



## Building America Case Study

# BrightBuilt Home, Modular Zero Energy

Portland, Maine

### PROJECT INFORMATION

**Construction:** New home

**Type:** Single-family

**Partners:**

Consortium for Advanced Residential Buildings, [carb-swa.com](http://carb-swa.com)

BrightBuilt Home, Portland, ME, [brightbuilthome.com](http://brightbuilthome.com)

Black Bros. Builders Inc., Rockland, ME, [blackbrosbuilders.com](http://blackbrosbuilders.com)

Keiser Homes, Oxford, ME, [keisermaine.com](http://keisermaine.com)

**Size:** 3,161 ft<sup>2</sup> gross including basement

**Construction Cost:** \$168/ft<sup>2</sup>

**Date Completed:** 2015

**Climate Zone:** Cold, moist 6A

When done well, modular home production can provide lower costs and excellent quality control (QC)—compared to conventional home building methods—while still allowing a great deal of customization. The Consortium for Advanced Residential Buildings (CARB) is a U.S. Department of Energy Building America team that worked with three Maine companies to compare standard code-compliant modular homes with a modular zero energy home. Those companies were BrightBuilt Home (BBH), Black Bros. Builders, and Keiser Homes.

The home pictured here, which is in Lincolnville, Maine, includes many BBH standard features such as: R-35+ walls, triple-pane windows, efficient air-source heat pumps, and an efficient heat-recovery ventilator. The modular boxes were manufactured in Oxford, Maine, by Keiser Homes. At the site, Black Bros. Builders oversaw setting the boxes and completed exterior extruded polystyrene (XPS) insulation, siding, roofing, all finishes, and heating, ventilating, and air conditioning. Although the boxes themselves were well air-sealed and insulated, the marriage walls, gables, and penetrations needed additional attention on site. Early blower-door tests showed infiltration below 1 air change per hour at 50 pascals (ACH<sub>50</sub>).

### PERFORMANCE DATA

HERS index: 14 with photovoltaics (PV) (preliminary), 35 without PV (preliminary)

Source energy savings: 41% without PV, 77% with PV

Projected annual energy cost: \$770, savings of \$2,400 over Building America benchmark



To protect heat pumps from snow and ice, outdoor units are covered and mounted well above the ground.

## Key Energy Systems in Lincolnvile BrightBuilt Home

### HVAC

- Three air-source heat pumps (two ductless and one ducted) with Heating Seasonal Performance Factor of 10–11 and Seasonal Energy Efficiency Ratio of 19–26
- All ducts and equipment inside the thermal envelope
- Balanced ventilation with heat-recovery ventilator.

### ENVELOPE

- Standing-seam metal roof greater than R-20, 4" XPS
- R-20 dense cellulose in 2×6 rafters
- R-25 cellulose in 2×4 double-stud walls. Two inches (R-10) of XPS on exterior and “smart” vapor retarder on interior
- Triple-pane low-e vinyl windows U-factor: 0.21
- Solar heat gain coefficient: 0.24
- R-22 insulated concrete form foundation
- Air sealing to achieve <1 ACH50.

### LIGHTING, APPLIANCES, AND WATER HEATING

- Light-emitting diode lighting
- ENERGY STAR® appliances
- Centrally located heat-pump water heater, 80 gal, 2.33 energy factor.

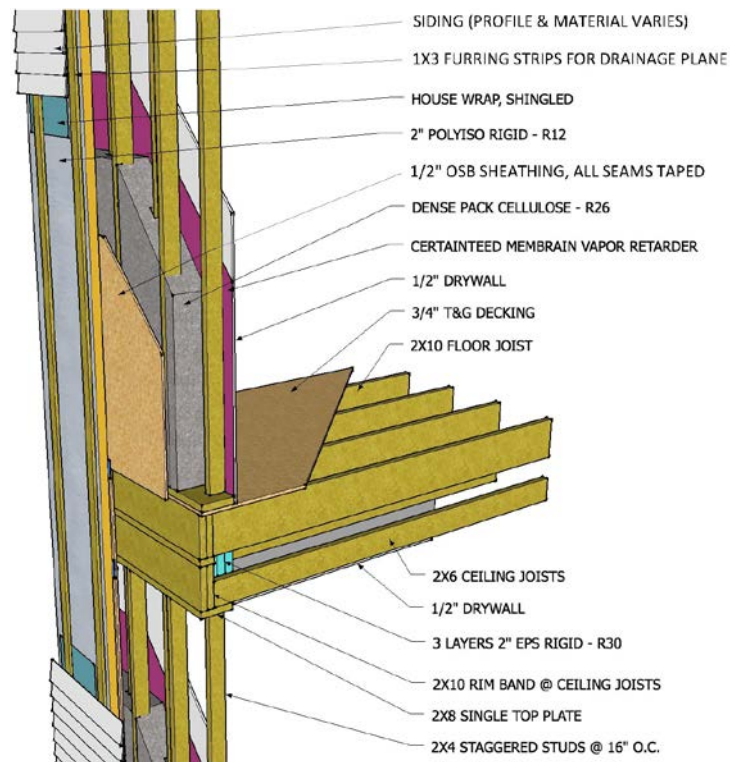
### RENEWABLES

- 7 kW of PV expected to provide most—if not all—energy needs.

For more information see the Building America Report *Modular Zero Energy: BrightBuilt Home* at [buildingamerica.gov](http://buildingamerica.gov).

Image credit: All images were created by BuiltBright Home.

The BBH wall system consists of staggered 2×4 stud walls on 2×8 plates. Additional insulation is provided by 2" exterior foam.



### Lessons Learned

- Compared to standard, code-compliant modular homes, performance features in homes by BrightBuilt Home typically add \$11–\$15 per square foot of floor area to the costs from the factory. Additional premiums are incurred on site, but Black Bros. is still able to deliver BBH homes at prices similar to those of code-compliant site-built speculation homes. At the home in Lincolnvile, BEopt™ modeling shows annual energy savings of \$2,400 above the Building America benchmark.
- Although modular production can provide benefits related to cost, construction time, and QC, there are challenges as well. When determining which BBH wall system to use, cost and performance were not the only considerations. The team also needed to design walls that could be built quickly without slowing the production line.
- With more parties involved in modular design and construction, there is some added potential for miscommunication and QC gaps. BBH has implemented checks and approval processes to limit problems. Home Energy Rating System (HERS) ratings and ENERGY STAR certification of all homes are now used to assist in QC.
- There is demand for these homes. BBH has completed 25 homes, 16 are under construction, and there is customer interest in dozens more. BBH now has agreements with modular manufacturers in New Hampshire and Pennsylvania to expand its geographic range.