A Home for Cold Seasons

by Scott Shipley

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In St. Lawrence County, New York, winters are typically long, dark, and cold. Up here near the Canadian border—Ottawa is our closest large city—we can see temperatures of -30°F and sometimes -40°F—not something to be experienced in a cold, drafty house. A constantly cold house, combined with high heating bills, can make an already long and difficult winter even harder—and that is the experience of most low-income folks in this neck of the woods. But improving the housing stock of low-income folks takes money, something that these folks don't have.

In 2002, the nonprofit organization Community Energy Services, Incorporated, where I am director for technical programs, partnered with Raquette Valley Habitat for Humanity and the New York State Energy Research and Development Authority (NYSERDA) to design a low-cost Energy Star home for cold climates. Habitat for Humanity chapters around the world work to provide housing that is priced within reach of low-income buyers, is safe and durable, and has reasonable energy and maintenance costs. Our goals were to design and build a home that fit the Habitat model, achieve as high an Energy Star rating as was practicable, incorporate local and green materials wherever feasible, meet the needs of the new owner as much as possible, and fit the home into the existing neighborhood satisfactorily. Erik Schulze, a local builder and contractor with experience in high-efficiency homes, was brought on board to oversee design and construction. In the end we built a 1,052 ft^2 home at a cost of $35,000 for materials and skilled labor that has had annual utility bills of $1,000. And most importantly, we moved a family from a leaky trailer into a comfortable home.

From the Ground Up

Raquette Valley Habitat for Humanity acquired a parcel of land in Rensselaer Falls, New York, a quiet little town of 330 people on the banks of the beautiful Oswegatchie River. There was a time when the town was a bustling center of

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Habitat volunteers lift a wall section into place. Studs were spaced on 24-inch centers to reduce heat loss and lumber use.

the local farming community. Hard times have changed that; now most of the businesses are closed and much of the housing is in disrepair. The original house on the site burned down several years ago, and the resulting debris was buried in the original basement. The original well was still functional, although the quality of the water was uncertain. The site was long and narrow, with the short edge facing one of the main town roads.

Habitat for Humanity has basic criteria for local chapters to use in choosing the design of a home, but ultimately the decision is up to the local chapter. We chose to stay as close as possible to the 1,000 ft^2 size suggested by Habitat's national organization. We decided to build a two-story building to reduce foundation costs and to leave more of the lot for lawn. (We live in a climate with ample rainfall, so extra lawn watering is not a problem.) All the surrounding homes are nineteenth-century one and a half- and two-story Victorian structures, so we designed the house to fit in. We made the house square to reduce the ratio of surface area to volume and therefore to reduce energy loss. In the end, we came up with a house with the maximum volume for its foundation and surface area. Design issues such as these have energy implications, and their handling can contribute to or detract from the overall goal of maximizing the Energy Star rating.

We decided to build on a slab foundation to keep down the cost of the entire home. Our design, however, could easily be adapted for a basement foundation. We insulated under the entire slab with 4 inches of EPS, giving us an R-value of 20 under the slab. We insulated the perimeter with 2 inches of EPS, which yielded an R-value of 10 there. We used concrete backer board to cover the 2 inches of perimeter foam. We chose not to insulate the perimeter with 4 inches of EPS because we could not come up with a satisfactory system for protecting the foam on the exterior, and because we felt that 4 inches of foam on the edge would make it difficult for us to attach the backer board to the slab foundation with any real assurance of durability.

We initially looked at double-stud framing to allow us to maximize the R-value of the wall using cellulose insulation only. Cellulose insulation is primarily a recycled product; using this insulation appealed to us. But in the end we decided not to use double-stud walls for two reasons. The first relates to our desire to build a house that others would feel comfortable building. Double stud framing, although it allows for the construction of a super-insulated wall using only cellulose, is a wall system that is unfamiliar to most builders and to all but a few of the volunteers Habitat depends on. The second reason we went with traditional framing is that Habitat enjoys a relationship with various companies that donate building materials to the house. In this case, we were able to obtain 2-inch extruded polystyrene (EPS) board at no cost. With this on the exterior and 5 1/2 inches of dense-pack cellulose in the stud cavities, we had a wall system with an insulation R-value of 28 (3.2 per inch for dense pack cellulose, 5 per inch for EPS).

Our building on 24-inch centers helped the R-value of the wall system. Around here traditional stud wall framing means 16-inch centers with headers over every wall penetration. Building with 24-inch centers reduces the amount of lumber, reduces the heat transfer through the studs, and leaves more space for insulation. Headers were not installed on non-bearing walls. It took some convincing of the local code enforcement officer to sign off on the project because of the stud spacing. A phone call to the regional code officer manager helped to alleviate the concern. The regional manager provided us with the code reference that allowed us to convince the local officer that what we were doing was acceptable.

We used raised-heel roof trusses that allowed us to install 16 inches of loose cellulose, with an R-value of 3.5 per inch, in the attic space for a total R-value of 56. We used local lumber for siding, flooring on the second floor, and trim around all the doors and windows.

We initially looked at using triple glazing for the windows. Triple-glazed windows with argon fill, low-e coating, and fiberglass sashes, with U-values of 0.2–0.25 are common across the border in Canada. The cost was approximately double the cost of Anderson Energy Star double-pane, vinyl-clad windows with U-values of 0.29–0.34 that were locally available in a truckload sale. We decided that it was unlikely that Habitat would go for the triple pane windows in the future, so we took the minor energy hit and went with the double panes. Doors were all Energy Star steel clad with no windows. The house has significant glazing, so windows in the doors were unnecessary. We were fortunate that the lot faced southwest, so that we were able to make use of the solar gain while orienting the house in the same direction as other homes on the street. The significant mass provided by the slab foundation helped us take advantage of this free solar energy. A minor amount of glazing was installed on the north side of the house to provide daylighting for a hall and stairwell.

Radiant floor heating was used in both the first and second floors to distribute heat to the home. We chose radiant floor distribution for its increased comfort level and space saving-properties. We chose a Munchkin boiler by Heat Controller to provide the heat for the home. Options for the boiler choice were limited, due to the low heat requirement of the home. REM:Rate computer software predicted the heating requirement for the home to be about 12,500 Btu per hour. The Munchkin was the only boiler we found that would modulate low enough without being seriously oversized for the home. The boiler provides domestic hot water (DHW) through an indirect tank. Fuel for the boiler is propane. Natural gas is not available at the site. We considered oil, but there was no room in the house for the tank, and we found no oil-fired boiler small enough to use in this home.

Energy Star homes built in New York must meet additional requirements above and beyond the national standards set by the EPA. Every Energy Star home must include both some form of continuous mechanical ventilation and a number of electrical energy savings measures. Ventilation to this home is provided through a FanTech model SHR 1505 R heat recovery ventilator (HRV). (We did not use an energy recovery ventilator, since it is generally not considered worth the extra cost in our climate.) Air is supplied to both bedrooms and to the first-floor living area, and exhaust is in the bathroom. Electrical energy savings measures can be achieved by the use of a combination of efficient lighting and appliances. Hard-wired Energy Star fluorescent fixtures provide most of the lighting. We installed CFLs in a few fixtures and lamps provided by the homeowner. Whirlpool provided an Energy Star refrigerator with a rating of 434 kWh per year. Local electrical rates average about $0.11/kWh, so anything that can be done without electricity usually saves money. Both the dryer and the range are fueled with propane.


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Energy trusses donated by a local company are installed by Habitat volunteers.


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Locally harvested and milled siding was applied board and batten-style over 2 inches of EPS.

Rating the Home and Living in It

The final rating of every Energy Star home in New York requires verification of installed shell measures, combustion safety testing of all combustion equipment in the home, and blower door testing for tightness. The blower door test measured 300 CFM at 50 Pa. This was the lowest infiltration rate I have measured in any home I have ever tested.

The final HERS rating score of the home was a gratifying 92, significantly higher than the minimum 86 required for the Energy Star designation. Because the final score is based on the sum total of all the shell and mechanical features, no one feature was responsible for the high score. When designing an Energy Star home, attention to the whole house is the key to achieving the best score—and house—possible.

In July 2003 final test-out was completed and the new owner was ready to move in. The new owner was given a tour of the home with an overview of the system, handed the keys, and told to call if there were any questions. My job was to answer questions as they arose, and to wait for one year's worth of energy bills to see how the house did. I installed a HOBO data logger by Onset Corporation to record indoor temperatures. This would allow me to see if the home experienced conditions outside the set temperature design parameters.

After one year, only one significant problem surfaced. Mold began to form on the lower edges of windows throughout the house. This was surprising, given the installation of the HRV, which should have eliminated this problem. But this is where theory can come crashing into the cold, hard brick wall of reality. Just having an HRV in the house is not enough. It has to be used. I had set the HRV to run continuously on a low setting, and I instructed the owner to adjust the device as needed. I assumed that this was all the training and instruction the owner required to manage moisture in a brand-new high-performance house. But many folks around here live in cold, drafty homes. High moisture is not generally a problem. Moving someone from a winter dry house to a winter humid house without proper instruction can lead to problems.

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Standing in front of the completed home are builder Eric Schulze (left), owner Jennifer, and Scott Shipley. The final HERS rating score for the affordable and energy-efficient home was a gratifying 92.

When I got the call from the homeowner, I contacted Erik Schulze. We went over to check out the situation and to look for all of the usual moisture suspects. Significant mold was growing on the bottom edge of all the windows. We found no significant unusual sources of moisture in the home. No water leaks from the shell or the plumbing were identified. The house may have had construction moisture trapped in it. The slab in particular may have given off extra moisture that became trapped in the house when it was closed down for the winter. The homeowner also owns two aquariums. The only other moisture problem reported was that when the homeowner cooked pasta, the windows would fog. The range hood vents to the outside, but it apparently was not used regularly.

It is clear to me now how important it is to emphasize to a new homeowner the importance of using, and adjusting, the ventilation system. Homeowners are used to adjusting a thermostat to change the temperature in the home. They have yet to become schooled in adjusting ventilation systems.

A challenge for builders of high-performance homes is teaching consumers how to maintain these homes, and how to respond to simple issues before they become big problems. In our case, we were fortunate. All we needed to do was increase the run time of the HRV and ask the homeowner to use the range hood while cooking. As of mid-December 2004, the homeowner reports having no more moisture problems. Now she understands the cause of—and solution to—a common building performance problem.

When designing high-performance homes, it is very important to make sure that the home is easy to maintain. The homeowner should easily be able to understand how the basic systems work and how to adjust them. The controls to operate systems must be simple. The effectiveness of the ventilation system won't be maximized if the homeowner can't control and adjust the system easily. The Fan-Tech Intellitek 5 MR control used in this home uses a variety of icons that are not especially clear to indicate various operating modes. It took significant effort on my part to understand from the manual how to adjust the system. Part of the difficulty is due to the fact that the control of the HRV is not like any other control in the house. People are used to dealing with numbers on their house mechanicals; "one" means low and "ten" means high. The icons take some getting used to, and I suspect they are a bit daunting to the average homeowner. Designing a control that is as easy to use as a thermostat should help in the effort to build a homeowner's confidence. I adjusted the existing control to increase the run time. Whether this homeowner, and others, can adjust it themselves will depend on whether they have the patience to work their way through the manual.

I recently asked the homeowner if she had experienced moisture problems in her house this winter. She promptly responded, "So far so good—no moisture at all! I have the fan running 15 minutes every hour and I think the moisture thingy is set at 46." It does not matter if she knows what the device is called or what units the device is measuring (in this case, percent relative humidity). I feel confident now that she knows what it's for and how to use it.

Scott Shipley is the director of technical programs for Community Energy Services, Incorporated, in Hermon, New York. He is a BPI-certified shell and heating specialist and holds a HERS certification. He installs solar-electric systems in his spare time, but that's another story.

EPA Honors First Green Power Community

PACIFIC POWER

"We are honored and excited to be 'first in the nation' as a green power community," says Moab Mayor David Sakrison (to the right of the speaker in the photo). "This designation clearly symbolizes our community's commitment to both the development of renewable energy technologies and protecting our environment."

Utah's Greater Moab Community has been recognized by EPA as the nation's first Green Power Community. The cities of Moab, Castle Valley, Pack Creek Ranch, and Spanish Valley, Utah, are the first community in the country to meet and exceed the EPA Green Power Partnership's minimum benchmark for green power usage with voluntary purchases.

Citizens, business leaders, and public officials led the green power campaign, with aid also provided by Utah Clean Energy and Utah Power. "We are honored and excited to be 'first in the nation' as a green power community," says Moab Mayor David Sakrison. "This designation clearly symbolizes our community's commitment to both the development of renewable energy technologies and protecting our environment."

Green power—electricity generated from renewable sources such as wind, solar, geothermal, and hydropower—accounts for 4% of the Moab community's electricity demand. EPA estimates that the environmental benefit of this green power use avoids the generation of 4 million pounds of carbon dioxide.

"To become the first EPA-designated Green Power Community in the nation is a testimony to the environmental ethic of this wonderful town," says Rich Walje, Utah Power executive vice president. "It was the efforts of Mayor Dave Sakrison and other Moab leaders that made this campaign a real success."

EPA's Green Power Partnership has established Green Power Communities as a method of providing assistance and recognition to organizations that demonstrate environmental leadership by choosing green power. EPA's Green Power Partnership recognizes Green Power Communities for having area homes, businesses, organizations, and local governments voluntarily commit to switch a portion of their electric power usage to green power through individual and organizational purchases.

For more information, see www.epa.gov/greenpower/.