Energy Woes Create Unprecedented Opportunity

Geothermal systems are the ultimate for efficiency and comfort.

By John Vastyan

When they made plans for their new 1900-square-foot four-bedroom home north of New Albany, Ohio, just northeast of Columbus, Jeff and Laura Heindrichs focused on ways to make their new home as environmentally friendly as possible.

Both Jeff and Laura considered the welfare of the environment to be a key concern when they constructed their home. They chose an Energy Star–certified builder and committed, early on, to installing a high-efficiency geothermal heating and air conditioning system.

Most geothermal loop installations are routinely completed in a day or two, but occasionally geothermal installations like the Heindrichs' offer unique challenges to the contractor and the loop installer.

The tract home builder, in this case, was unwilling to permit several tweaks to the design during the construction phase, including installation of the geo system. So the Heindrichs' waited until final occupancy before modifications could be made. The mechanical equipment installed by the builder was a 90% natural gas furnace with an air conditioning system — all of it packed into a small utility closet.

Adapting geothermal to their home called for creativity. Fortunately, the Heindrichs' research led them to Jeff Persons, president of Plain City, Ohio-based Geo Source One Inc., a mechanical contracting firm that specializes in geothermal and radiant heat systems.

A hydrogeologist who once served as a research associate for the National Water Well Association, a contributor to the *Water Well Journal*, and an instructor for NGWA education programs, Persons performed a detailed site review and recognized that the tight confines of the mechanical room called for the use of a "split system" geothermal unit with a coil installed on top of the existing gas furnace and the geothermal compressor section installed as a replacement for the outdoor condensing unit.

A WaterFurnace dual-capacity system was chosen as the most cost effective means to apply geothermal to the existing system. In addition, Persons expressed concern about the limited space for drilling in a small rear courtyard and several utility easements that presented new challenges.

If it was to work, this application called for a clean and precision drilling process. As the first order of business, Persons phoned Tim Yoder of Yoder Drilling and Geothermal Inc. in Sugarcreek, Ohio. A site visit by Yoder confirmed that their reverse circulation air rotary rig could access the site with minimal surface disturbance.

Plans were set to provide three boreholes to a depth of 150 feet to support a 3-ton (36,000 Btu) geothermal load. The reverse circulation air rotary system is particularly well suited to this type of application and is ideal for unconsolidated and soft rock conditions.

John Vastyan, based in Manheim, Pennsylvania, is a journalist and communications professional whose work focuses on the plumbing and mechanical, radiant heat, and geothermal industries. He can be reached at (717) 664-0535 or *cground@ptd.net*.

Yoder drilling crews arrived a few days after the August closing. Sheets of ¾-inch plywood were carefully laid down on the new asphalt driveway. New sod was shielded from the drilling process and a vacuum extraction line was used to remove excess water from around the drill site. As the drilling progressed, two crew members prepared the 150-foot vertical heat exchanger loops. Each geothermal loop is spooled out from a double spool coil, and a "U" bend is fused to the lines. Once the U-bend fusion cools, the lines are flushed with water and placed under a pressure test to assure there are no leaks.

Yoder crews, assisted by Geo Source One field personnel, then installed the 150-foot vertical heat exchangers plus a tremie line for pressure grouting the wells from the bottom to the top using a bentonite grout.

A Geo Source One crew arrived later in the week to begin installation of the high efficiency, dual-fuel split system. Once the drilling site had time to dry out, it was time to connect the three vertical loops to the geothermal unit. Sod was cut and rolled back to expose the area where the connective trenches would be dug. Refrigerant lines now connect the outdoor geothermal unit with the interior heating and A/C coil.

"We were so much more comfortable knowing that the system uses fossil fuels only for auxiliary heat," Laura says. "Our previous home was an old, drafty gas-guzzler."

The Heindrichs' first energy bills have been about $100 less per month than their previous, smaller home. "We're delighted with the system, our comfort within the home, and of course, the energy savings we're seeing," Laura adds. "We don't know yet what our neighbors are paying for fuel during these cold winter months, but judging from their curiosity about the geothermal system we installed, it's probably substantial."

Manufacturers use measurements of system efficiency, known as EER (energy efficiency ratio) for cooling and COP (coefficient of performance) for heating efficiency. The Heindrichs' WaterFurnace geothermal system has an EER of more than 20 — far higher than the highest efficiency air source units. The unit's COP of 4.0 (or 400% efficiency) means that it gives them four units of energy for every unit of electricity it consumes.

The Heindrichs' system taps the earth's abundant energy in one of the most efficient means possible, through direct contact with the soil, rock, and water below the earth's surface. Depending on the season of year, the heat pump system harvests or rejects heat directly from its contact with the earth, which maintains an average year-round underground temperature of about 53°F in central Ohio. While air-source heat pumps rely on a wide range of ambient air temperatures, the earth's constant temperature provides a much more favorable source for heating and cooling.

"Most geothermal systems operate at ranges of 250% to 400% efficiency. The systems we install most frequently — often coupled with radiant heat as the primary source of heat distribution — are made by WaterFurnace, the leading U.S. manufac-

Teamwork to maintain all connections in their correct position allows Ron Whaley of Geo Source One to make quick work of over 60 copper-to-copper fittings on a massive primary-secondary geothermal pumping manifold. Geo Source One prefers the Pro-Press system for this work. Photo courtesy of WaterFurnace.

Jeff Persons of Geo Source One trims the polyethylene loop manifold lines prior to connecting to the geothermal loop "flow center" pump pack. Photo courtesy of WaterFurnace.

A drilling crew from Yoder Drilling and Geothermal sets up and drills the first of three 150-foot vertical heat exchange wells at a job in New Albany, Ohio. Photo courtesy of WaterFurnace.

turer of water-source geothermal systems," Persons says. "They also offer several systems of even higher efficiency for residential and commercial application. With the variety of options available for installation of the earth field, and the highest operational system efficiencies, up into the 400% to 450% range, geo systems are a great choice for many homes or buildings, especially now as energy rates skyrocket."

Persons has seen the development of a trend during the past few years. "Homeowners with gas-fired furnaces are fed up with increasing fuel costs, so they're asking about geothermal retrofits. We've been doing a lot more of these recently where the existing system's fan unit is used as the new geothermal system's air handler, and the gas burners need only operate for supplemental heat in the very coldest of weather conditions."

Commercial geo drilling: A different realm

Geo Source One routinely taps Mansfield, Ohio-based Jackson & Sons Drilling and Pump Co., a firm, unlike Yoder, that specializes in large commercial geothermal drilling projects. The rigors of commercial geo work are illustrated in an experience that unfolded recently.

Jackson was hired by the project's engineering firm. One of their crews spent several days working on a test well that was supposed to go to 300 feet. Engineers had specified the need for a test well prior to drilling 50 or more 300-foot vertical holes for a public building. But the limestone bedrock became so fractured and loose that the test well could progress to only about 225 feet. It took three attempts while running the drill tools to get the hole open to allow passage of the loop lines. The Jackson crew had to stop drilling, not because of the loose rock formation but because the well was producing more than 250 gallons per minute of water flow.

Clearly, the test well for this commercial project proved invaluable, and because a single 300 gpm well (not 50, 300-foot wells) could potentially serve the needs of this entire building, it opened the possibility of a much less expensive open-loop geothermal system.

"No doubt, there are many factors to take into consideration when planning a large project," says Greg Wells, a certified geoexchange designer at Jackson. "Hasty bidding without a good understanding of the subsurface conditions could be potentially devastating to anyone who may have bid this project, site unseen and untested. Site conditions can play a key role in how a project should be designed."

geothermal/*continues on page 16*

Annual Heating, Cooling, and Hot Water Cost Comparison

	System Type	Est. Cost
Northern Climate	Geothermal with Dedicated Hot Water	$746
	Geothermal with Hot Water Assist	$874
	Heat Pump	$1,552
	Heat Pump with Natural Gas Backup	$1,737
	Fuel Oil & A.C.	$2,218
	High Efficiency Natural Gas & A.C.	$2,418
	Electric Furnace & A.C.	$2,476
	Standard Efficiency Natural Gas & A.C.	$2,895
	High Efficiency Propane & A.C.	$2,999
	Standard Efficiency Propane & A.C.	$3,605
Southern Climate	Geothermal with Dedicated Hot Water	$596
	Geothermal with Hot Water Assist	$737
	Heat Pump	$1,213
	Electric Furnace & A.C.	$1,278
	High Efficiency Natural Gas & A.C.	$1,458
	High Efficiency Propane & A.C.	$1,698
	Standard Efficiency Natural Gas & A.C.	$1,708
	Standard Efficiency Propane & A.C.	$1,960

Based on Fuel Rates of:
Electric: $0.07/kWh
Natural Gas: $1.50/ccf
Propane and Fuel Oil: $1.75/gal

A crew installs a 150-foot polyethylene vertical loop line into a completed vertical heat exchanger well. Photo courtesy of WaterFurnace.

Jeff Persons of Geo Source One reviews wiring connections that will link the WaterFurnace Synergy III system to the multiple tasks for forced air and radiant heating loads it will handle. Photo courtesy of WaterFurnace.

geothermal/*from page 15*

Water-source systems: A popular choice

"Only a small amount of electricity is needed to power geo systems," says Bruce Ritchey, president and CEO of Fort Wayne, Indiana-based WaterFurnace. "The rest of the process uses the free, clean, and renewable energy that's tapped just below the earth's surface."

There are two basic types of water-source geo systems: open-loop and closed-loop (see illustrations). An open-loop system typically pumps water out of a deep well, extracts heat from it (or, in the summer, rejects heat into it), and then moves that water back into another well, pond, or river.

A closed-loop system uses a continuous loop of buried plastic tubing as a heat exchanger. The tubing is connected to the indoor heat pump to form a sealed, underground loop through which an antifreeze solution is circulated. Unlike an open-loop system that consumes water from a well, a closed-loop system recirculates its heat-transferring solution in the pressurized pipe. Many closed loops are trenched horizontally in yards adjacent to the home, set in vertical wellbores, or submerged into a pond.

Comparing the two water-source units, an open-loop system tends to be more efficient because it simply transfers thermal energy to and from a steady stream of subterranean water. It's not recirculated as with a closed-loop system. The choice of loop type depends mostly on:

- water table, well yield, water quality, and an environmentally sound means to accommodate the discharge water if using an open-loop design, or
- surface area, soil moisture, soil type, depth to bedrock, drilling conditions, and site access when opting for a closed-loop system.

Although not yet familiar to everyone, ground-source heat pumps have been installed for more than 30 years and are recognized as the most highly efficient heating and cooling systems available today.

"Geothermal heat pump technology offers a renewable energy solution that's right for almost any home," adds Ritchey. "Thermal energy of sufficient temperatures anywhere in the United States and Canada is harvested from the earth and transferred into buildings by a heat pump that provides heating and cooling."

With just an acre or more of land or the ability to drill holes or tap an existing water source (pond or lake), chances are it's your customer's best hedge against an energy crisis that creeps closer to home each day.

A geothermal unit works like a conventional heat pump to cool a home in the summer and heat it in the winter. The key difference between an air source heat pump (which can't heat a home efficiently when outdoor temperatures dip below 30°F) and a geothermal heat pump is that the geothermal unit harvests the stable and renewable heat from beneath the earth's surface. In the summertime the cycle is reversed and heat is released into the ground. As a result, a geothermal unit saves energy, which reduces greenhouse gas emissions and can cut utility bills by up to 70%. And, very little maintenance is required.

Earth loop guidelines

There are a couple key recommendations to follow when drilling or excavating a geo field. Before the soil is disturbed, of course, the site must be inspected to ensure the absence of electric, gas, water, sewer, irrigation, and telephone lines. Excavations are subject to OSHA regulations (*Federal Register*, volume 54, no. 209, October 31, 1989. Rules and Regulations page 45965 [29 CRF Part 1926]). Earth loop installations are not to be within 10 feet of a water line or 50 feet of a water well, septic system, drainage zone of a building downspout, or below the collection basin of de-icing salts or barnyard runoff.

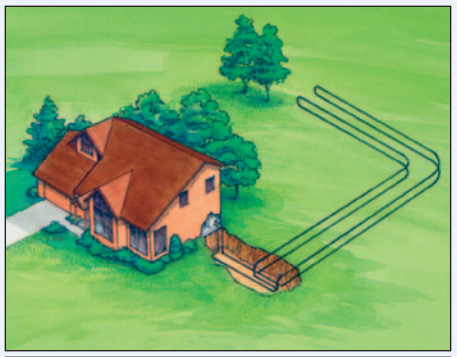
Once the earth loop (or geo field) is in, installation of a ground source heat pump is very similar to an air source installation. Geothermal condensing units (the enclosure with the compressor) do not require air circulation, as do typical air source systems, so they may be installed in a basement or utility room. System ducting and the setting of equipment is comparable.

Typically, any geothermal system provides service for up to 20 years or more, substantially longer than

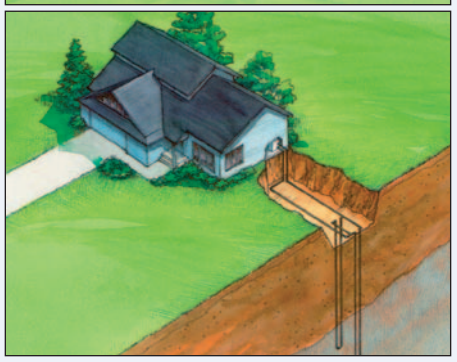
geothermal/*continues on page 18*

Four Basic Geothermal Energy Sources

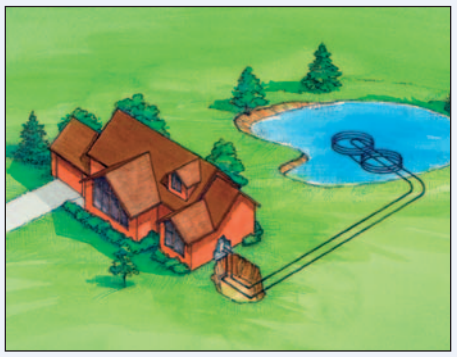
Closed-loop systems circulate a water-based solution through a "loop" of small-diameter, underground pipes. Closed-loop systems can be installed horizontally, vertically, or in a pond. Open-loop systems use an existing water well. Regardless of whether the system is open or closed, heat is transferred to or from the home to provide year-round comfort, no matter what the outdoor temperature is.



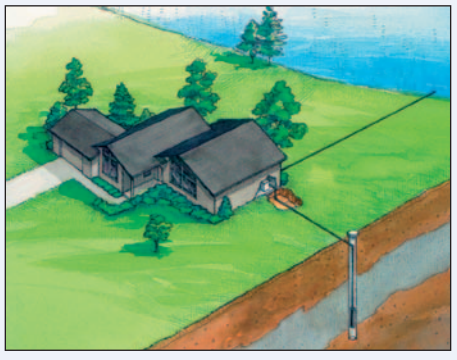
Horizontal Loops
These are often considered when adequate land surface is available. Pipes are placed in trenches that range in length from 100 to 400 feet.



Vertical Loops are the ideal choice when available land surface is limited. Drilling equipment is used to bore small-diameter holes from 75 to 300 feet deep.



Pond (Lake) Loops are very economical to install when a body of water is available, because excavation costs are virtually eliminated. Coils of pipe are simply placed on the bottom of the pond or lake.



Open Loops use ground water as a direct energy source. In ideal conditions, an open-loop application can be the most economical type of geothermal system.

geothermal/ *from page 16*

the life expectancy of air source heat pumps. This is because the stable heat source avoids thermal stresses to the compressor, the enclosed unit is out of the weather, and no fossil fuel is burned by the system.

All-in-one system for low cost hot water

Geothermal heat pump systems do the work that typically requires two appliances: a furnace and an air conditioner. Many systems can provide a third function, which is to heat a home's domestic water by one of two means: through integrated full-time water preheating, or through "desuperheating" water heating.

Integrated water heating (on demand) uses the heat pump system to heat water at any time of the year. Its first cost is higher, but it provides operating savings all year. Because this water heating option has the full heat pump system capacity available to heat water, it can provide quicker recovery (going from cold to hot) than an electric resistance water heater.

A desuperheater reclaims heat from the air conditioning cycle to heat water. Its first cost is lower. Savings are realized in the cooling season by transferring waste heat to your hot water storage tank. Even in the heating mode, the desuperheater can provide pre-heating to the water heater, reducing the work required of the electric resistance elements. A desuperheater provides free water heating throughout the summer season. The average year-round savings is typically in the 40% to 60% range.

"It's been a real education for both of us," Jeff Heindrichs says. "We're certain we made the right move to install geothermal, especially considering that we expect to be in this home a long time.

We're very pleased with the system. We recommend geothermal — and Geo Source One — to anyone who asks." *WWJ*

Industry Sources

Jeff Persons
Geo Source One
(614) 873-1140
www.geosourceone.com

Geothermal Resources Council
www.geothermal.org

Geothermal Heat Pump Consortium
www.geoexchange.org

James Jackson and Greg Wells
Jackson & Sons Drilling and Pump Company
(800) 343-8037
www.jacksongeothermal.com
wellsgeo@aol.com

WaterFurnace
(888) GEO-SAVE (436-7283)
www.waterfurnace.com

Tim Yoder
Yoder Drilling & Geothermal Inc.
(330) 852-4342
tim.yoder@starband.net

A Tale of Two Drillers

Jeff Person's best resources for geothermal drilling and vertical loop placement are Jackson Drilling in Mansfield, Ohio, and Yoder Drilling in Sugarcreek, Ohio. Each has their own unique approach to the business. "They're both excellent drilling firms who play a valuable role in the success of our business," says Persons. At a glance, here's a look at both firms.

Jackson & Sons Drilling and Pump Co.
James Jackson and Greg Wells

- Primary business: commercial drilling and geothermal loop installation.
- 5 Ingersoll Rand air-mud rotary drilling rigs (T55 and T60).
- 1 VersaSonic drilling rig (a recent $1 million purchase). "It's the best system for unconsolidated formations like sand, gravel, glacial tills and fines, and large cobbles," says Greg, a certified geoexchange designer. For typical commercial jobs, Jackson crews drill and insert loops, taking their materials to the building wall and stop there.
- Jackson's advantage is the size of the firm. "We can bring multiple drilling rigs to the project," Greg says. "Many commercial jobs today require more than one rig on site to meet the schedule."
- Commercial geothermal drilling is 50% of the company's overall business.
- The company, in business since 1978, has 35 employees.

Yoder Drilling & Geothermal Inc.
Tim Yoder

- Yoder Drilling got its start in the drilling business 39 years ago while working in the mining industry. In its early years, it did mine hole blasting exclusively. Today, the firm gets 65% to 70% of its income from residential geothermal drilling, with the remaining income stemming from drilling associated with coal exploration and blasting.
- Tim Yoder is a third-generation co-owner of the business.
- Most of Yoder's drilling rigs are reverse-circulation air rotary systems based on a SIMCO framework but are then customized for special application. "We also have one conventional air rotary rig for solid formation drilling," says Yoder.
- The company has 32 employees and provides geothermal drilling services to many mechanical contracting firms in Ohio.