Efficient Plans Run Into Reality

by Lori Marsh

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In the summer of 1996, I signed on the dotted line and set in motion the construction of my dream home. This was not my first experience with home ownership, but it was my first time having a home built. The number of decisions I had to make was staggering, and of course each one translated into money spent.

Perhaps I was a bit atypical in that energy efficiency was at the top of my wish list for my home. Professionally, I promote efficient use of energy in the residential sector through my position as extension engineer for Virginia Cooperative Extension, a program at Virginia Tech offering energy efficiency guidance to contractors and builders. I considered the construction of my house to be my opportunity to live what I preach, to implement all the energy-saving measures I promote statewide.

I selected two builders to bid on my house project. Both are known in the area for quality custom building. At my job, I had used blower doors to test homes each had built, so I knew they understood the concept of a tight house.

Everything I had read implied that structural insulated panels (SIPs) provide a superior thermal envelope. But when I suggested using them, my troubles began. One builder—Eric Sallee, president of Shelter Alternatives Incorporated in Blacksburg, Virginia—politely told me I was nuts. "Why would you want to build an experimental house [using SIPs] when we can build you one we know works and will last 100 years plus?" The other builder—Erik Kraft, owner of Kraft Construction—told me to work with a panel manufacturer to get a quote, and then he would bid on the entire job.

I asked Sallee to estimate Shelter's price for a stick-built house, and I contacted five panel manufacturers within a 250-mile radius of my home for quotes. The lowest bid from a SIP builder was 30% higher than Shelter's bid for stick framing. Meanwhile, inquiring about SIPs had added six weeks to the bidding process. I abandoned SIPs. I continued working only with Shelter, because they actively promote themselves as energy-efficient builders.

I then concentrated on the insulation package and the heating and cooling system. The house is on a rural site, built into a hillside with good southern exposure. Having passed on the SIPs, I decided the next best thing was dense-pack cellulose. "Yep," Sallee told me, "It's great stuff, but we hardly ever use it. It costs too much. Our clients don't want to pay for it."

The literature implies that dense-pack cellulose doesn't cost much more than fiberglass batts, so I was not so easily dissuaded. Working with my professional contacts, I got a bid for the cellulose. And guess what? It was almost 75% more than the same R-value in fiberglass (R-21 walls, R-30 ceiling).

I asked myself, "Is it worth it?" The biggest advantage of dense pack is that it reduces infiltration in leaky homes. The Shelter homes I had tested used batts, and they were tight. I decided I had little to gain from the cellulose and went with fiberglass insulation.

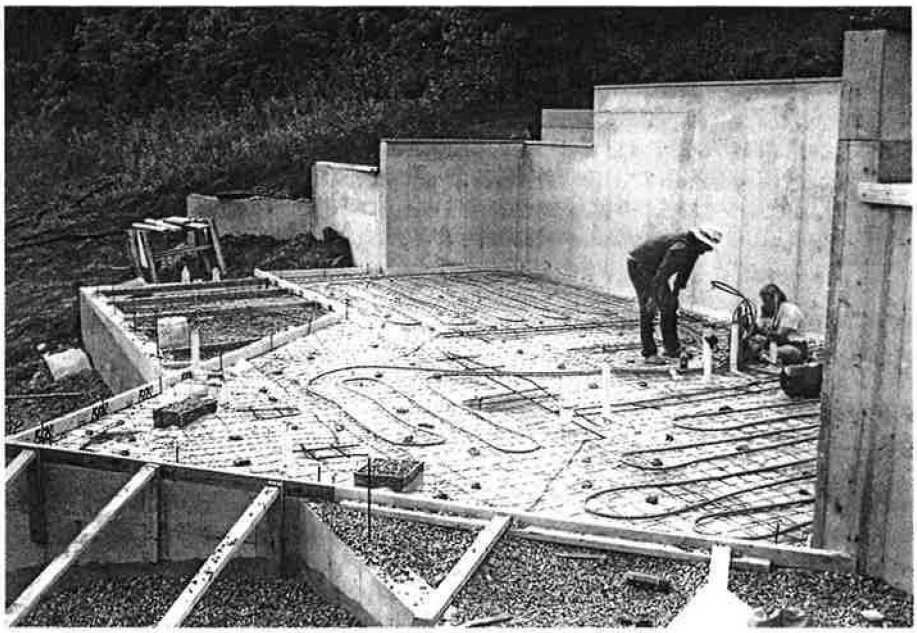
I was actively involved in the selection of my HVAC system—more so than any client Shelter Alternatives had ever dealt with. Except for a wood stove to serve as emergency heat, I decided to use all-electric HVAC—natural gas is not available in my remote location, and I didn't want a propane tank. For maximum efficiency, I wanted a ground source heat pump. Through my job, I had many contacts with both HVAC distributors and contractors. I began making inquiries with contractors, only to be told over and over again, "We don't fool with ground source systems."

Not willing to take no for an answer, I persisted. I made contact with Waterfurnace, the largest manufacturer of ground source heat pumps in the United States. They put me in touch with the nearest dealership—60 miles away. This process took two weeks. And the outcome? I needed a 2½-ton heat pump for my house; the final price quote was over $13,000.

I ended up with a 14-SEER, variable speed, air-to-air Amana heat pump that cost $5,800. Elite Software's load calculation program had estimated my annual heating and cooling bill at about $350, and I didn't think the additional $7,000 for the geothermal system would have been recovered over the life of the unit.

I selected an HVAC contractor whom I had worked with professionally. I knew she would size the duct system and unit properly and seal the ducts—and she did. Using my DuctBlaster, I measured a leakage rate in the installed duct system, including the air handler, of only 36 CFM when pressurized to 25 Pascals. I was thrilled.

One of the first research projects I conducted at Virginia Tech involved comparing the life cycle costs of space heating using an electric water heater with a radiant slab under a time-of-use electric rate with a high-efficiency heat pump on a standard electric rate. The results showed that for the electric rates offered by my electric utility, American Electric Power–Virginia, the two systems cost about the same. I was interested in the idea of a radiant slab, and I was convinced that, because of my schedule, the time-of-use electric rate could save me money. To take advantage of it, I put my domestic water heater on a time clock and invested in a programmable thermostat to control the heat pump.



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The radiant slab was one of the few unusual items the homeowner ended up installing. Here, she checks polyethylene tubing. Heating the water with electric resistance heat is a major energy drain, but the homeowner expects to pay little thanks to a time-of-use electric rate.

As my pet project on the house, I installed piping for a three-zone radiant slab in the concrete floor on the ground level. Shelter graciously worked with me on project scheduling to allow me one-half day to get the pipe in place and the slab edge insulated before the concrete arrived. I didn't intend to hook up the radiant slab immediately, but since pouring concrete is such a permanent thing, I decided to put the pipe in so that it would be an option for future use.

Moving In

In January 1997, I moved in on the heels of an ice storm and the coldest weather of the year. Air temperatures were dropping into the single digits (Fahrenheit) at night and reaching only into the 20s during the day. My emergency heat—the wood stove—sat in my living room, waiting for special-order vent pipe to arrive.

The house experienced lots of solar gain and was toasty warm on sunny days. However, there wasn't sufficient thermal mass to carry through the night—I hadn't built in extra solar mass since off-peak energy is so affordable. Affordable or no, the house wasn't comfortable. During the night, the heat pump got overloaded, and the ambient temperature was in the low 60s by morning. I was huddling in bed at night with my goose down sleeping bag and an electric heating pad. To make matters worse, the downstairs bathroom was extremely cold.

I thought, "These *are* extreme temperatures. And I *did* elect to put only 5 kW (instead of the recommended 10) as backup electric resistance heat. Everything will be OK as soon as I get my wood stove hooked up."

So I shivered through January and February, assuming all would soon be made right. And then the first electric bill came. My energy modeling with Elite Software had predicted that my energy-efficient, 1,800 ft² home would have a heating bill of $60 per winter month; Virginia Home Energy Rating System software had estimated energy

use at a comically low $5 per year. But somehow, I had used over 3,000 kWh at a cost of $250.

I looked at my electric meter and discovered that the clock was set wrong! This meant the water heater was running during the peak period. I notified AEP; they gave me a new meter and made an adjustment to the bill.

I called my HVAC contractor and begged for help. She sent a crew out to check the system. It turned out they had wired the thermostat wrong—when it called for heat, the air conditioning was coming on. When it couldn't reach the setpoint temperature, it was bringing on electric resistance strip heat. No wonder I was cold and the bill was outrageous! While checking the HVAC, I discovered that the drywall contractor had completely covered the only heat register in the downstairs bathroom.

Now, a little over a year after moving in, I love my house. It is warm in the winter and cool in the summer. It is full of natural light. My monthly electricity bills are about $90 in winter, $70 in summer, and $30 in spring and fall. Largely due to the electric resistance space heat, the energy use is not low, at 740–2100 kWh per month, but it is affordable and comfortable. The time-of-use electric rate saves me $15–$20 per month.

The Voice of Experience

While my profession has educated me on some aspects of efficient buildings, the people at Shelter Alternatives have been hard at work finding the right compromise between installed system efficiencies and first costs. In the end, my home is not very different from what they would have built without all my micro-managing. Most of the innovative techniques I explored (SIPs, cellulose insulation, and a ground source heat pump) didn't end up getting used. However, Shelter never would have suggested installing the timers and thermostat to support the time-of-use electric rate, nor would they have achieved a duct system as tight as mine. They wouldn't have installed radiant tubing in the slab, but I'm not yet using that, either. Unless a customer requests otherwise, Shelter deals almost exclusively with one HVAC contractor, who refuses to use mastic on ducts—he uses "mastic tape."

I have learned that the economic viability of many energy-saving features depends on local standard practice. No matter how good a technique looks in the magazines, if there aren't contractors around who regularly do it, it probably won't be cost-effective.

I have also come to appreciate that building must go on. Decisions need to be made early in the construction process, so all scheduled work can proceed on time.

Finally, even with the best contractors, things can go wrong, and problems must be worked out. Persistence pays.

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