Building America
U.S. Department of Energy
Research Toward Zero Energy Homes

COMPREHENSIVE ENERGY RETROFIT

Case Study:

Chesapeake Habitat for Humanity
Baltimore, MD

Building America's CARB team provided technical assistance to Chesapeake Habitat for Humanity to rehabilitate this and three other row houses on Cross St. in Baltimore.

In 2006, Chesapeake Habitat for Humanity renovated four row houses in Baltimore using Building America's best practices for achieving increased energy efficiency. At the same time, they renovated a fifth row house on the same street using their standard building techniques. During testing, the Building America rehabs consumed 32% less energy than the standard rehab.

"The control house was barely meeting code requirements," said Matt Metzger, the Construction Director with Chesapeake Habitat for Humanity. "It was definitely a significant difference."

Row houses have been prominent in Baltimore's architecture for centuries, with over 140,000 still standing today. Many are abandoned. Since 1982, Chesapeake Habitat for Humanity has renovated over 100 row houses in the city for low-income families.

In 2006, Chesapeake Habitat for Humanity used a grant from the Maryland Energy Administration through the U.S. Department of Energy's Building America program to develop a "template" for improving the energy efficiency and green features of their rehabilitated homes. The Consortium for Advanced Residential Buildings (CARB), which is a Building America team led by Steven Winter Associates, provided technical direction.

"We are still applying what we learned," said Metzger. "A lot of our techniques and strategies for envelope sealing, which has really been the Achilles heel of our projects, came out of this original work with Steven Winter."

Energy Efficient Features

In planning meetings, the team identified sealing of the building envelope as the key to successfully reaching their energy efficiency goals. "A lot of the structures are 80 to 120 years old, air leakage was the challenge," said Metzger.

Improved Building Envelope

Sealing the building envelope started with the walls. "We have been trying to find the ideal wall assembly for dealing with these old brick shells," said Metzger. The builder's standard practice was to stud out the above-grade walls and fill the cavities with fiberglass batts. However, this method allowed for a significant amount of heat loss through the framing. To avoid this thermal bridging at the studs, volunteers with direction from Steven Winter Associates

BUILDER PROFILE

Chesapeake Habitat for Humanity (CHfH)
Baltimore, Maryland
410-366-1250
www.chesapeakehfh.org

Founded: 1982

Number of Staff: 45 (Recently merged with another Habitat affiliate) with up to 500 volunteers working on each house

Featured project:
Rehabilitated five 2-story row houses at W. Cross St. and Bayard St. in Baltimore, MD

Size:
4 rehabs following Building America guidelines and 1 rehab as a control house following minimum code requirements

Square Footage:
Living space is 836 sq. ft., basement area is 412 sq. ft. (two bedrooms, one bath, and a basement)

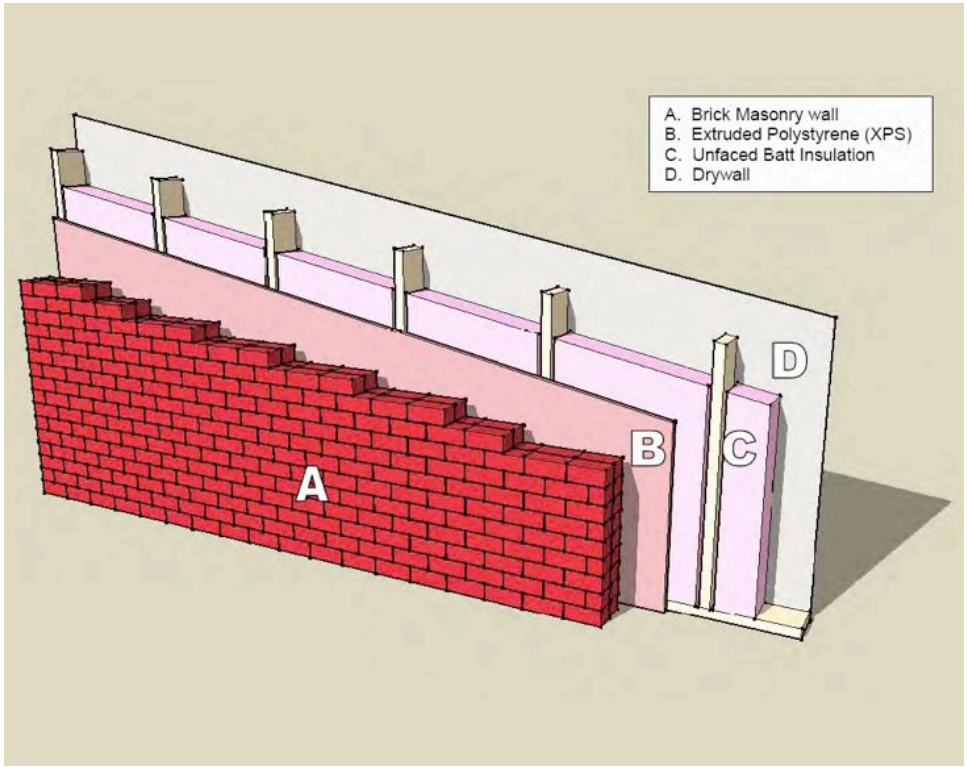
Rehab Cost:
$125,000

(left) Habitat for Humanity volunteers learned how to air seal floor joists from Steven Winter Associates, a Building America team leader.

(right) To avoid "thermal bridging," volunteers installed ½-inch XPS rigid insulation between the brick and the metal stud framing.

installed a ½-inch layer of rigid XPS insulation between the brick and stud framing. They air sealed edges and gaps with low-expansion foam. The old brick walls are two bricks thick with an air gap between the two layers of brick allowing for ventilation, so moisture does not pass through to the foam layer.

Next, as shown in the graphic, fiberglass batts were installed within stud cavities for R-19 insulation.



"When I started here 7 years ago, we drew plans on the floor of the house. We were kind of a mom and pop shop acquiring rehab houses as any small contractor operation might do. Working with the Steven Winter crew forced us into pre-development work, really considering design early in the process, looking at the building envelope, the structure, and the design as a whole. Their partnership on this project for me personally really emphasized the need, especially as we have grown, to do pre-planning with these rehabs."

Matt Metzger, Chesapeake Habitat for Humanity Construction Director

(left) A Rinnai tankless water heater provides domestic hot water on demand.

(middle) The direct-vent Goodman natural gas furnace (93% AFUE) reduces space heating costs by approximately 10% per year.

(right) Hard ducted returns reduce energy losses compared to using existing cavities between studs and joists as return pathways, which can lead to pressure imbalances within the home.

To further seal the envelope, the basement front and rear walls were insulated above grade with 2 inches of foil-faced rigid polyisocyanurate (R-13) between the floor joists and on a portion of the party walls.

The windows were upgraded to low-e double-pane vinyl-frame windows. Maryland has both cold winters and hot summers: the low-emittance glass coating keeps heat inside during the winter and outside during the summer.

Because of significant improvements in the air tightness of the home, mechanical air ventilation was essential. The team met the ASHRAE 62.2 standard for ventilation and acceptable indoor air quality in low-rise residential buildings by installing one ENERGY STAR® bath fan that operated on a timer to ensure air changes each day.

Improved HVAC Equipment

Affordable housing is only truly affordable if the homeowner can afford the utility bills. Direct-vent Goodman natural gas furnaces (93% AFUE) and programmable thermostats were installed to reduce gas bills and increase air quality. Hard ducted returns were installed and sealed with mastic tape to reduce duct leakage and prevent air pressure imbalances in the home.

Rinnai tankless water heaters replaced the conventional storage tank water heaters. These gas-fired systems provide hot water on demand, thus avoiding the energy required to keep water heating in a tank all day. The energy analysis shows a 25% decrease in annual domestic hot water energy use with the tankless system.

Other Energy Savers

Chesapeake Habitat for Humanity outfitted homes with ENERGY STAR refrigerators. Compact fluorescent light bulbs account for 100% of all lighting, which reduce energy lighting consumption by 50% to 75% while the bulbs last seven times longer than incandescent lights.

The low-flow faucets and dual-flush toilets installed in the bathrooms reduce water usage by about 40%. These low-flow faucets can save a family of four an estimated 22,000 gallons of water per year, further reducing water heating needs as well.

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(left) Programmable thermostats.

(right) Volunteers and Building America technical leaders pose in the gutted structure before beginning the rehabilitation

Key Energy-Saving Features

Basement Wall – 2-inch foil-faced polyisocyanurate rigid insulation (R-10)

Exterior Wall – Brick wall with ½-inch XPS on interior surface plus 2x6 stud wall with R-19 fiberglass batts

Party Wall – Brick wall with ½-inch XPS on interior surface, 2x4 stud wall with R-13 fiberglass batts

Windows – Vinyl-insulated windows with low-e (U-0.30 / SHGC 0.48)

Roof/Ceiling – R-30 fiberglass batt

Duct System – Uninsulated sheet metal. Mastic at all joints, including return

Air Handler Unit – Located in the basement

Space heating – Direct Vent 90+ AFUE Goodman Natural Gas Furnace

Thermostat – Programmable

Hot water – Tankless 0.82 EF

Ventilation – ENERGY STAR fan/light unit with control timer

Lighting – 70%-100% fluorescent lighting package

Appliances – ENERGY STAR refrigerator and clothes washer, gas dryer, gas range with electric ignition

Dollars and Sense

Metzger says the cost of adding versus not applying the energy-efficient features was marginal. In 2005-06 building costs, the cost per home for all energy-efficient features was $3,055. The cost per home for green (sustainable) products was an additional $706 for a total of $3,762. Assuming electricity at $0.14/kWh and natural gas at $1.30/therm, the estimated annual energy savings is $597.

"Our average budget for a rehab is $125,000, and we stayed within this for the four energy-efficient rehabs," said Metzger.

The Bottom Line

"We did testing at the end of the project. We tested the control house and compared this to the four energy-efficient rehabs," said Metzger. "Our hope was to hit a 30% energy-efficiency increase over the control house. We hit 32%." The builder achieved a 15% increase in energy efficiency compared to the Building America baseline home, which is a home built to the 1993 Model Energy Code.

The primary energy loss culprits were the lack of air sealing in the basement at the floor joists and in the chimney. Although capped at the top, interior conditions in the chimney brickwork were unknown, and the chimney was difficult to seal.

"What excited me the most [about the project] was the air sealing," said Metzger. "We are still applying what we learned."

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