Chesapeake Habitat for Humanity Project in Baltimore, MD

Rowhouses Rehabbed for Energy Efficiency

MEA MARYLAND ENERGY ADMINISTRATION

Introduction

Row houses have been prominent in Baltimore's architecture for centuries, with over 140,000 still standing today. Many are abandoned and are being renovated in an attempt to improve the quality of life in these urban neighborhoods. Over 17,000 permits were issued last year for residential rehabilitation projects, indicating a significant opportunity to improve the quality of existing housing in Baltimore, in a sustainable and energy-efficient way.

Background

The Maryland Energy Administration (MEA) provides technical and financial assistance to private, non-profit, and governmental entities for the purposes of furthering energy conservation, sustainability and renewable energy.

The MEA received a grant from the US Department of Energy (DOE) for State Energy Program Special Projects under the Building America Program, to implement an "Energy Efficient and Green Technology Building Templates Program," for new and rehab construction. The Consortium for Advanced Residential Buildings (CARB), was chosen to provide Building America technical support to the MEA.

CARB, led by Steven Winter Associates (SWA), is one of the Building America teams working throughout the country to develop, test, and design advanced building energy systems for all major US climate regions. The goal of the Building America program is to develop innovative system engineering approaches to advanced housing that will enable the US housing industry to deliver affordable and environmentally sensitive housing while maintaining profitability and competitiveness of homebuilders and product suppliers.

The Chesapeake Habitat for Humanity was selected as the builder for the rehabilitation projects. Chesapeake Habitat works in Baltimore, rehabilitating vacant houses to provide home ownership opportunities to low-income families. Relying on a large volunteer staff, they have already completed 103 homes in various Baltimore City neighborhoods, and eight additional units are currently under construction.

ENERGY EFFICIENCY

- Improved Building Envelope
- Improved HVAC
- Tankless Water Heater
- ENERGY STAR® Appliances
- Compact Fluorescent Lighting

GREEN FEATURES

- Low VOC paints and caulks
- Durable fiber-cement board siding
- Low flow faucets
- Dual flush toilets
- Bamboo flooring

Building America U.S. Department of Energy

Chesapeake Habitat for Humanity

Low-income families may spend over 15% of their income on energy to operate their homes. Money saved on utility bills means more money for food, clothing, and other essentials.

Incorporating CARB's recommendations, Chesapeake Habitat has rehabilitated five 2-story row houses on West Cross Street and Bayard Street into energy-efficient, affordable housing. Although the recommendations require a few extra steps and some additional first costs, the increased energy-efficiency of these homes reduce the utility bills homeowners will face, making them truly affordable for low-income families.

Energy Efficient Strategies and Technologies

It is the goal of the Building America program to find energy-efficient solutions for new and existing housing that can be implemented on a production basis. Row houses are a large majority of construction in Baltimore and offer a big opportunity to improve energy efficiency of existing housing. Much like other row houses in Baltimore, these units are 2-story, brick construction, with two bedrooms, one bath and a basement.

CARB's recommendations for rehabilitations focused on improving energy efficiency and the health and safety of occupants while minimizing the impact on the environment. Energy analyses showed that if the recommendations were implemented, there could be a 22% annual savings in cooling energy, a 17% savings in annual heating energy, and a 25% savings in annual domestic hot water heating savings (compared to the Building America benchmark home). Energy consumption from lights and appliances could be reduced by over 60%. When compared to Habitat's standard practice, overall energy consumption is reduced by 32%. The biggest obstacle to realizing these savings would be to successfully air-seal the building envelope.

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Improved Building Envelope

In order to increase the energy efficiency of these five rehabilitation projects, improvements to the building envelope needed to be made. Once deconstruction was complete, the builder's standard practice was to stud out the above grade walls and fill the cavities with fiberglass batts. This method allowed for a significant amount of heat loss through the framing. To avoid this "thermal-bridging," CARB recommended installing 1" XPS rigid insulation between the brick and stud framing (1) and provided on-site training on how to foam the seams to prevent any air pathways(2). The effectiveness of the air sealing determines how much energy is lost due to infiltration, which can be significant in these older brick row houses. For even greater R-value, fiberglass batts were installed within stud cavities and 2x6's were specified on exterior walls to accommodate R-19 batts.

Basements in typical row houses are unfinished and uninsulated, resulting in significant heat loss. Because the rehabilitated row houses would be directly conditioned, CARB recommended the installation of 2" foil-faced polyisocyanurate rigid insulation (R-13) on the front and rear basement walls, between the floor joists and on a portion of the party walls. Due to the international partnership between DOW and Habitat for Humanity, DOW Styrofoam rigid insulation was provided free of cost for the above grade walls. Other builders could expect to pay less than **$1 per square foot** for this improvement. Due to the potential fire hazard when left unfinished, this material could not be used in the basement. The incremental cost incurred for the foil-faced basement insulation totaled **75¢ per square foot**.

To further improve the building envelope, CARB recommended upgrading the windows commonly used by Habitat to low-e, insulated glass(3). Higher performing double pane windows have lower U-values, indicating less heat transfer through this building

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component. The low-emittance glass coating is a thin film applied to the glass that keeps heat inside during the winter and outside during the summer.
Because Maryland has both cold winters and hot summers, a low-e glass with a moderate solar heat gain coefficient is desired, such that the house is kept cooler in the summer but a good amount of sun is still let in during the winter. The incremental cost to upgrade the windows: **$32 per window.**

Improved HVAC Equipment

Affordable housing is only truly affordable if the homeowner can afford the utility bills. To complement the improvements to the building envelope, it was also necessary to make improvements to the mechanical equipment. Habitat does not provide central air conditioning, so efficiencies of cooling equipment will be limited by window air conditioners installed by the homeowners.

A high efficiency furnace was recommended by CARB that would reduce space heating costs by approximately 10% per year. A direct-vent Goodman natural gas furnace (93% AFUE) was installed to improve indoor air quality and reduce gas bills(4). **Incremental cost: $400**

Mechanical ventilation was specified by CARB in order to meet the indoor air quality requirements of ASHRAE 62.2, a standard for ventilation and acceptable indoor air quality in low-rise residential buildings set by the American Society of Heating, Refrigerating and Air-Conditioning Engineers. This was accomplished by installing one ENERGY STAR® bath fan that operated on a timer to ensure a certain number of air changes each day. If fan noise is a concern, be sure to specify "low-sone" when purchasing. The cost to install one fan was **$130.**

Hard ducted returns were specified by CARB to reduce energy losses due to duct leakage(5). Using existing cavities between studs and joists as return pathways is ineffective and can lead to pressure imbalances within the home. These pressure imbalances affect the air distribution and can possibly lead to backdrafting of flue gases. Hard ducted returns can be properly sealed, using mastic or UL-181 rated butyl tape with aluminum backing, and the flow of air can be better controlled.

Tankless Water Heater

A Rinnai tankless water heater provides domestic hot water on demand (6). This gas-fired equipment offers a substantial improvement in water-heating efficiency compared to a conventional storage tank water heater. Storage tank systems not only use more energy to heat water to higher temperatures than are actually needed, they also use more energy to keep the temperature hot all day long. Tankless systems provide hot water, at the temperature you need, when you need it. For these rehab units, the energy analysis shows a 25% decrease in annual domestic hot water energy use and an estimated annual savings of $36. The incremental cost for this improvement for Habitat was approximately **$1,000.**

Other Energy Savers

ENERGY STAR® Appliances—ENERGY STAR® appliances reduce energy consumption and save occupants money on their energy bills. Appliances provided by Habitat include a refrigerator and a bath exhaust fan. Homeowners are responsible for installing their own clothes washers, and many ENERGY STAR® models are available. Energy savings from these upgraded appliances generally pay for themselves in just a few years.

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Energy efficiency and sustainable design can be applied to existing construction to build better quality homes, conserve resources and to improve the environment.

Compact Fluorescent Lighting—Lighting in all rooms and hallways are compact fluorescent, accounting for 100% of all lighting. Fluorescent fixtures reduce energy consumption by 50–75%, saving homeowners money on their energy bills. They also last up to seven times longer than incandescent lamps, thus reducing maintenance and replacement costs. Fluorescents generate less waste heat than incandescent lamps and fixtures. Fluorescent bulbs also use about one-quarter of the energy of conventional incandescent light bulbs, justifying their higher incremental cost **($10 for a 4 pack of CFL's).**

Programmable Thermostat—When used properly, programmable thermostats (7) save heating and cooling energy when the house is unoccupied. **Cost to upgrade: $30**

Green Features

As part of the grant, MEA strongly promoted the use of green materials and technologies. Building 'green' means using sustainable products and being environmentally sensitive before, during, and after construction. In at least one row house, bamboo floors were installed on the first floor and low-VOC paints and adhesives were used. Non-vinyl, Hardi plank fiber cement board was used in the rear exterior wall and low flow faucets and dual flush toilets were installed in the bathroom and kitchen.

Low-VOC paints, sealants, and adhesives can substantially reduce the indoor air pollution that causes irritations of the eyes, lungs, and skin and respiratory and internal organ problems. Nationally, these products are often cost-competitive with traditional counterparts. **Bamboo floors(8)** utilize a rapidly renewable resource and **Hardi plank recycled-content cement board** is a durable low-maintenance alternative to traditional wood siding.

Chesapeake Habitat for Humanity volunteers gather in front of a recently deconstructed row house on West Cross Street.