Building America Case Study

Whole-House Solutions for New Homes

Transformations, Inc. Net Zero Energy Communities

Devens, Easthampton, Townsend, Massachusetts

PROJECT INFORMATION

Construction: New home

Type: Single-family, market-rate and affordable

Builder: Transformations, Inc. *www.transformations-inc.com*

Size: 1,064 to 2,365 ft^2

Price Range: $125,000-$400,000

Date Completed: 2010-ongoing

Climate Zone: Cold

PERFORMANCE DATA

HERS Index Range: -21 to 43

Projected annual energy cost: $88*

Incremental cost of energy efficiency measures: $3/ft^2*

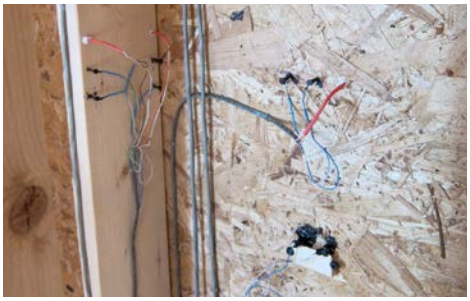
Incremental annual mortgage: $535*

Billing data: Not available

*Cost based on one of the developer's standard designs, the "Farmhouse," and compared with the 2009 International Residential Code

In 2009, Transformations, Inc. partnered with U.S. Department of Energy (DOE) Building America team Building Science Corporation (BSC) to build new net zero energy houses in three developments in Massachusetts. The company has been developing strategies for cost-effective super-insulated homes in the New England market since 2006. After years of using various construction techniques, it has developed a specific set of assemblies and specifications that achieve a 44.9% reduction in energy use compared with a home built to the 2009 International Residential Code, qualifying the houses for the DOE's Challenge Home.

The super-insulated houses provide data for several research topics in a cold climate. BSC studied the moisture risks in double stud walls insulated with open cell spray foam and cellulose. The mini-split air source heat pump (ASHP) research focused on the range of temperatures experienced in bedrooms as well as the homeowners' perceptions of equipment performance. BSC also examined the developer's financing options for the photovoltaic (PV) systems, which take advantage of Solar Renewable Energy Certificates, local incentives, and state and federal tax credits.



Moisture monitoring sensors were installed at one of the houses in Devens to determine the moisture risks of 12-in.-thick double stud walls insulated with cellulose or open cell spray foam. Six stud bays with three different wall constructions on both the north and south walls of the house were selected. The walls were 12 in. of open cell spray foam, 12 in. of netted and dry blown-in cellulose, and 5.5 in. of open cell spray foam at exterior of the double stud wall to approximate conventional 2×6 construction and insulation levels.

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Key Energy Efficiency Measures

HVAC

- 23 ASHP, two heads per house, one on each floor (open living area on first floor and hallway on second floor)
- Whole-house ventilation with exhaust-only fans, energy recovery ventilator or heat recovery ventilator
- Kitchen and bath fans vent outside

ENVELOPE

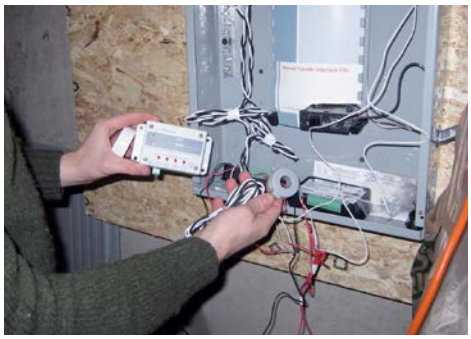
- R-63 blown cellulose ceiling insulation in vented attic
- R-46 open cell spray foam insulation in 2×4 double stud frame wall
- R-20 closed cell spray foam insulation at foundation walls
- R-10 extruded polystyrene (XPS) rigid foam insulation below slab in full basement
- R-30 XPS rigid foam insulation below slab in slab-on-grade
- Triple-pane, low-e vinyl windows, U = 0.21, solar heat gain coefficient = 0.19
- Infiltration Range: 0.7-1.9 air changes per hour at 50 Pascals
- PV System Range: 7-18 kW

LIGHTING, APPLIANCES, AND WATER HEATING:

- 100% compact fluorescent lighting
- ENERGY STAR® appliances
- Tankless gas (Energy Factor [EF] = 0.96) or propane (EF = 0.97) water heater

For more information, see the Building America report, *Transformations, Inc. Net Zero Energy Communities,* at *www.buildingamerica.gov*

Image credit: All images were created by the BSC team.



To determine the range of temperatures experienced in bedrooms of homes heated by point sources, data loggers were installed at two unoccupied and two occupied houses. Monitoring of the unoccupied houses began in July 2011 and data from the installed loggers was collected in July 2012. The sensors in the occupied homes in the Easthampton development were installed in May 2012; the data has yet to be collected.

Lessons Learned

- The first winter showed sheathing moisture contents high enough to cause concern in the double stud cellulose walls, but acceptable conditions in the remaining walls. However, all walls dried to safe ranges in the summer; seasonal drying is expected behavior. In addition, it is possible that the cellulose wall can withstand high moisture content levels without damage due to borate preservatives and moisture storage. High winter moisture content might not compromise the durability of the walls if temperatures are sufficiently low during wet periods, thus inhibiting mold growth. BSC will continue collecting the data for the winter of 2013–2014 and possibly longer.
- The first year of data from the unoccupied homes show that under favorable conditions, mini-split heat pumps can provide thermal comfort and uniformity equal to conventional forced air systems. Once the homes were occupied, residents reported high levels of comfort, consistent with the measured temperature uniformity. Most occupants seem to accept the concept of keeping bedroom doors open most of the time, facilitating thermal distribution and thus enhancing comfort. BSC collected data through the winter of 2012–2013 and is continuing its monitoring through winter 2013–2014.
- With the help of local incentives as well as state and federal tax credits, Transformations, Inc. was able to create three viable options for financing a PV system—the lease option and two purchase options—that can suit a number of buyers of both market rate and affordable homes. Incentive programs may vary significantly in other states; therefore, buyers are encouraged to learn details about available programs in their area.

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

For more information, visit:
www.buildingamerica.gov

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The U.S. Department of Energy's Building America program is engineering the American home for energy performance, durability, quality, affordability, and comfort.

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