Building America Case Study

Retrofitting a 1960s Split-Level Cold-Climate Home

Westport, Connecticut

PROJECT INFORMATION

Construction: Existing home

Type: Single-family, split-level

Partners:

General Contractor: Preferred Builders, *preferredbuilders.biz*

Consortium for Advanced Residential Buildings, *carb-swa.com*

Size: 1,712 ft^2

Date Completed: 1960

Climate Zone: Cold (5A)

PERFORMANCE DATA

HERS Index:

Pre-retrofit = 114

Post-retrofit:

- With PV = 26
- Without PV = 56

Validated annual energy cost savings:

- With PV = $4,032
- Without PV = $2,199

Simple payback with PV:

- With incentives = 13.2 years
- Without incentives = 17.9 years

Simple payback without PV:

- With incentives = 18.2 years
- Without incentives = 20.8 years

Building America U.S. Department of Energy

The U.S. Department of Energy Building America team Consortium for Advanced Residential Buildings (CARB) partnered with Preferred Builders and the owners of a 1960s split-level home in Westport, Connecticut, to evaluate and implement a cost-effective solution package to reduce energy use and costs by 30%. In addition to reducing annual operational and maintenance costs, the homeowners wanted to eliminate oil heating and enhance their comfort. The initial inspection revealed that improved indoor environmental quality would also need to be addressed because of pests and other hazards. The kitchen and bathrooms had already been updated, so the energy-efficiency measures had to be as nonintrusive to the interior finishes as possible.

The solution package focused on improving the building envelope, upgrading the space-conditioning system (before adding a 5.2-kW photovoltaic [PV] array), and installing new lighting and ENERGY STAR® appliances. Subsequently, the source energy savings were calculated to be 30.2% without PV generation (65.5% with PV). From a homeowner's perspective, the critical criterion was operational cost reductions, which were a savings of 38.4% without PV and 70.3% with PV. In terms of comfort, the mechanical systems were able to maintain temperatures at ±2°F from the set point during the winter and at ±3°F during the summer; relative humidity levels were in desirable ranges (25%–45% for the winter and 48%–62% for the summer).

The siding replacement provided an opportunity to properly insulate the walls. A strip of sheathing was removed along the perimeter of the home to allow the old batt insulation to be removed. Once the sheathing was repaired, holes were drilled and cellulose was blown into the wall cavities. An infrared camera was used to verify that the walls were completely filled.

DESCRIPTION

- 95% annual fuel utilization efficiency sealed combustion natural gas condensing boiler feeding hydronic baseboards with variable-speed circulation pump
- Seasonal energy-efficiency ratio 15.5/8.7 heating seasonal performance factor multiport air-source heat pump. Wall-mounted and ceiling cassette indoor units
- Negative pressure whole-house ventilation system (continuous bathroom exhaust fan)
- Passive radon vent pipe system with crawl space exhaust fan and ground vapor barrier.

ENVELOPE

- R-13 dense-packed cellulose insulation in 2 × 4 frame walls
- 7 in. of ccSPF (R-40) at roof deck in unvented attic. 3.5 in. of ccSPF (R-20) plus 6 in. of dense-packed cellulose (R-24) in cathedral ceilings.
- Double-pane, low-e, vinyl windows. U = 0.35, solar heat gain coefficient = 0.28
- Tightly air-sealed house (ACH50 = 1.9) with exterior plywood sheathing taped at seams and ccSPF blocking at floor joists and garage wall intersections.

LIGHTING, APPLIANCES, AND WATER HEATING

- 100% light-emitting diode bulbs
- ENERGY STAR exhaust fans
- ENERGY STAR refrigerator
- ENERGY STAR dishwasher
- ENERGY STAR clothes washer
- Combi-boiler feeds a 10-gal storage tank

For more information see the Building America technical report *Retrofitting a 1960s Split-Level, Cold-Climate Home* at *buildings.energy.gov*.

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

The vented attic over the bedrooms was converted to warm storage by applying closed-cell spray polyurethane foam (ccSPF) to the roof deck to make an unvented attic. In the cathedral ceilings, drywall was removed to allow for 3 in. of ccSPF to be applied to the roof deck before dense-packing the remaining roof rafters with cellulose.

Approach to Retrofitting Existing Building Enclosures

In existing homes, energy-efficiency options are limited, especially if the owners want to maintain interior finishes. In this project:

- The exterior siding was already in poor condition and was due for replacement. This provided an ideal opportunity to insulate the exterior wall cavities with dense-packed insulation and to seal the exterior air barrier by taping the sheathing joints.
- If the casing and trim details around the windows, doors, and roof could have been installed without significant added cost and complication, an inch or more of exterior rigid insulation would have been beneficial. The rigid insulation (with seams taped) could also act as the drainage plane to minimize condensation risk within the wall cavity, improve overall airtightness of the building enclosure, and provide more sound attenuation inside the home.
- In attic spaces, the two primary insulating options are to air seal the ceiling plane before applying loose-fill insulation and to apply ccSPF to the roof deck. The homeowners wanted to keep the storage space, so ccSPF was applied to the roof deck to create an unvented attic.
- Cathedral ceilings present unique challenges. No unobtrusive methods are currently available to insulate the rafter cavities. Many builders still install dense-packed insulation into cathedral ceilings, but this can cause condensation. Exposing the rafter spaces is unavoidable, so careful coordination of trades is essential to ensure speedy completion of air sealing, insulating, and refinishing of the ceiling.

U.S. DEPARTMENT OF
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DOE/GO-102015-4692 • August 2015