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INSIDE:

ZERO Energy, ZERO Excuses

The $8.64 monthly utility bill is here ... and it's realistic. PAGE 14

Missouri builder makes her own home an experiment lab for greener things to come.

Concocting an Energy-Saving Formula

by John Vastyan

Gemma McKee-Bartholomew's new home in the Ozarks has radiant heat comfort, air conditioning and domestic water heat-sourced from a geothermal system. More than that, the home is what she calls "a lab," by which she has developed a process for incorporating such systems.

"I planned this house for several years," McKee-Bartholomew explains. "Every facet of its construction, with special attention given to all mechanical components — my specialty — was thought through deliberately. It's essentially a live-in laboratory that was 'green-build' from the start, before 'green' became iconic as the new Holy Grail in construction that it is today."

McKee-Bartholomew is a nationally acclaimed geothermal expert who owns Kimberling City, Mo.-based High Tech Homes Construction, Consulting & Seminars and also owns Air Brokers HVAC LLC. McKee-Bartholomew's championship of smarter, earth-wise construction has earned her the local moniker, "Queen of Green."

McKee-Bartholomew fiddled with plans for a near-zero-energy home design for several years. Her plans finally took shape when she completed the home she built for herself near Branson, Mo. "When we at last broke ground, there were few surprises," she says. "Today, the home has surpassed my expectations for energy efficiency, performance and comfort. The lab test proved-out nicely, but we're still looking for ways to improve the formula. That's what High Tech Homes is all about."

Green from the Ground Up

McKee-Bartholomew is reluctant to ignore any key facet of a home's design. So, she often incorporates insulated concrete form (ICF) structural components to create an air-tight envelope. With her own Branson home, she opted for superbly insulated ICF for this slab-on-grade project.

Embedded in that concrete, the 3,570 square-

The 3,570-square-foot home uses 2,700 lineal feet of underfloor radiant systems in two heating zones.

foot single-level home incorporates about 2,700 lineal feet of Watts Radiant's RadiantPEX underfloor radiant systems in just two heating zones. The great room, office, master bedroom and all bathrooms comprise one zone. The second heating zone is made up of the dining room, living room, kitchen and guest bedroom. They also needed 1,200 lineal feet of Watts Radiant WaterPEX, a cross-linked polyethylene tubing used for radiant floor heating, snow melting and potable water.

The home was designed to require minimal maintenance, to maximize the use of renewable resources and for energy efficiency. "These were the key ideas from the earliest point," McKee-Bartholomew says. "On them, we hung every design, construction and mechanical concept."

Piling On Energy-Conscious Options

For the driveway, McKee-Bartholomew chose a "cultured" cobblestone, which requires no maintenance. Similarly, she used gutter helmets to whisk leaves from rooftops and composite decking that needs no regular sealing.

McKee-Bartholomew also selected a composite flooring with laminate oak, designed specifically for use over the radiant heat system. She also used compact fluorescent lights and low-flow toilets throughout the home.

Although McKee-Bartholomew knew her house would be an energy miser, McKee installed electrical sub-meters that measure energy use by the geothermal and domestic water heating systems. To do this, she uses three of the devices typically found in commercial or multi-housing buildings. Their purpose is to continuously monitor and track energy used for specific purposes.

"We expected 10 to 15 percent better efficiency, and a whole lot more comfort inside," McKee-Bartholomew says of her home. "What we got — with comparable winter conditions — was an astounding 22 percent greater efficiency with radiant. That's hard, objective data provided by the sub-metering of energy use." She adds, "With much better comfort from the radiant, we can set thermostats at around 68–69 degrees and accomplish a comfort level greater than the forced-air when set at 74–76 degrees."

Of course, this radiant system was not yet fully in place in time for the home's first winter season (2005/2006), but that didn't seem to matter. "The first winter heating of the home was provided strictly via the 2-ton, ground loop-to-air geo system that was originally intended for use only as a cooling system," McKee-Bartholomew explains.

In fact, from August 2006 through July 2007, the home required a net electric use of 1,104 kilowatt-hours. At 9 cents per kilowatt-hour, the 11th month period cost McKee-Bartholomew just $99.36 or $8.64 a month.

McKee-Bartholomew's energy data from last winter reveals that, when taking into consideration all the benefits of radiant heating (from an efficiency standpoint as well as a comfort and health perspective) radiant has a rapid payback, which dispels yet another misconception about the affordability of these systems, she says.

The Geo-Radiant Connection

The geothermal unit McKee-Bartholomew most recommends for super energy-efficient combination with radiant heat is ClimateMaster's Tranquility water-to-water heat pump. The "geothermal boiler" is a high-temperature, 4-ton (48,000 BTU) unit that accomplishes this with no electric heating of the water, giving it a coefficient of performance (COP) 25 percent higher than current units on the market, she says.

New scroll compressors within the Tranquility units make it possible to generate leaving water temperatures of up to 145°F even at ground loop minimum temperatures.

Until now, many experts in the hydronic industry, like Bob "Hot Rod" Rohr, have been reluctant to couple geothermal boilers with radiant. Rohr is *Phc News* magazine's hydronic columnist and is also president of Rogersville, Mo.-based Show Me Radiant. According to him, prior to the upgraded compressors, geothermal systems were producing temperatures typically in the 110-degree to 120-degree range. "With temperatures above 140 degrees," he says, "we can use it for all types of radiant heat, many forms of hydronic convection and to exchange heat for domestic water supply — all without need of expensive, additional electricity to generate that heat."

The hydronic system for McKee-Bartholomew's own home was designed by Rohr to deliver a range of temperatures. "We needed to accommodate the varying demands of an extensive floor heat system, one hydro-air coil and domestic hot water," Rohr says. Among the controls were Italian-made Caleffi three-way thermostatic valves, an air separator, a boiler fill and a backflow preventer. Rohr says Caleffi has won a stable following among hydronic devotees nationwide.

"And, because Gemma [McKee-Bartholomew]'s system may be altered and tweaked at a later time," Rohr explains, "we also used several three-speed SuperBrute circulators from Grundfos." He says that the circulators gave the home "the flexibility of increasing or reducing flow with the simple flick of a switch." He adds, "I'm also a real fan of the wet rotor design among circulators, using the liquid that's circulated to lubricate the device."

McKee-Bartholomew acknowledges that most "geo homes" are coupled with ducted water-to-air geothermal systems. "Radiant heat delivery offers comfort without compromise, but it is less expensive to provide heating and cooling through a ducted system," she says.

Nevertheless, McKee-Bartholomew insists, in the long run, such "geo home" designs are worth it. "An ultra-high efficiency geothermal system, a straight forward design and incredible energy savings all accelerate payback to the homeowner," she said. "While many in the residential construction industry will claim the cost to install geothermal HVAC systems is prohibitive, I say it's dirt cheap. And I have the data to back that up."

Water: Clean and Unwasted

According to some industry estimates, a family of four wastes 12,000 to 16,000 gallons of water per year without recirculation (or hundreds of thousands, if not millions, of wasted gallons per sub-division).

McKee-Bartholomew chose Grundfos' UP10-16 pump to recirculate domestic water within the home. The pump is installed above McKee-Bartholomew's indirect water heater and uses a dedicated return line (that's insulated) to accomplish the recirculation path.

In the opinion of McKee-Bartholomew, EcoQuest's Springhouse system has revolutionized the industry. Its seven stages of sediment filtration are augmented with a sequestering agent to treat hard water and prevent scale. It then uses a powerful UV light to disinfect the water it treats, instantly killing a host of microorganisms.

Upgraded compressors make it easy to couple geothermal boilers with radiant heat, says Bob Rohr of Show Me Radiant.

Inspired by the success of all the mechanical systems in her home, McKee-Bartholomew now hopes to take green construction into her region's affordable housing market.

McKee-Bartholomew is now preparing to develop a subdivision of small, energy efficient homes in the 960- to 1,400-square-foot range, with the goal of providing heat, air conditioning and domestic hot water production for as little as $12 to $15 a month.

"Why should sophisticated, energy-wise homes be available just to people of greater means?" she asks.

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Geothermal, the Understood System

A geothermal system is a heat exchanger that taps the earth's abundant energy in the most efficient means possible. The system harvests heat directly from the earth, which in North America maintains a constant temperature of about 50°F to 60°F year-round. This is possible because the earth absorbs about 48 percent of the sun's radiant energy.

While air-source heat pumps rely on ambient air temperatures that can range anywhere from 20°F to 120°F, the earth's constant temperature provides a much more favorable source for "geo-exchange" heating and cooling.

Drilling small diameter holes or excavating to accommodate geothermal heating/cooling isn't very complicated, according to Mike Bartholomew.

A modern geothermal system harvests heat from the earth through a liquid transfer medium, such as groundwater or an earth-friendly antifreeze solution. Typically, in a "closed loop" system, fluid flows through an extensive network of underground tubing. The fluid then flows into a heat pump.

The systems use ground water (or the earth itself) as a source of building heat in the winter and as a place to "sink" or bury that heat in the summer. The final process of thermal exchange takes place in mechanical equipment that serves both heating and cooling needs for homes and commercial buildings alike.

Depending on the size of the HVAC system to be installed, a series of holes are drilled in the earth near the home in which the ground loops are installed. Once installed and connected to the components inside the home, the loops are then filled with a water-glycol or water-methanol solution that ultimately transfers temperature from the home to the earth in the cooling mode, and from the earth into the home the heating mode.

According to geothermal expert Gemma McKee-Bartholomew, installation of a geothermal home comfort system is becoming simpler each year. Drilling small diameter bore holes, or excavating ground to insert PEX loops isn't very complicated. Either way, thermal transfer is achieved.

In the Winter

During the heating cycle, a geothermal system uses the earth loop to pull heat from the ground. It then distributes the heat through a conventional forced-air duct system or through radiant heat tubing in the floor.

In the Summer

In the cooling mode, a geothermal system conditions the air in interior spaces by reversing the process of thermal exchange. THB