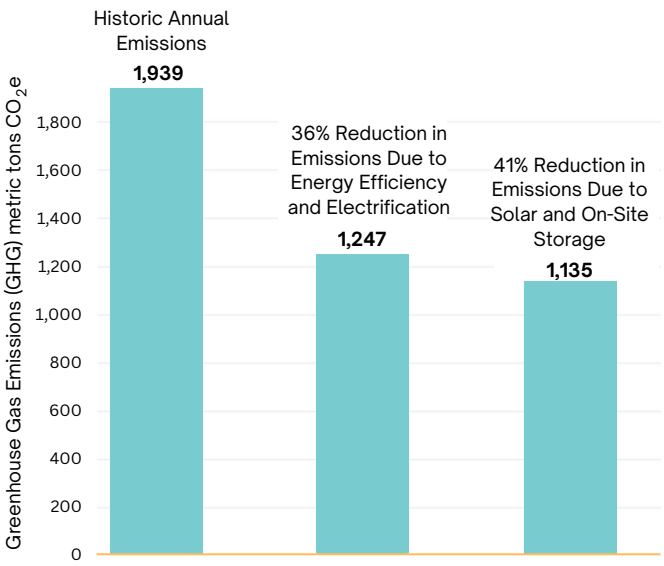
Salem, MA

Salem Heights Apartments is a deep energy retrofit that was completed in the fall of 2023. This affordable, low-income property of 281 apartments is striving to meet passive house performance criteria and is on track to cut energy usage by 60 percent.

Salem Heights Apartments, after renovations.

The two buildings were wrapped in a new superinsulated exterior shell and outfitted with all-electric mechanical systems. In addition to a rooftop solar photovoltaic (PV) array on building B, a vertical solar array was installed on the south-facing walls. The solar panels double as the finished siding outboard of the exterior insulation assembly for these walls.

Deep Energy Retrofit Analysis



Annual Operating Emissions with Current Electricity Supply*

Without Solar

Anticipated energy reduction from energy efficiency and electrification	60 percent
Energy use intensity (EUI) before retrofit	111.2 kBtu/sf
Modeled EUI after retrofit	42.5 kBtu/sf
Anticipated greenhouse gas (GHG) emissions reduction with current electricity supply	36 percent*

With Solar

Total load served by renewables	9 percent
Solar PV system	209.7 kW
Anticipated energy reduction with solar	65 percent
Modeled EUI with solar	39 kBtu/sf
Anticipated GHG emissions reduction with solar with current electricity supply	41 percent**

*Annual operating emissions are calculated using state-specific long-run marginal emission rates (LRMER) for electricity instead of average historical emissions rates. This method is justifiable when projecting emissions savings over longer periods of time, because LRMER more accurately reflect the current and future electric grid supply.

*As with the indirect greenhouse gas footprint continuing to fall to zero as the regional electric grid becomes greener.
**Assumes the Renewable Energy Credits (RECs) from on-site solar remain with the property and are not sold to a third party.

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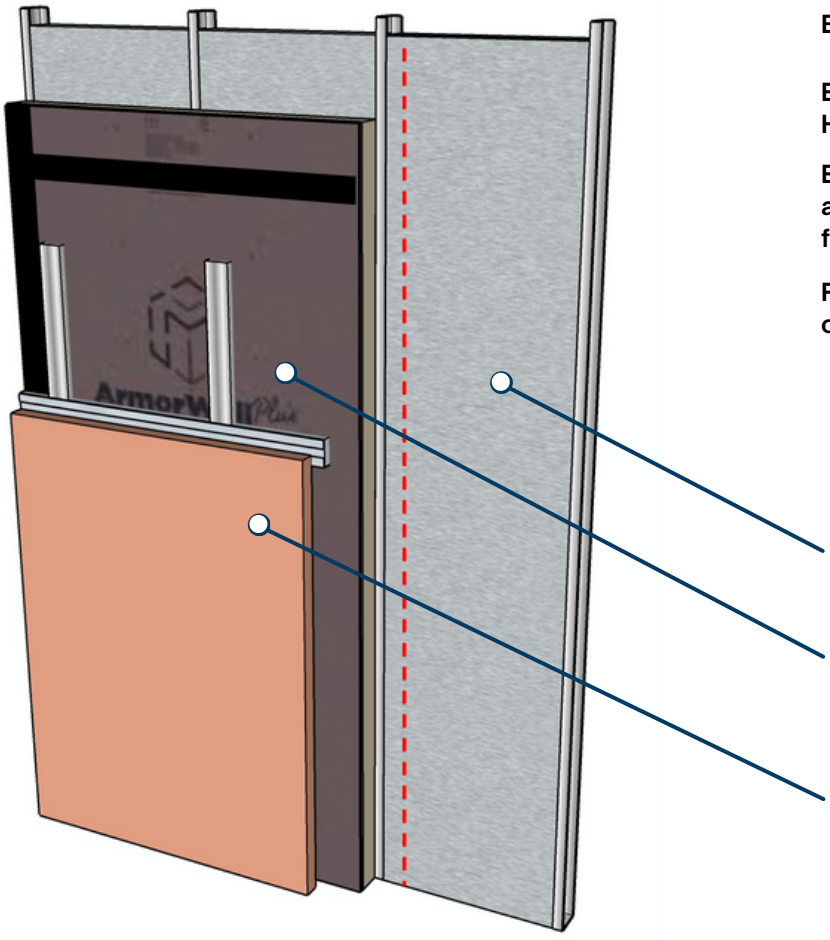
Building Envelope Strategy

Built in 1974, the existing brick facade was only supported from the foundation and lacked shelf angles. An investigation of the existing wall, with the brick removed at select locations, found the brick ties to be structurally inadequate. As a result, the project team chose to remove the brick rather than recladding over it. After the brick was removed, R-21 ArmorWall was installed on the facade, attached directly to the existing metal studs. ArmorWall is a composite panel product that includes magnesium oxide structural sheathing on its exterior face with poured polyurethane insulation. In addition to providing continuous insulation, the panels act as an air and weather barrier once sealed to each other and have a one- to two-hour fire rating. Aluminum panel cladding is attached to metal furring on top of the ArmorWall.

New Insulated Building Envelope (R-28)



Existing fiberglass-insulated wall stripped of the brick and paper-faced gypsum sheathing

ArmorWall structural, R-21 insulated sheathing panel with fire retardant and air- and water-resistive barrier

Exterior metal panel finish with metal furring strips and associated fastening

Building Overview

Project name	Salem Heights Apartments
Building type	Multifamily residential
Location	Salem, MA
Year built	1974
Status of renovation	Completed in 2023
Number of stories	9 and 10 stories
Number of apartments	281
Floor area	292,000 square feet
Certifications	Phius anticipated

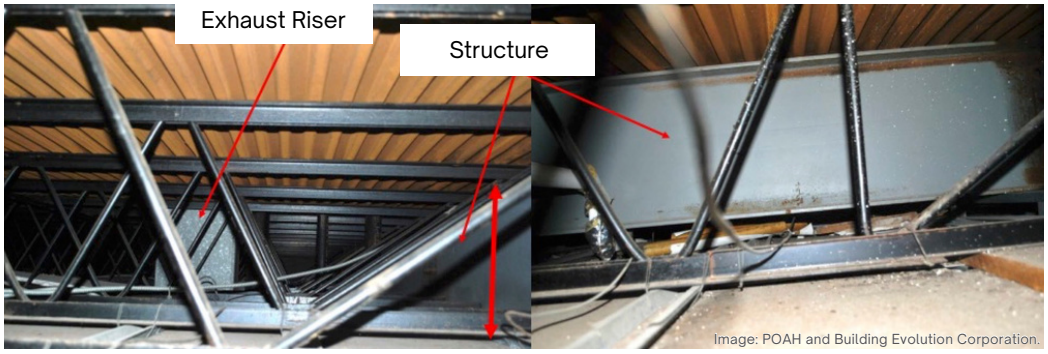
Building Team

Building owner	Preservation of Affordable Housing (POAH)
Architect	ICON Architecture
Building scientist	Building Evolution Corporation
Engineer for apartment HVAC	Seaman Engineering Corporation
Engineer for common areas, plumbing, and fire protection	RW Sullivan
Passive house consultant	Building Evolution Corporation

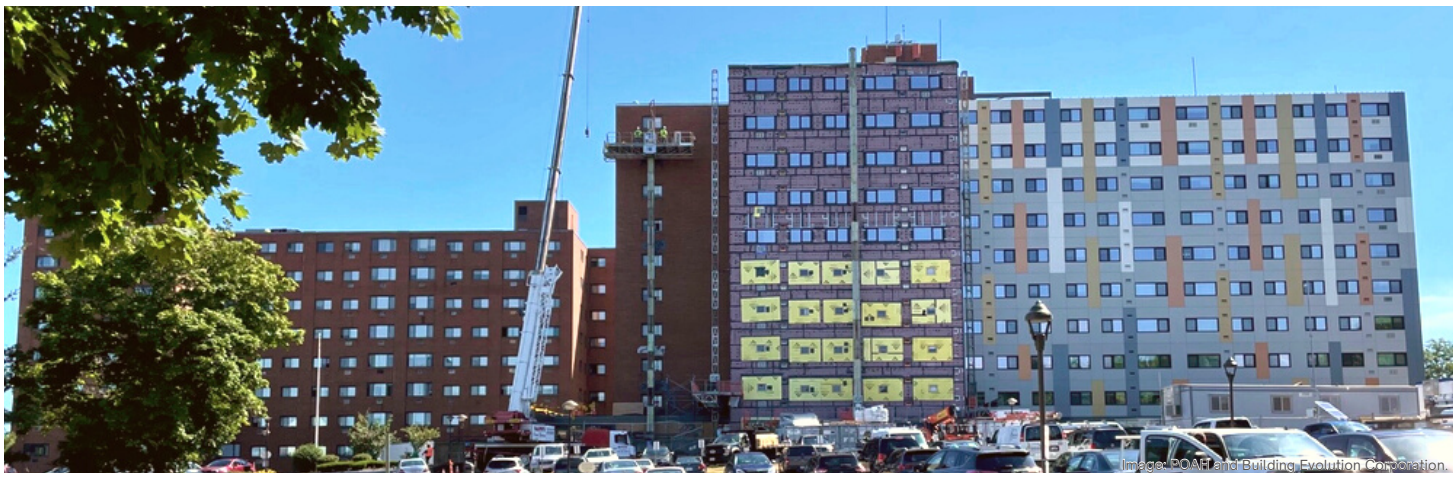
Exterior Insulation Wall System

Wall Insulation	
R-value before	R-5
R-value after	R-28
Roof	
R-value before	R-14
R-value after	R-30
Windows	
U-value before	U-0.48
U-value after	U-0.20
Solar heat gain coefficient (SHGC) before	0.70
SHGC after	0.37
Target Airtightness	0.62 ACH; 0.10 CFM50

Improving ventilation was a priority, but finding a way to duct fresh air to apartments was a challenge. A steel beam running along the common corridor wall prevented horizontal ducting as a feasible option. Current fire safety regulations made retrofit of vertical shafts prohibitively expensive in this building. Due to these constraints, the team decided to install combined, packaged air treatment units in each apartment. This required building a closet for the equipment along the exterior wall and installing soffits below the ceiling to house ductwork. Exhaust ductwork from the bathrooms and kitchen was added to an existing soffit containing a sprinkler system. Routing ductwork around existing sprinklers while addressing asbestos-laden ceilings and walls made this a costly solution, but it was the least expensive solution that the team investigated for this project.



Ventilation ductwork could not be hidden in the ceiling cavity due to obstructions by structural members. Instead, it had to be installed in soffits below the ceiling.



Scope of Work

Exterior Insulation (Walls)

- Removal of existing brick and paper-faced gypsum sheathing
- ArmorWall structural sheathing system with continuous insulation and air barrier (R-21)
- Metal furring girt system
- Aluminum panel cladding or vertical solar PV as the finished cladding

Exterior Insulation (Roof)

- Polyisocyanurate board insulation (R-30)
- SBS modified bituminous membrane

Mechanicals

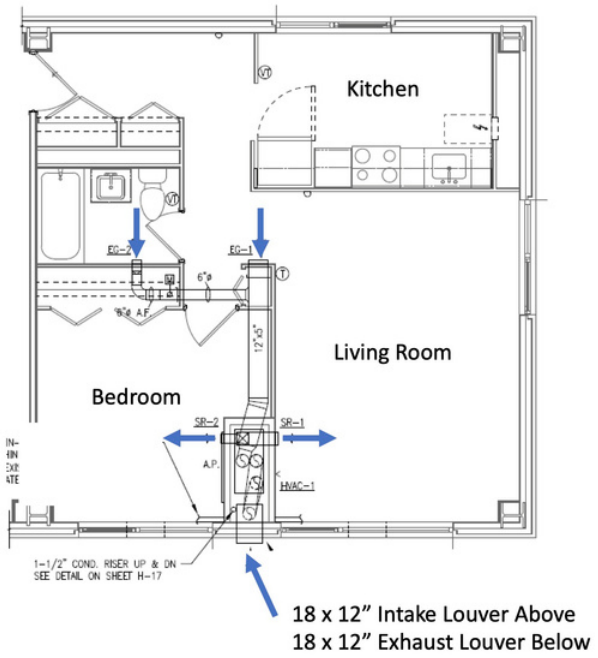
- Heating, cooling, and ventilation:
  - Minotair Pentacare V12 combined air-source heat pump and heat recovery ventilator in apartments
  - Friedrich's FreshAire® packaged terminal air conditioner (PTAC) system in corridors
  - Renewaire energy recovery ventilators (ERVs) and Daikin VRV in offices and common areas
- Domestic hot water: HTP Elite XL condensing boiler

Solar PV

- Combined 209.7 kW rooftop and vertical wall array

HVAC Strategy

In each apartment, individual Minotair Pentacare V12 units, which include a heat pump and heat recovery ventilator, were installed to provide fresh air, heating, cooling, and dehumidification. To accommodate this decentralized HVAC system, a new mechanical closet was built on the exterior wall of each apartment. Intake and exhaust air openings for the Minotair units were created in the new exterior wall. Intake and exhaust louvers were offset to achieve sufficient separation between fresh air and exhaust air. The building's existing central gas-fired baseboard heating is not anticipated to be used, but was left in place as a backup until the heat pump units have demonstrated consistent heating load coverage under real-world conditions.

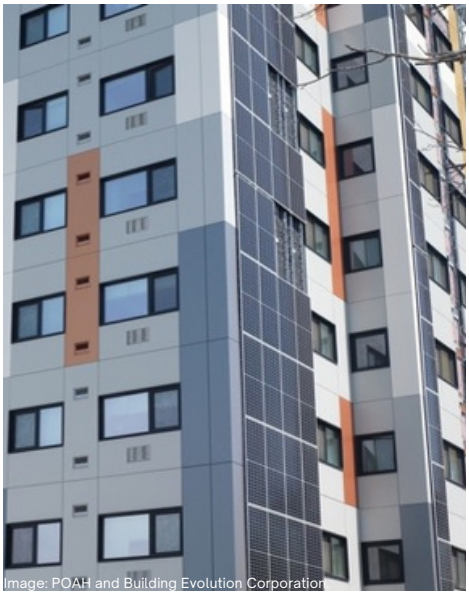


Images: POAH and Building Evolution Corporation.

A Minotair heat pump and heat exchanger was installed in a new mechanical closet on the outside wall of each apartment.

Renewables

Because tall buildings have a small amount of roof area relative to the floor area or number of apartments, on-site solar generally cannot cover all the electric load. On this project, solar is anticipated to cover 9 percent of the building's electric load. To optimize solar exposure, a combined 209.7 kW solar system was installed on the roof and on the south- and southwest-facing building facades, where vertical solar PV panels take the place of aluminum cladding. The owner is considering expanding on-site solar production in the future by building solar PV canopies in the parking lots.



Rendering by Icon Architects of Salem Heights Apartments deep energy retrofit after construction.

Cost Breakdown*

Total hard construction cost of deep energy retrofit scope (envelope improvements and mechanical)	$37,000,000
Cost per square foot of floor area	$127
Cost per apartment	$132,000
Total cost of installed exterior envelope assembly (walls, windows, and roofs)	$26,300,000
Cost of installed exterior envelope assembly per square foot of exterior wall surface area	$220
Cost of installed exterior envelope assembly per apartment	$93,600

*Based on construction cost estimates from 2023.

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