

COMPREHENSIVE ENERGY RETROFIT

Case Study: Habitat for Humanity Newburgh, NY



85 Nicoll St. post-retrofit.

Dozens of century-old brick homes line the streets of Newburgh, New York, a historic community on the Hudson River 70 miles north of New York City that once served as headquarters for General Washington and the Continental Army. Preserving these old brick homes is a priority for Habitat for Humanity of Greater Newburgh, NY, which has conducted 20 renovations and 16 new constructions since incorporating in 1999.

Unfortunately the uninsulated two- and three-story homes can burn up \$6,000 or more in heating oil or natural gas over the winter months. Without some serious improvements in energy efficiency, these homes are simply too expensive to heat for Habitat's partner families.



85 Nicoll St. pre-retrofit.

That is why Greater Newburgh Habitat for Humanity's director, Deirdre Glenn, jumped at the opportunity to work with Building America when she first heard about the U.S. Department of Energy program in a Habitat Northeast bulletin in 2001. "We are trying to build affordable homes for needy families. To do that in this day and age, you have to make sure the energy bills are affordable too," said Glenn.

Glenn contacted Building America partner Steven Winter Associates, Inc. (SWA), which leads Building America's Consortium for Advanced Residential Buildings (CARB) team. CARB staff Ric Guilbert and Amanda Magee began working with the affiliate in April 2003.

Their first project together was renovation of two old homes. The affiliate implemented several innovative cold-climate, high-performance retrofit strategies that CARB had developed as part of DOE's Existing Residential Buildings Program. They certified one of the homes, a two-story house at 85 Nicoll St., through New York State's ENERGY STAR program. "It passed with flying colors getting a HERS score of 89.7" (on the pre-2007 HERS scale), said Glenn.

The CARB team went on to help the Newburgh affiliate design and build a 6-unit row house project on Liberty St. that was completed and inspected in July 2005. Both projects were supported by DOE's Building America program.

According to Glenn, the affiliate learned a lot from working with Building America. Since finishing 85 Nicoll St., the Newburgh affiliate has completed several more new and renovated homes, all of them incorporating energy-efficiency features. The affiliate now has 36 homes

BUILDER PROFILE

Habitat for Humanity
of Greater Newburgh, Inc.

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Founded: 1999

Number of Staff: 7

Number of Houses Built/
Renovated to Date:
16 new, 20 retrofit

Number of Houses
Built/Retrofitted per Year: 7

Featured Project: Single-family
two-story, historic row house,
1,000 sq. ft. plus basement,
at 85 Nicoll St.

Energy Efficiency Status:

Since 2004, all homes built using
Building America principles.



The Habitat affiliate replaced old lathe and plaster on exterior walls with steel-framed walls containing batt insulation and a layer of rigid foam insulation between the framing and the brick exterior.

Lessons Learned for Retrofit Builders, based on findings from CARB

Help the developer/management team understand how reduced monthly utility bills make homes truly affordable for low-income families.

Educate the developer/management team about the increased project scope and hold a pre-bid/pre-construction meeting to outline the new expectations.

Know that significant energy efficiency gains require more than aesthetic remodeling; they usually require a gut rehab.

Choose climate-specific energy-efficiency measures.

Recognize that simple measures, like air sealing, better windows, and more insulation, can result in large energy savings.

Expect a steep learning curve before a technique is truly replicable.

Educate subs and volunteers on site, inspect frequently, and use blower door and duct testing to confirm results.

under its belt (20 retrofit and 16 new) and is pushing forward with an ambitious goal of 7 or 8 completed homes per year. In 2009, the Newburgh affiliate began work on one rehab and three new-construction homes to replace demolished homes. It also made plans to launch its most ambitious project yet—a mixed-income development of 24 new homes on East Parmenter St. that includes 8 Habitat homes along with 16 homes built by a for-profit builder.

Retrofit Strategy

Wherever possible, the affiliate tries to retrofit the properties it acquires, choosing demolition only when structural damage is too severe or lead and asbestos cannot be safely or cost effectively removed. The affiliate faces all the typical challenges that come with retrofit projects—original components in varying and questionable states of disrepair and decay, sometimes poorly executed prior renovations, and potential health and safety hazards. In addition to these, affiliates must also work within the constraints particular to Habitat: using volunteer-friendly construction techniques, making use of donated supplies, and working within limited budgets. In projects such as the Nicoll St. home, the affiliate also needed to be compliant with local historical district criteria.

“We need to insulate very well to make the homes affordable, not just in terms of purchase price but also in terms of monthly living expenses.”

*Deirdre Glenn, Executive Director
Greater Newburgh Habitat for Humanity*

Glenn admits that renovation is much more complicated than constructing a new building from scratch, but there is considerable community and volunteer interest in saving the city’s historic homes. “In the Northeast, there is so much existing housing stock that is beautiful—whole neighborhoods of historic homes, if you can just see past the existing state of disrepair,” said Glenn.

Many of the homes the Newburgh affiliate has retrofitted are bigger than typical Habitat homes, often 1,900 to 2,100 square feet, plus a basement, and most were built in the 1880s and 1890s. They have no insulation. According to Glenn, they were originally heated with fireplaces in every room, then converted to coal then to oil heat. Some had been converted to multi-family dwellings; some have been abandoned.

To conduct a rehab, Glenn said they basically gut the house, removing flooring, ceilings, and wall covering, and replacing heating, plumbing, electrical, and roofing. Most of the rehabs are brick exterior, with lathe and plaster inside. On the exterior walls, they remove the lathe and plaster and replace it with framing, wall insulation, and sheetrock to meet code. They insulate the basements but leave them unfinished. Glenn estimates that most rehabs take 12 months to complete, although they can take longer depending on the home’s structural deficits.

Removing the lathe and plaster is a move that has bothered some volunteers who see its historic value but, according to Glenn, gutting the exterior walls is a necessity to meet the New York state code and interior plaster walls are kept whenever possible, if they are in good condition.

Because the affiliate’s renovations are usually in historic districts, they need approval from the city’s architectural review committee. Because many of its rehabs are being converted from multi-family or commercial back to single-family homes, they usually do not need zoning approval. However, full inspections are required during construction for electrical, plumbing, structural, and concrete where foundations are replaced or repaired. The affiliate is also required to conduct lead and asbestos testing.

According to Glenn, the state of New York basically treats a gut rehab as new construction so it has to meet the revised New York state code, which went into effect in 2004 and includes much higher energy-efficiency standards than the previous code. (The code was again revised in 2007.)

Energy Efficiency Measures and Innovations

85 Nicoll St.

On its first project with the affiliate, a two-story, semi-attached home rehab at 85 Nicoll St. in Newburgh, CARB recommended several measures. The unit was completely gutted and rehabbed with advanced framing (2x6 24-inch-on-center using steel studs). Advanced framing reduces the number of studs in the walls, which reduces the amount of thermal bridging, while increasing the wall cavity space for insulation. Donated rigid foam XPS insulation was used equivalent to R-15 in the walls and R-40 in the ceiling.

Because the exterior walls of row houses in this Newburgh neighborhood are typically brick with no cavity insulation, CARB developed a wall detail that allowed the Newburgh affiliate to use rigid insulation to increase the R-value of the envelope. Unlike fiberglass batt insulation, closed-cell rigid foam insulation resists moisture and maintains its R-value even if wet. Three 1-inch layers of rigid extruded polystyrene insulation were placed directly against the brick. Each piece was cut to fit around the joists, rafters, and penetrations. Metal studs held the insulation tightly against the brick and provide an anchor for the gypsum board. Air movement behind the insulation and between layers was thwarted by caulking the seams between each piece of foam board, all penetrations, and the perimeter of each wall. The exterior brick wall had three layers of brick with an air gap between the layers, which allowed for drying of the brick from any moisture driven into the wall from the outside.

The rigid foam insulation was also laid in the attic in four 2-inch layers above the second floor ceiling, providing R-40 attic insulation. Plywood sheets were laid over the insulation to prevent the edges from curling and to provide a hard surface to make the attic usable storage space. Volunteers also cut pieces of insulation to fit on the back of the attic hatch and applied weather stripping around the opening. When an initial blower door test revealed high leakage rates, an additional layer of rigid insulation was applied on the underside of the second floor ceiling and caulked at the edges to form a tight air seal. Extra attention was given to air sealing throughout the house, especially around the fireplace, which was closed off and left in place for its decorative value. The final infiltration rate, measured for ENERGY STAR requirements, was 0.60 ACH.

Holes were bored through the brick walls so that new kitchen and bath fans could be vented to the outside. A Panasonic Whisper Lite Series fan/light providing 90 CFM at 0.1" of static, with a sound rating of 0.6 sones was installed in the bathroom and controlled by a Grasslin KM2 In-Wall Timer Switch mounted in a nearby closet that was set to run the fan for 20-minute intervals throughout the day.

A water-proof coating was applied to the inside surface of the rubble foundation walls and rotten window wells were replaced. Concrete block porch steps that had pulled away from the house creating a channel for water to enter the basement were removed. Rather than insulating the uneven basement walls, the floor above was insulated by adding R-19 fiberglass batts between the floor joists; the batts were held in place with mesh. The perimeter rim joists were covered with pieces of rigid foam sealed in place with caulk and expanding foam to keep moisture from wicking into the batt insulation.

For space heating and water heating, CARB recommended a combination-unit high-efficiency gas boiler with an indirect tank for water heating. A Teledyne Laars model EBP 110 was installed. This compact, affordable, direct-vent, sealed combustion boiler modulates from 61.8 to 108.2 MBtu/hr as the demand changes. The boiler provides priority domestic hot water on demand, as well as hydronic space heating. The boiler has an efficiency rating of 85.5% AFUE for space heating.

Windows that faced the street in front of the home were required by the historical preservation committee to be wood framed. The Newburgh affiliate was able to get approval for double-pane, low-emissivity windows and used vinyl-framed windows on walls not facing the front.



The Habitat for Humanity of Greater Newburgh has renovated 20 historic row houses in Newburgh, NY, improving energy performance and dramatically cutting winter heating bills.

Key Energy-Saving Features

Teledyne Laars direct-vented, sealed-combustion, 85% AFUE combination boiler and water heater for hydronic space heating and domestic hot water

8 inches, R-40 rigid XPS foam insulation in attic

3 inches, R-15 rigid XPS foam insulation on walls between double-layer brick outerwall and steel-stud inner wall

Insulated, weather-stripped attic hatch

R-19 fiberglass batt insulation between floor joists above basement, held in place with mesh

Basement rim joists insulated with rigid foam board, caulked and foam sealed

Waterproofing applied to inside of foundation walls

Rigid insulation caulked and sealed to ceiling to improve envelope air sealing

Double-pane low-emissivity windows

ENERGY STAR certified with pre-2007 HERS score of 89.7

Blower door testing

ENERGY STAR refrigerator

70% CFL lights

Panasonic Whisper Lite 0.6 sone fan in bathroom on timer for continuous 20-minute cycle ventilation

Kitchen fan vented to outside



Building America's CARB team worked with the Newburgh, NY, Habitat affiliate to train its volunteers on energy-efficient building practices that the affiliate has incorporated into all of its renovations and new construction projects.

Energy Efficiency Measures Used on Many New Homes and Retrofit Homes

2x6, 24-inch-on-center advanced framing

Quietside combined water heater/space heater (gas-fired) or tankless hot water heaters and gas-fired furnaces

Low-emissivity double-pane windows

Fiberglass batt, faced insulation: R-21 in walls, R-38 in basement ceilings, R-57 in attic

ENERGY STAR-certified refrigerator

Ceiling fans and attic ventilation fan where possible

Dehumidifiers

Panasonic Whisper Green low-sones, high-efficiency exhaust fans in bath and kitchen that run constantly at low speed and on a timed higher speed cycle; vented outside.

Programmable thermostats

CFL lighting

Low VOC paints

Extensive air sealing/blower door testing

For additional information, contact:

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Compact fluorescent lighting and ENERGY STAR appliances added to the savings. Low-volatile organic compound (VOC) paint and mechanical ventilation were used for better indoor air quality. Taking advantage of national partnerships helped lower first costs. Habitat for Humanity International has partnerships with Whirlpool for free ENERGY STAR refrigerators, with Dow Chemical Company for free XPS rigid foam insulation, and with Panasonic for discounted bathroom exhaust fans.

The Nicoll St. home was completed in May 2004 and performance testing by CARB showed a HERS score of 89.7, with a projected heating and hot water energy savings of almost 38% compared to the HERS reference home.

Since Nicoll St.

“We’ve changed our ways” since working with Building America on 85 Nicoll St. said Glenn. The affiliate now works to incorporate energy efficiency measures into every house it renovates, although measures vary depending on how much of the original structure can be saved. Where possible, the affiliate uses advanced framing with 2x6 24-inch-on-center stud walls. They also consistently install hall ceiling fans, attic ventilation fans, and high-performance windows that are double pane, low emissivity, and argon filled. The windows are double hung to allow for improved air circulation and passive cooling. The affiliate has increased insulation levels since 85 Nicoll St. and routinely installs R-21 in the walls, R-38 in the basement ceiling, and R-57 in the attic. Most of this is fiberglass batt insulation, not rigid foam insulation because of difficulties obtaining donated XPS from a local supplier. One Panasonic Whisper Green ventilation fan is installed on each floor of the home. Many homes are equipped with Quietside gas-fired high-efficiency combination hot water/heater units. Existing dirt basement floors are capped with a vapor barrier and cement, which keeps moisture minimal. Mechanical dehumidification is provided where needed.

Glenn noted that they spend quite a bit of time training volunteers. “We have onsite training days for insulation, and caulking and sealing,” said Glenn. CARB provided training on the early projects: now the affiliate does its own training, including on-site sessions for volunteers and pre-construction sessions for supervisors.

Affordable, Durable, and Sustainable

“Working with Building America has changed the way we do construction. Now there is the recognition that energy efficiency is a topic that needs to be addressed *always*. That puts energy efficiency at the forefront of our planning. Building America helped us look at the house as an entire system. We have a much more comprehensive approach to planning,” said Glenn.

“In the early days we took it as we found it, room by room. We use a much more professional approach now,” said Glenn. “When we start a renovation, we walk through with the building captains and architects. We evaluate the structure for soundness. We establish our planning parameters. We come up with building and structural plans, specify mechanicals and insulation, and determine what we need for approvals for local building permits and to meet the New York state code.”

Bottom Line

Despite their large size compared to the 1,400 square feet typical of Habitat homes, Newburgh’s renovated homes are still affordable. The purchase price is typically below \$60,000 with a 20-year zero-interest mortgage. Federal tax credits and state incentive programs like ENERGY STAR help offset the costs of upgraded equipment and windows and reduced energy bills make them more affordable to live in.

“We want to provide people with a very efficient home so that it can truly be affordable to live in for the long term,” said Glenn.