**Hano Homes**

Boston, MA

**Hano Homes** in Boston is a zero-carbon deep energy retrofit scheduled for renovation in 2023–2024. This affordable, low-income property of 20 apartments will achieve passive house (Phius) certification and cut its energy usage by 69 percent through energy efficiency and electrification.

The building will be wrapped in a new superinsulated exterior shell and outfitted with all-electric mechanical systems. With rooftop solar, the building will meet all its energy needs with renewables, eliminate fossil fuels altogether, and make Hano Homes net-zero energy in operations. To eliminate embodied carbon emissions from the building materials used in the renovation, the team has specified a carbon-storing, bio-based exterior insulation system. Through this deep energy retrofit, the building will be transformed from a carbon emitter to a building that stores carbon!

### Deep Energy Retrofit Analysis

![Greenhouse Gas Emissions](chart)

- **Historic Annual Emissions**: 105 metric tons CO₂e
- **50% Reduction in Emissions Due to Energy Efficiency and Electrification**: 53 metric tons CO₂e
- **Zero Emissions with Solar and On-Site Storage**: 0 metric tons CO₂e
- **Negative Emissions Due to Carbon Storing Materials**: -5 metric tons CO₂e

**Without Solar**

- **Anticipated energy reduction from energy efficiency and electrification**: 69 percent
- **Energy use intensity (EUI) before retrofit**: 75.2 kBtu/sf
- **Modeled EUI after retrofit**: 23.2 kBtu/sf
- **Anticipated greenhouse gas (GHG) emissions reduction with current electricity supply**: 50 percent

**With Solar**

- **Total load served by renewables**: 100 percent
- **Solar PV system**: 100-110 kW
- **Anticipated energy reduction with solar**: 100 percent
- **Modeled EUI with solar**: 0 kBtu/sf
- **Anticipated GHG emissions reduction with solar with current electricity supply**: 100 percent

*Assumes the Renewable Energy Credits (RECs) from on-site solar remain with the property and are not sold to a third party.
**Building Envelope Strategy**

As with many cold-climate deep energy retrofits, the existing buildings will be wrapped in a new superinsulated skin to increase the thermal resistance of the walls to R-36.8 and the roof to R-59.1. After stripping the existing siding down to the original sheathing, new 7/16 inch ZIP System Wall Sheathing will be attached to the original leaky wood plank sheathing to act as an air barrier and provide structural reinforcement. Eight inches of carbon-storing wood fiber insulation will be installed. A weather-resistant barrier and strapping will be attached to the wood fiber insulation and will be finished with James Hardie fiber cement siding.

**Building Overview**

<table>
<thead>
<tr>
<th>Project name</th>
<th>Hano Homes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building type</td>
<td>Multifamily residential</td>
</tr>
<tr>
<td>Location</td>
<td>Boston, MA</td>
</tr>
<tr>
<td>Year built</td>
<td>1888</td>
</tr>
<tr>
<td>Status of renovation</td>
<td>In design; planned for 2023-2024</td>
</tr>
<tr>
<td>Number of stories</td>
<td>2</td>
</tr>
<tr>
<td>Number of apartments</td>
<td>20</td>
</tr>
<tr>
<td>Floor area</td>
<td>24,083 square feet</td>
</tr>
<tr>
<td>Certifications</td>
<td>Phius anticipated</td>
</tr>
</tbody>
</table>

**Building Team**

- **Building owner**: Allston Brighton CDC
- **Architect**: Onion Flats Architecture
- **MEP engineer**: TBD
- **Building scientist**: Onion Flats Architecture
- **Construction manager**: Placetailor
- **Passive house consultant**: Onion Flats Architecture

Existing 4x4" wooden stud framing with old fiberglass insulation

Layers of exterior siding stripped down to existing wood sheathing

7/16" ZIP sheathing panel as an air barrier

8" wood fiber insulation (R-28.8)

Weather-resistant barrier

New rain screen with furring strips and James Hardie siding
**Exterior Insulation Wall System**

**Wall Insulation**
- R-value before: R-10
- R-value after: R-36.8

**Roof**
- R-value before: R-20
- R-value after: R-59.1

**Windows**
- U-value before: U-0.39
- U-value after: U-0.16
- Solar heat gain coefficient (SHGC) before: Unknown
- SHGC after: 0.31

**Target Airtightness**
- 1.79 ACH; 0.06 CFM50

One of the most challenging elements of this exterior retrofit is the unique, irregular building footprint. Construction is further complicated by site-specific physical constraints, such as limited street access and overhead wires, which prompted the team to adopt a site-built strategy for exterior insulation rather than utilizing prefabricated panels. With a complicated building facade and existing site challenges, Hano Homes must adopt multiple approaches to address the building envelope efficiently.
## Scope of Work

<table>
<thead>
<tr>
<th>Exterior Insulation (Walls)</th>
<th>Exterior Insulation (Roof)</th>
<th>Mechanicals</th>
<th>Solar PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 7/16 inch ZIP System Wall Sheathing (air barrier)</td>
<td>- Blown-in dense-packed cellulose in existing roof frame (R-3.7/inch)</td>
<td>- Heating, cooling, and ventilation: All-electric Minotair combined ERV and air-source heat pump units</td>
<td>- Rooftop 100–110 kW solar PV system</td>
</tr>
<tr>
<td>- 8 inches wood fiber insulation (R-28.8)</td>
<td>- 6 inches wood fiber insulation (R-21.6)</td>
<td>- Domestic hot water: All-electric heat pump hot water heaters</td>
<td></td>
</tr>
<tr>
<td>- New furring strips and James Hardie siding</td>
<td>- EPDM membrane</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### HVAC Strategy

Built in 1888, the apartments are currently served by central gas boilers and gas water heaters with no cooling or ventilation. They will be replaced by a decentralized system with compact air treatment units from Minotair in the existing basements of each apartment to supply ventilation, heating, and cooling. The Minotair Pentacare V12 is a multifunctional electric unit with a self-contained heat pump, air exchanger, dehumidifier, and high-efficiency particulate air filtration. Heat pump water heaters will replace gas water heaters, eliminate all on-site gas consumption, and make the building fully electric. Each apartment will be served by its own Minotair unit, individually ducted from the basement and run within the new building envelope. The ductwork remains minimal and cost-effective because of the short runs. New exhaust ductwork will tie into existing direct vented exhaust lines from the kitchen and bathrooms.
Renewables

With ample roof space for a solar array that will power the entire building complex, Hano Homes is on track to be a net-zero energy building with increased indoor air quality and thermal comfort for residents. It will also achieve Phius certification. The flat roof will allow for a solar PV system estimated at 100–110 kW. With a new, highly efficient building envelope and electrified mechanical systems, the building can achieve 69 percent energy savings, bringing down the existing EUI from 75.2 kBTU/sf to 23 kBTU/sf. After reaching these energy efficiency goals, the solar array is intended to supply 100 percent of energy demands, saving Hano Homes $43,566 in annual utility costs.

Cost Breakdown

- Anticipated hard construction cost of deep energy retrofit: $3,039,995
- Cost per square foot of floor area: $122
- Cost per apartment: $152,000
- Total cost of exterior insulated envelope assembly (wall and roof): $1,757,855
- Installed exterior envelope assembly cost per square foot of exterior wall surface area: $178
- Installed exterior envelope assembly cost per apartment: $87,893