A SUPPLEMENT TO PENTON MEDIA PUBLICATIONS FALL 2009

GREEN MECHANICAL CONTRACTOR

Mixed-use building green from the ground up

Making sense of WaterSense for homeowners

Trials of an alternative energy contractor

Even my toilet paper is green!

Save water, grow your business

Rockies NET-ZERO HOUSE has tiny carbon footprint

page 14

Your Resource on Efficient Water and Energy Systems

online at www.greenmechanicalcontractor.com

Cover Story

By Lisa Murton Beets

Net-Zero House

These homeowners used resources conservatively and wisely during the construction process, and use only renewable energy sources to reduce their carbon footprint.

When Dale and Leslie Miller set out to build their dream home, they knew they wanted it to be a green home – one that would be kind to the environment and reduce their carbon footprint.

Dale, an instructor in the environmental studies program at the University of Colorado at Boulder, says it was "all about our values." He says their idea was to build something that others would pay attention to.

And pay attention they have. The home won a 2008 Sustainability Award from the city of Lakewood, Colo., in the Sustainable Home Construction category. The award program was instituted in 2008 to promote green building in the area. But three years ago, when the Millers first started out, they found a lot of balking when they mentioned they were building an "environmentally friendly" house.

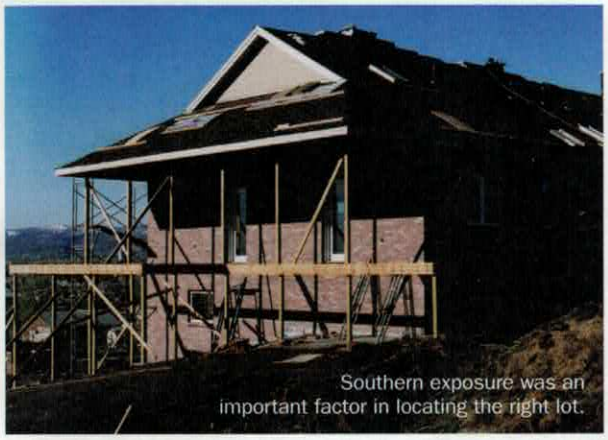
"We wanted to build our home with as many green and sustainable aspects as we both had time for and could afford, using mostly standard construction materials and methods," Dale says. "Limitations to building green came from all dimensions, from planning to construction financing to building codes to finding cooperative, informed contractors and laborers."

A lot of that changed last year, Dale adds, when there was a change in city administration. "Last year, we had about 45 people, including the entire city planning department, come out to tour our home," he says. "They see that it is a normal-looking house just like any other, and they become much more interested in the newer ideas we incorporated."

THE RIGHT FIT

Dale, who has a degree in physics, has been building things all his life. So it was no surprise to Leslie that he wanted to serve as general contractor for the project. "To me, it was

The Millers set out to prove that "green can be beautiful."



Southern exposure was an important factor in locating the right lot.

exciting; to her, it was a lot of work," he smiles. But together the two turned their vision into a reality and have done much of the building and finishing work on their own.

It took the couple about one year to find the right lot. They settled on an area in transition, which features homes built back in the 1920s all the way up to the present. They needed southern exposure – since the home would feature both solar photovoltaic (PV) and solar thermal tubing – and enough room for their animals. They ended up buying three small empty lots and consolidating them.

During the process, they found an architect on the Internet – Debra Rucker Coleman of Sun Plans, who specializes in passive solar designs. All of their work with Sun Plans, which is based in Alabama, was done online.

SOLAR POWERED

The house is a ranch style with a basement. The main floor has 2,340 sq. ft. and the basement has 1,440 sq. ft., for a total of 3,780 sq. ft. of living area. There are two covered porches totaling about 700 sq. ft. and another 500 ft. of deck.

"We wanted the house to feel spacious, while not being wasteful," Dale says. "From the start, we wanted to eliminate or reduce any contributions to climate change. We worked to use resources conservatively and wisely. During construction, this meant minimizing waste in the building process and recycling or reusing as many materials as possible; after construction, it meant using only renewable energy sources. Energy efficiency was an important goal – we knew that we wanted to strive for net-zero energy consumption from non-renewable sources. On top of that, we wanted the house to be beautiful and upscale, and built to last."

An important priority was to use free, clean energy from the sun. "The first choice was that we would not connect to natural gas," Dale says. "The house uses only electricity and is almost entirely energized by the sun."

To accomplish this, a 4 kW solar PV system is in place and is connected to the Xcel Energy grid. The system makes electricity whenever the sun shines and feeds it into the electrical grid. When this occurs, the Millers' meter spins backward. When they consume energy, they pull it back out of the grid, and their meter spins forward. The system was installed in April 2007 and produced all the energy the Millers needed for construction and to heat and light the house all winter. For the last two years, their annual utility bills have been around $700 – about three times less than what many other homeowners in their area pay.

"Generally speaking, a 4 kW PV system like ours reduces greenhouse gas emissions from power plants each year by about 16,000 pounds, or about the same as removing 1½ cars from the road, or about the same amount of carbon sequestered by 200 full-size Douglas Fir trees," Dale says. "Of course, the system also reduces mercury emissions, which cannot be sequestered."

The house also has a solar thermal system that heats water for domestic use and for the radiant floor heating system. One hundred twenty evacuated solar thermal tubes can produce up to 200,000 Btus per day.

Another energy-producing feature is a wood-burning fireplace rated by the EPA as 85 percent efficient. The Millers use wood left over from construction as fuel, and estimate they have enough left over for two more years.

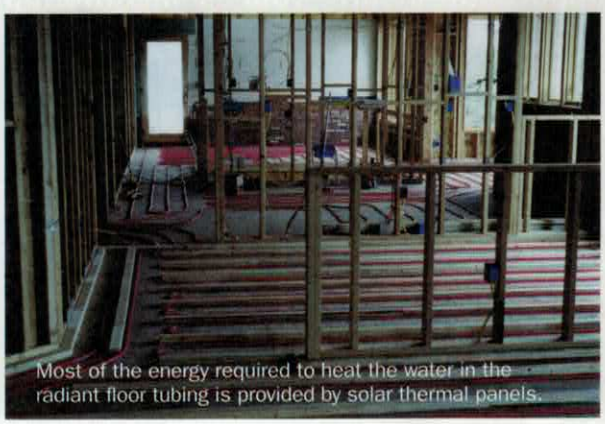
In addition, the Millers selected all high-efficiency appliances and use compact fluorescent lights (CFL), except for a few decorative bulbs.

EFFICIENT COMFORT

The longest dimension of the house has numerous windows and a southern exposure to allow sunlight in during the winter months, and the interior of the house has several thermal masses to absorb the heat, including interior brick walls and tile floors. The rooms that a family normally would like to be warm in the winter (such as the living room, dining room, kitchen, office, etc.) are on the front or south side of the house, while the rooms that are normally kept cooler are on the north side of the house (such as bedrooms, utility rooms, laundry rooms, storerooms, etc.).

There is no air conditioning, but the Millers installed an evaporative cooler, which lends itself to the indoor/outdoor living style they prefer; in warm weather, windows and doors are left open, and much of their time is spent out on the porches and decks.

"In the winter, when the sun is low in the sky, the sun shines in through the many windows to warm the rooms and the thermal masses; in the summer, when the sun is high in the sky and heat is not desired, the extra-long roof



Most of the energy required to heat the water in the radiant floor tubing is provided by solar thermal panels.

eaves prevent the sun from shining in the windows," Dale says.

A variety of different windows with soft and hard low E coatings were used throughout, depending on their orientation to the sun. The covered porches, which are on the east and west sides of the house, prevent the summer sun from heating the sides of the house when it is rising and setting. Interior thermal masses, such as brickwork around the staircase, help to moderate the interior temperature by absorbing heat, and the high ceilings on the south side of the house (up to 14 ft.) allow any excess heat to rise above the living areas.

If you were to ask Dale what his favorite aspect of the home is, he'd say all the brickwork. If you asked Leslie, she'd say the fireplace. But if you asked the entire family, kids included, what they loved best, they'd all say the radiant floor heating system.

"The warm floors are terrific," Dale says. The system works well with the travertine tile that is used throughout the house. It will work just as well with some additional floor finishes Dale is still in the process of installing – stained concrete and carpet.

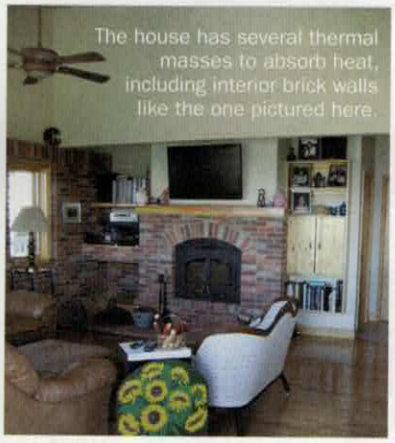
Most of the energy required to heat the water in the radiant floor tubing is provided by the solar thermal panels. The radiant heating and solar thermal systems were sized, designed and specified by Michael Willburn, vice president of Infloor Heating Systems, Buena Vista, Colo., whom Dale met at a Denver home and garden show. Willburn also assisted by overseeing the installation. In addition, Robert Vessa of Robert Vessa Plumbing & Heating Company in Denver consulted on the design and installation of the system.

While talking with Dale, Willburn suggested they design and build an experimental underground storage area to capture excess solar energy in the sunnier and warmer months, which the house can then draw upon when it gets colder.

"It's a three-compartment planter in the front of the house," Dale explains. "It measures about 28 ft. x 8 ft. x 6 ft. deep. Each compartment contains a 'cube,' insulated on each side and containing radiant tubing laid out in lifts between moist, compacted soil to capture and hold the excess energy."

Last year, the temperature in the cubes got up to about 150°F, and the Millers were able to draw heat out of them from September through December.

"We calculated that we will be able to store enough energy in the ground storage to provide about 25 hours of continuous heat to the house, or somewhere in the neighborhood of 4 million Btus," he says. Willburn adds that moving forward, they will do some further experimenting with the underground storage system to


The house has several thermal masses to absorb heat, including interior brick walls like the one pictured here.

increase the amount of energy they can store.

The system controls are designed so that the solar thermal panels first direct captured energy to the domestic hot water tank. Once the tank is heated, the energy is directed to the radiant floor heating system, then to the ground storage.

If the radiant floor heating system cannot draw energy from the solar panels or the ground storage, it uses a backup electric hot water heater, which Willburn chose to undersize. Any electricity required for the backup heater is generated by the solar electric PV system.

REDUCING CONSTRUCTION WASTE

The Miller home is well-sealed and insulated, with insulating values in the basement walls and attic of R40+. The main floor has 6-in. walls with R19 insulation, and they chose a brick exterior because of its beauty, energy-moderating qualities, and because they could obtain the brick locally.

The foundation of the house was built using insulated concrete forms (ICFs), which provide an insulating value of over R40 with concrete sandwiched between 4½-in. slabs of Styrofoam.

Materials were selected not only for their timeless appeal, but also for proximity in order to reduce energy usage required for transportation. During construction, paper and cardboard were sent to recycling centers; steel, copper wire and copper pipe were recycled as well.

"Unfortunately, some building materials cannot be recycled or reused," Dale says. "We had to take some materials to the dump in a pickup truck and trailer. This consisted of small pieces of oriented strand board (OSB), plywood and drywall, and other unusable or unrecyclable materials totaling about 20 cubic yards. Many homes the size of ours use five or six 40-yard 'roll-off' dumpsters during the construction process; one house built nearby filled 10 40-yard roll-offs, totaling 400 cubic yards of waste that was sent to the landfill."

GREEN IS BEAUTIFUL

"The terms 'building green' or 'sustainable building' have numerous connotations, some of which vary depending on who you are talking with at that moment," Dale says. "When we began three years ago and were describing our project as environmentally friendly or green, lots of folks thought we were going to build using straw bales or used tires or build a dome house or a variety of other nontraditional homes. It is our hope that projects like ours will help dispel these notions."

So much so that Dale and Leslie are writing a book about their experience building the house.

"Our story goes to show that you can have a home that is both beautiful and environmentally friendly," he says. "Plus it was affordable to build."

In fact, Dale says that the topic of green affordability is one they will address in the book. "We found that by making certain tradeoffs – and yes, we do have granite countertops – did not increase our costs by much, if at all."

Lisa Murton Beets is a Cleveland-based freelance writer specializing in HVAC-related topics. She is a frequent contributor to Green Mechanical Contractor *and* Radiant Living *magazines.*