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

BUILDING TECHNOLOGIES PROGRAM

Building America
Efficient Solutions for Existing Homes

Case Study: Deep Energy Retrofit in the Pacific Northwest

Portland, Oregon

PROJECT INFORMATION

Construction: Retrofit

Type: Single-family, total rehab of foreclosed home

Retrofit Contractor: Homeowner

Size: 2,430 ft^2 including conditioned basement

Date Retrofit Completed: November 2011

Climate Zone: Marine

PERFORMANCE DATA

HERS Index:
Pre-retrofit = unknown
Post-retrofit = 68

Air Leakage:
Pre-retrofit = unknown
Post-retrofit = 5.9 ACH50

Duct Leakage:
Pre-retrofit = unknown
Post-retrofit = 50 cfm25 to out

Projected annual energy cost:
$1,400/yr

Total cost of efficiency improvements:
$38,300

Building America® U.S. Department of Energy

Project Description

This one-and-a-half-story, two-bedroom home with a half-basement is typical of 100-year-old homes in Portland, Oregon. The home had no insulation, an unfinished basement, old appliances and air leaks everywhere when purchased by its current owner in 2010. The owner performed a full deep energy retrofit, including air sealing and insulation exterior walls and attic and installing new, efficient appliances. Building America researchers from the Pacific Northwest National Laboratory audited the home after the retrofits had occurred and used Energy Gauge USA simulation software to predict energy savings. They also partnered with local home performance contractor Imagine Energy to meter the circuit-level electricity use and the natural gas use of the tankless hot water heater and 95% condensing gas furnace. Based on these calculations, the retrofit home achieved a HERS score of 68.

(left) In the crawlspace, R-30 fiberglass batts were installed between the 2x10 floor joists. The joists were then covered with 1 inch of expanded polystyrene (EPS) rigid foam board that was taped at the seams to provide a continuous air barrier and flashed at the edges to protect against rodents. The crawlspace floor was covered with a 6-mil visquene vapor barrier.

(right) On the lower 4 ft of the concrete basement walls 1" EPS was installed. Then a new 2-ft-high concrete stem wall was added in front of the rigid foam to support the aging existing foundation wall. The upper portion of the wall was covered with a plastic vapor barrier and framed with 2x4 studs; R-15 faced fiberglass batts were installed between the studs. Taped and mudded sheetrock provided a fire barrier, air barrier, and finished look to the basement wall assembly

KEY ENERGY EFFICIENCY MEASURES

HVAC:

- 95% condensing, sealed-combustion gas furnace located in attic
- 2-ton, SEER 13 air conditioner
- All ducts are insulated flex duct, sealed with mastic and located in insulated attic space.

Envelope and Windows:

- Exterior walls were insulated with blown-in cellulose; 1 inch extruded polystyrene (XPS) rigid foam was installed over old siding and covered with new Hardiplank siding for R-17.
- Basement walls were lined with vapor barrier, framed with 2x4s, and insulated with R-15 faced fiberglass batts and/or rigid EPS.
- Crawlspace was insulated with R-30 fiberglass batts between floor joists and 1 inch of EPS rigid foam below joists, taped at the seams and rimmed with metal flashing.
- Partial cathedral ceiling was insulated with 3 inches EPS foam board below the rafters. Flat attic floor insulated with two layers of R-21 fiberglass batt or one layer R-15 batt plus 10 inches blown cellulose. Kneewalls were covered with 1 inch EPS and filled with blown cellulose.
- All operable windows were replaced with double-pane, wood-framed, metal-clad windows. Custom, double-pane storm windows were added to fixed windows.

Lighting, Appliances, and Water Heating:

- ENERGY STAR® refrigerator, dishwasher, and washer
- 0.85 EF natural gas tankless hot water heater

New high-efficiency heating and cooling equipment, water heater, and appliances lower energy consumption and improve indoor air quality.

(left) A 0.85 EF tankless hot water heater eliminates standby energy consumption.

(right) The 95% AFUE, sealed-combustion gas furnace and well-insulated and sealed ducts, are located in an insulated but air and vapor permeable side attic.

Lessons Learned

- The homeowner avoided lead paint remediation costs by installing rigid foam insulation and new fiber-cement siding directly over the old exterior lead-painted wood siding.
- The homeowner kept the charming but air-leaking diamond-paned fixed windows and covered them with wood-framed, double-paned glass storm windows built on site. These were more efficient than single-pane metal-framed storm windows and a better fit with the home's historic character.
- Rigid foam insulation was used on the walls, under floor joists and in the attic wherever possible to add insulation value, stop air leaks, and reduce thermal bridging. The rigid foam enclosed open attic kneewalls to hold blown-in insulation where nonstandard stud spacing prevented the use of batt insulation.
- Conducting a pre-retrofit assessment and planning ahead might have reduced the number of contractor visits.

"Decision to cover the old siding allowed us to drill-and-fill and install wiring without disturbing the lath and plaster walls and original woodwork inside. The new rigid foam and exterior siding encased the old lead-painted walls and decreased infiltration through the walls."

Homeowner

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PNNL-SA-84955 • December 2011

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