Building America Case Study
Whole-House Solutions for New Homes

The Performance House: A Cold Climate Challenge Home

Old Greenwich, Connecticut

PROJECT INFORMATION

Project Name: Performance House

Location: Old Greenwich, CT

Partners:

Preferred Builders Inc.
www.preferredbuilders.biz

Consortium for Advanced Residential Buildings
www.carb-swa.com

Size: 2,700 ft^2 plus basement

Year Completed: 2012

Climate Zone: Cold

PERFORMANCE DATA

Source Energy Savings: 30.9%

HERS Index: 43 (20 with PV)

Projected Annual Utility Costs: $2,508; $795 with PV

Incremental Cost of Energy Efficiency Measures: $47,337 (excluding PV)

Savings-to-Investment Ratio (over 15 years):

- Solution Package (SP) = 0.29
- SP with Incentives = 0.34
- SP with Solar = 0.52
- SP with Solar & Incentives = 0.82

Building America U.S. Department of Energy

By working with builder partners on test homes, researchers from the U.S. Department of Energy's Building America program can vet whole-house building strategies and avoid potential unintended consequences of implementing untested solution packages on a production scale. To support this research, Building America team Consortium for Advanced Residential Buildings (CARB) partnered with Preferred Builders Inc. on a high-performance test home in Old Greenwich, Connecticut. The philosophy and science behind the 2,700 ft^2 "Performance House" was based on the premise that homes should be safe, healthy, comfortable, durable, efficient, and adaptable to the needs of homeowners. The technologies and strategies used in the "Performance House" were best practices rather than cutting edge, with a focus on simplicity in construction, maintenance, and operation. Achieving 30% source energy savings compared with a home built to the 2009 International Energy Conservation Code in the cold climate zone requires that nearly all components and systems be optimized. Careful planning and design are critical.

The end result was a DOE Challenge Home that achieved a Home Energy Rating System (HERS) Index Score of 20 (43 without photovoltaics [PV]). To help builders and architects match the performance of this home, a step-by-step guide through the building shell components is provided in the technical report associated with this project.

For this home, achieving 30% source energy savings while maintaining traditional systems required pushing to the point of diminishing returns on investment (based solely on the annualized energy related costs) at current market costs. The largest cost impediment was related to the light-emitting diode (LED) lighting. Of course, this cost analysis doesn't account for the numerous ancillary benefits (indoor environmental quality, comfort, durability, etc.) of this solutions package.

Key Energy Efficiency Measures

HVAC AND WATER HEATING:

- Two 1.5 ton seasonal energy efficiency ratio 16 single-stage air conditioners
- Two hydro-coils (24 kBtu/hr heating capacity) with variable-speed fans
- Natural gas wall-mounted boiler, 96% annual fuel utilization efficiency
- Ducts and air handling units located within thermal/air barrier. Less than 2 cfm/100 ft^2 total leakage
- Energy recovery ventilator with CO_2 override control
- All exhaust fans vented to outside

ENVELOPE:

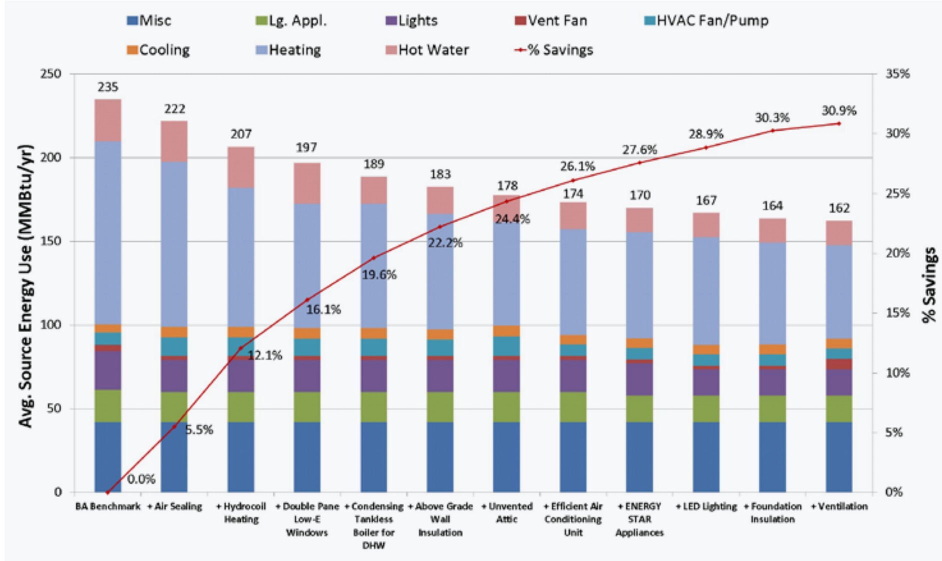
- Closed-cell spray polyurethane foam (ccSPF) on interior foundation wall (R-20) and under the slab (R-13)
- 1.5 in. of extruded polystyrene (R-7.5) over sheathing, Owens Corning Energy Complete system, and R-21 blown cavity insulation
- Unvented attic with 5.5 in.ccSPF (R-36), 3.5 in. foil-faced fiberglass (R-13), and cool roof (solar reflectance index = 29)
- Dual pane, low-e windows w/vinyl frame (U-0.28/solar heat gain coefficient-0.27)
- Tightly sealed, air changes per hour at 50 pascals = 1.0

LIGHTING, APPLIANCES, AND MISCELLANEOUS:

- 100% LED lighting
- ENERGY STAR® appliances
- Energy monitoring system

For more Information, see the Building America report: *The Performance Home: A Cold Climate Challenge Home*, at *www.buildingamerica.gov*

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



CARB used the National Renewable Energy Laboratory's BEopt energy simulation software to analyze each of the energy efficiency measures for optimized whole-building performance.

Lessons Learned

- A successful project requires that an integrated project team including the builder, architect, heating, ventilating, and air-conditioning (HVAC) contractor, third-party verifier, and owner work through design challenges before building.
- Exterior insulation was limited to 1.5 in. of extruded polystyrene so that finishing details around windows and doors met manufacturers' guidelines and avoided cladding warranty issues (several major manufacturer installation guidelines limit thickness of exterior insulation under cladding to 1.5 in. unless furring strips are used).
- Care must be taken during the design and commissioning process to ensure that hydrocoil return water temperatures to the boiler are less than 130°F (low enough to promote condensation of combustion vapors) in order to achieve high system efficiencies.
- During one of the inspections, the builder noticed some shrinkage of the closed cell spray foam in the rim/band joist area of the foundation wall. It is theorized that there was moisture on the foundation shelf. Water can react with the blowing agent to form carbon dioxide (CO_2), which may have pushed the foam off the surface as it was setting up.

"Building science is a big part [of the design process], especially with new products that have come out. Everything needs to be compatible with each other. It starts by design and planning well before construction begins."

– Peter Fusaro, Graduate Master Builder, Preferred Builders Inc.

Source: Greenwich Post 2012

U.S. DEPARTMENT OF ENERGY
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