Fairweather Apartments

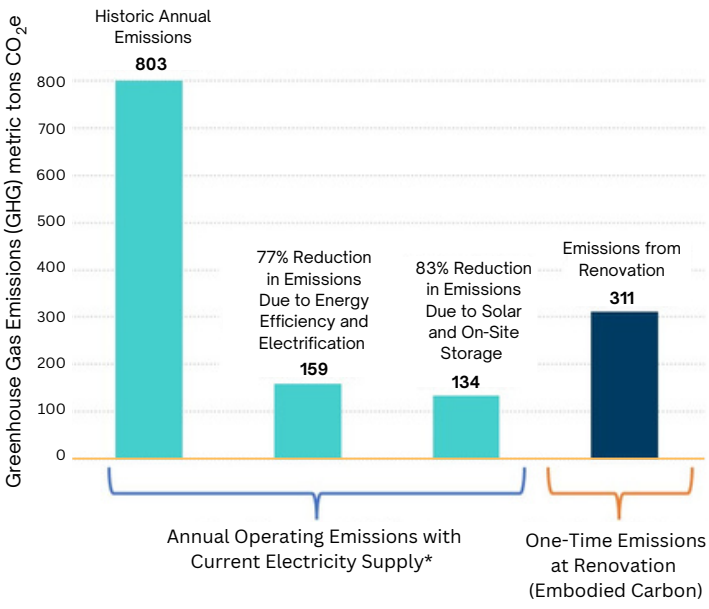
Salem, MA

Fairweather Apartments in Salem is a deep energy retrofit planned for construction in the next two years. This affordable, low-income property of 127 apartments was originally constructed in 1968 and is anticipated to meet passive house performance criteria and cut its energy use by 86 percent through energy efficiency and electrification.

Fairweather Apartmnents, Salem, prior to renovations.

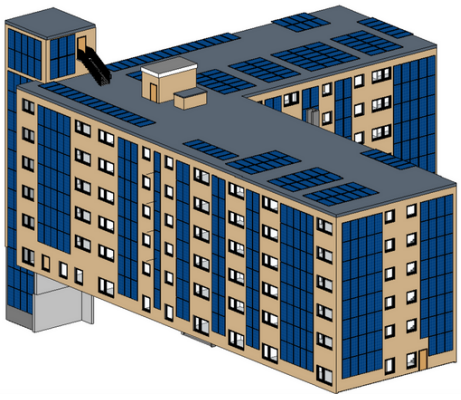
Overall, the property is anticipated to reduce its greenhouse gas emissions by 80 percent in the near term. Once the electric grid decarbonizes, this building will reach zero-carbon operations. The building will be wrapped in a new superinsulated, panelized exterior shell and outfitted with all-electric mechanical systems. Fairweather Apartments is one of four similar buildings in four Massachusetts cities under the same ownership, comprising more than 600 apartments total, which means solutions developed here can easily be applied at the other properties.

Deep Energy Retrofit Analysis



*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.

Anticipated energy reduction from energy efficiency and electrification	86 percent
Energy use intensity (EUI) before retrofit	150 kBtu/sf
Modeled EUI after retrofit	21.4 kBtu/sf
Anticipated greenhouse gas (GHG) emissions reduction with current electricity supply	80 percent



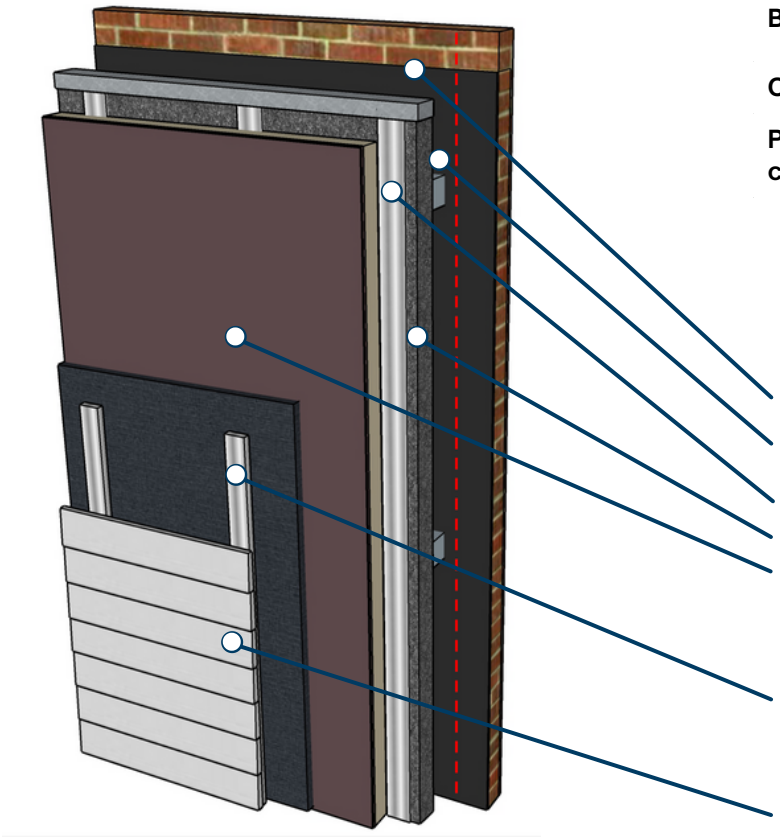
Early rendering by Onion Flats Architecture of Fairweather Apartments deep energy retrofit after construction.

realize@rmi.org

Building Envelope Strategy

The existing building will be wrapped in a new superinsulated skin to increase the effective thermal resistance of the walls to R-30 and the roof to R-60. After the uninsulated exterior brick and concrete masonry walls are coated in a fluid-applied air and water barrier, prefabricated panels will be installed to create an airtight, highly insulated building envelope. The panels will consist of a light gauge metal framing system with mineral wool cavity insulation (R-10.5), insulated structural sheathing panels with exterior fire retardant (R-21), and a weather resistive barrier wrapped around panel returns and edges. A ceramic-coated panel finished siding will be installed on-site, and all panel joints will be double gasketed and sealed. The panel assembly will be held four inches off the existing facade and will be anchored to the original building structural system. Additional mineral wool will be utilized within the cavity for fire compartmentalization as required.

New Insulated Building Envelope (R-30)



Building Overview

Project name	Fairweather Apartments Salem
Building type	Multifamily residential
Location	Salem, MA
Year built	1968
Status of renovation	In design
Number of stories	6
Number of apartments	127
Floor area	73,920 square feet
Certifications	Phius anticipated

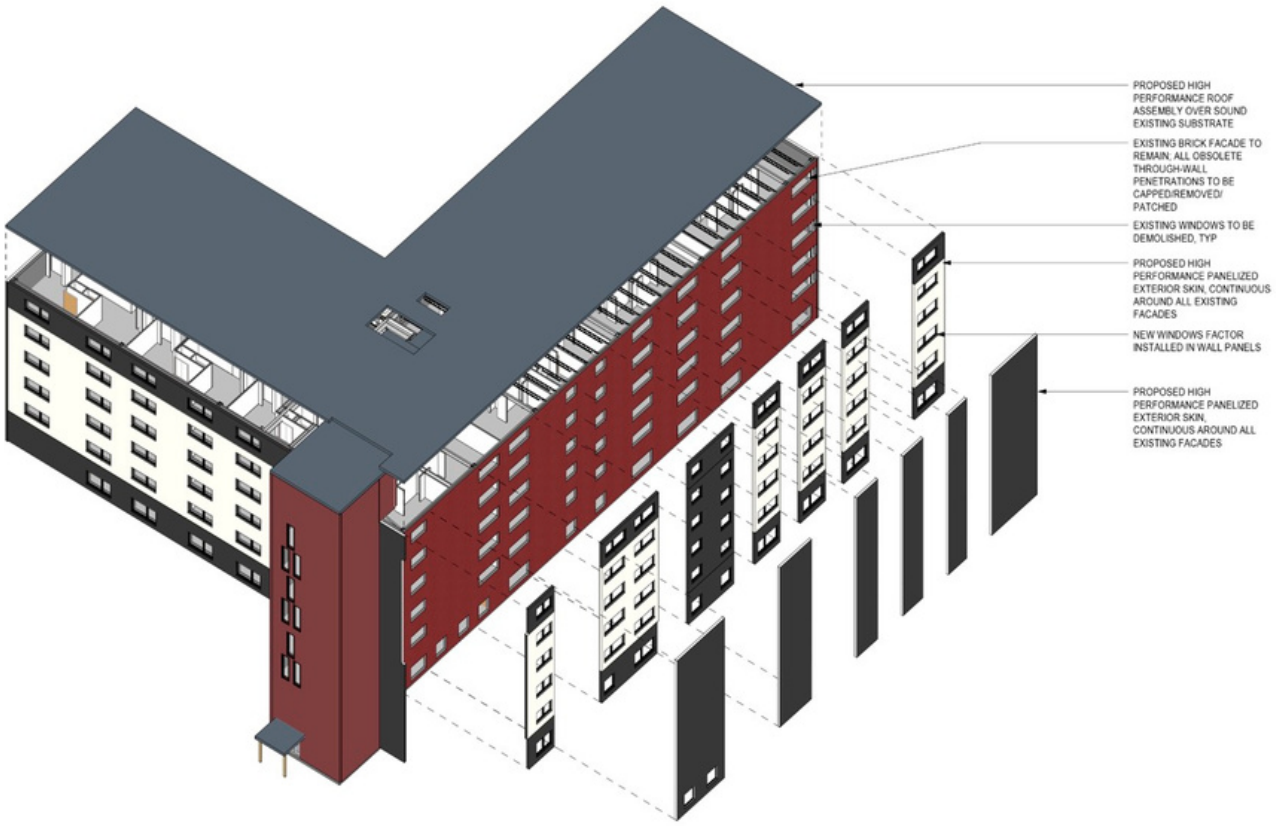
Building Team

Building owner	Preservation of Affordable Housing (POAH)
Architect	Onion Flats Architecture
MEP engineer	Seaman Engineering Corporation
Building scientist	Building Evolution Corporation
Construction manager	Placetailor
Passive house consultant	Onion Flats Architecture

Exterior Insulation Wall System

Wall Insulation	
R-value before	R-4
R-value after	R-30
Roof	
R-value before	R-15
R-value after	R-60
Windows	
U-value before	U-0.36
U-value after	U-0.12
Solar heat gain coefficient (SHGC) before	Unknown
SHGC after	0.36
Target Airtightness	0.97 ACH; 0.06 CFM50

The wall panels will be manufactured off-site with triple-pane windows and doors factory installed. A key aspect of this project is employing a prefabricated, panelized wall solution to demonstrate the effectiveness of the method across cost, timeline, and scalability metrics. Improvements to the roof insulation will include a minimum of six-inch polyisocyanurate continuous insulation installed on the existing roof structure. Additional tapered insulation will be installed atop the six inches to allow for adequate drainage. This will remedy current roofing problem areas where insufficient tapering has caused moisture issues and deterioration of the existing insulation. Because of fire testing requirements for buildings four stories and above, carbon-storing wood fiber insulation was not considered for this property. However, carbon-storing, bio-based materials could theoretically be used on similar buildings with additional investment in preliminary assembly fire testing approvals and compliance.



Rendering by Onion Flats Architecture of panelized facade solution for Fairweather Apartments.

Scope of Work

Exterior Insulation (Walls)

- Fluid-applied air/vapor barrier over existing facade
- Prefabricated, panelized wall solution composed of:
  - 3⅝ inches light gauge metal framing, cavity filled with mineral wool (R-10.5)
  - Magnesium oxide (MgO) insulated structural sheathing panel with exterior fire retardant and peel-and-stick weather-resistant barrier (R-21)
- Ceramic-coated rain screen fiber cement siding
- Steel lateral braces and associated anchoring to existing structure

Exterior Insulation (Roof)

- Minimum of six inches polyisocyanurate continuous insulation
- Additional tapered insulation for drainage
- New TPO membrane

Mechanicals

- Heating and cooling: Central variable refrigerant flow (VRF) system with heat recovery, unitized wall-mounted fan coil units
- Ventilation: Central rooftop energy recovery ventilation (ERV) system
- Domestic hot water: Central air-source heat pump

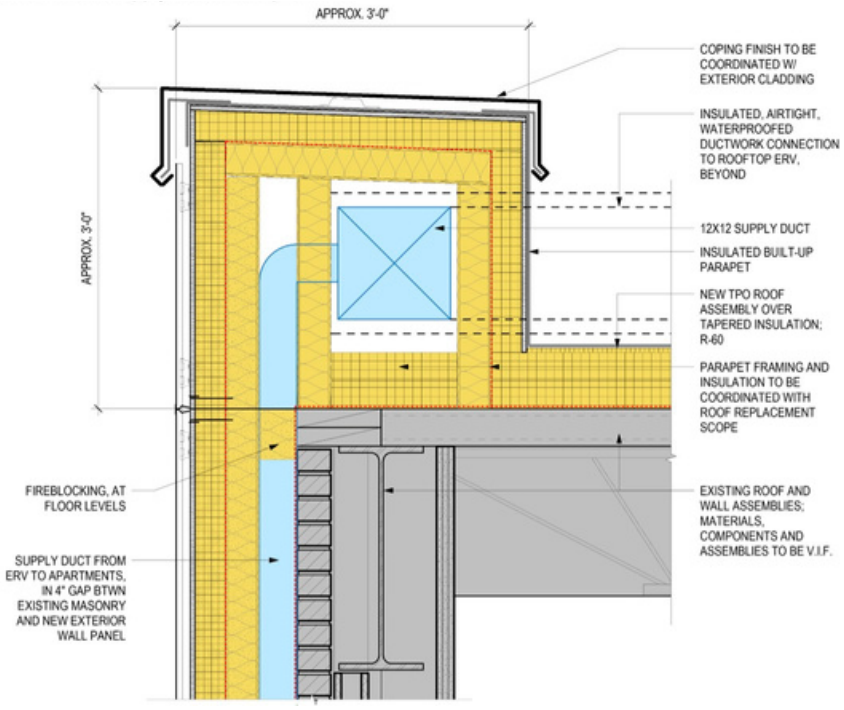
Solar PV

- Rooftop array on available roof area
- Existing 26.7 kW ground array

HVAC Strategy

The apartments are currently served by central gas boilers feeding hydronic baseboards and gas water heaters. Cooling is provided by through-the-wall air conditioning units in each apartment, and an ineffective central ventilation system runs through the common access corridors. The air handling unit does not cool or dehumidify and is often turned off during hot and humid periods. This system will be replaced by a central ERV with three rooftop ERV units. There are preliminary plans to clean and seal existing exhaust ducts using Aeroseal and install new supply ducts that run down the building exterior within the four-inch gap between the existing wall and new panelized envelope.

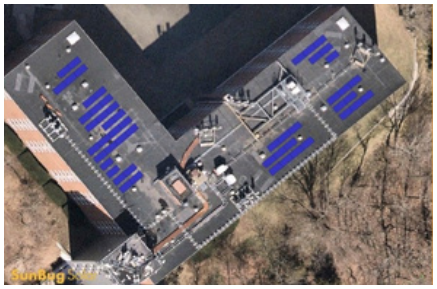
The corroded gas boilers will be replaced by a central VRF system with heat recovery, providing efficient heating and cooling to apartments. The VRF system will require 60 tons of VRF outdoor condensing units located on the roof and branch controllers located either in corridor closets or a rooftop enclosure to minimize the length of refrigerant lines. Within each apartment, a wall-mounted 8,000 Btu fan coil unit (FCU) will allow for individual heating/cooling control with a centralized controller (AE200) monitoring the system. The FCU types and sizes will depend on the apartment size. The mechanical systems have yet to be selected, as the project is still in the early design stage.

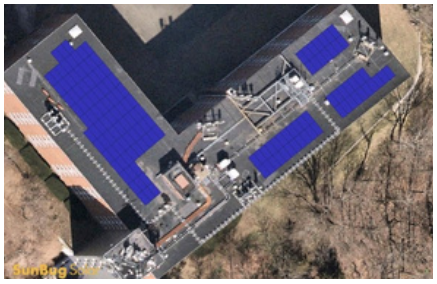


Proposed parapet and supply ductwork routing on the exterior envelope. Rendering by Onion Flats Architecture.

Renewables

Due to extensive tree coverage on-site, limited rooftop space, and rooftop cell towers and equipment, the building will not be able to reach net-zero energy with on-site renewables. While the existing 120-panel, 27.6 kW ground-mounted array will help offset the building's electric load, there are plans to increase on-site rooftop solar. The building team is exploring two options for rooftop solar: a ballasted 23.9 kW array or a mechanically fastened 63.5 kW array. During analysis, it was determined that a vertical wall array was not appropriate for this building. The other Fairweather properties have more favorable conditions for solar energy. Once the scope of the HVAC systems and required ductwork is solidified, options for solar will be reassessed.





Proposed 23.9 kW rooftop array (top left) and 63. kW rooftop array (bottom left). Existing 120-panel 27.6 kW ground array located on site (right).

Cost Breakdown

Anticipated hard construction cost of deep energy retrofit	$10,176,000
Cost per square foot of floor area	$137
Cost per apartment	$80,126
Total cost of exterior insulated envelope assembly (wall and roof)	$3,193,200
Installed panelized wall system cost per square foot of exterior wall surface area	$65
Installed panelized wall system cost per apartment	$19,850

Image: POAH.

realize@rmi.org