Direct-Exchange Geothermal Systems Coming Into Their Own

John Vastyan

New, more efficient geothermal technology is bumping aside the standard, water-source heat pump system. A shrinking landscape, higher system efficiency and the need to give progressive HVAC contractors a solution for their customers has shined its light on one of the most exciting developments in the "geo" field: direct-exchange systems.

Santa Cruz, Calif., homeowners Mark and Karen Pace in 2003 took the geothermal plunge, having a direct-exchange (DX) EarthLinked heating and cooling system installed at their circa '76 geodesic dome. Glenn Bland, owner of Bland Air Conditioning and Heating, Inc., based in Bakersfield, installed a 42,000 BTU direct-exchange geothermal system to heat and cool the 2,000 square foot structure, supported on the side of a wooded mountain by 20 steel piers.

"We made it without air conditioning until the summer of 2002," Mark Pace said. "When the temperature outside reached 118 degrees, we decided we'd taken enough punishment."

The type of system the Paces chose—at the cutting edge of heat pump technology—is offered by two firms, ECR Technologies, Inc., and American Geothermal DX, a pair of purveyors and developers of higher-efficiency DX technology.

Owners of similar systems in other parts of the country have reported paying significantly less for heating and cooling bills after their systems were installed. Witness Del Leese who, in 2001, installed a similar system in his 3,200 square-foot home in Mechanicsburg, Pa. Last year, Leese paid only $650 (about $55 per month) for heat, air conditioning and hot water. When compared to the average $220 per month that his neighbors are paying for these services in homes of about the same size, Leese is saving more than 70 percent for utility expenses. It's typical of what he's seen during the last three years: "For four years now, we've seen how it gives us four to five units of energy for every unit of electricity it consumes," Leese said.

While Mechanicsburg's climate doesn't have much in common with Santa Cruz's, the principles at work remain the same. Manufactured by Lakeland, Fla.-based ECR Technologies, Inc., Leese's system taps the earth's abundant energy in the most efficient means possible: The system harvests heat directly from the earth, which maintains a constant temperature of about 52 degrees Fahrenheit. 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.

Jody Hoffman of Hoffman Mechanical installed the 3?-ton (42,000 BTU), 14-loop DX system for the Leese home by drilling fourteen 2?-inch diameter holes at 45 degree angles to depths of 50 feet.

Bore-holes are drilled into the side of a manifold pit, connected by trenching.

From the variety of loop configurations available for a DX system, Hoffman and Leese chose the diagonal method, which disturbs the least amount of earth. For homes where ground space is limited, or especially for existing homes with mature landscaping, this configuration is ideal because all of the small-diameter drilling takes place from a shallow, six-square-foot pit, with drill holes radiating outward and down at an angle from the base of the pit.

"Most geothermal systems operate between ranges of 250- to 350 percent efficiency," said Hoffman, who's installed many types of geothermal heating and cooling systems for more than 20 years. "With the variety of options available for installation of the earth field, and the highest operational system efficiencies, up into the 400 percent range, conservatively, DX is a great choice for many homes or buildings."

While some geothermal systems rely on plastic piping to

System description	Total heating cost	Total cooling cost	Water heating cost	Total operating cost	Average monthly cost
Direct-exchange geothermal	$356	$282	$163	$801	$67
Closed-loop, water-source geothermal	$478	$326	$389	$1,193	$99
Air source, 12 SEER HP	$487	$431	$554	$1,472	$123
12 SEER A/C w/80% nat-gas furnace	$1,057	$443	$373	$1,873	$156
12 SEER A/C w/80% fuel oil furnace	$1,407	$453	$502	$2,362	$197
12 SEER A/C w/80% propane furnace	$1,142	$464	$322	$1928	$161

This representative example for Fresno, Calif., used $.10 per KWh for electricity, $1.30 per therm for natural gas, $1.620 per gallon for propane (LP), $1.55 per gallon for fuel oil. For hot water, we assume the need for 60 gallons of full-temp. hot water, calculating a 65°F rise in temp.: 60°F ground (entering water temperature) with a tank temp. of 125°F.

transfer water and antifreeze through a plastic loop and an intermediate heat exchanger, DX technology circulates a refrigerant through highly conductive copper earth loops embedded in a protective thermal grout that enables direct transfer of energy with the earth. The loops are inserted into bored holes between 50- and 100 feet deep.

DX and water-source geo systems usually run about the same installed cost—usually several thousand dollars more than a conventional, air-to-air heat pump—though with DX you'd see better operating efficiencies and, possibly, something akin to "surgical insertion" of the ground loops. The process of getting the tubing in place for a DX system is faster and far less invasive to the property, making it possible to retrofit homes with mature landscaping.

Although not yet familiar to everyone, ground-source heat pumps have been installed for more than thirty 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," said Gemma Tiller, spokesperson for Air Brokers HVAC, based in Branson, Mo. "Thermal energy of sufficient temperatures anywhere in the U.S. and Canada is harvested from the earth and transferred into buildings by a heat pump that provides heating and cooling."

Even if a customer has a small patch of land, chances are it's their best hedge

The proximity to the house and lack of spaciousness during this California installation made the diagonal boring method preferable

against an energy crisis that creeps closer to home each day. Thermal energy is stored in the ground, ready to be used. "Newer technology extracts it with greater ease, with little disruption to the surrounding landscape, and at such high operating efficiencies, it makes payback on the investment faster than ever before," Tiller said.

A ground-source unit works like a conventional heat pump to cool and heat a structure. The key difference between an air source heat pump and ground-source, is that the ground-source unit harvests the stable and renewable heat from beneath the earth's surface.

"The equipment transfers virtually endless thermal energy from the earth into the home during the winter months and transfers excess heat from interior spaces into the earth where it's stored during the summer," Bland said.

As a result, a ground-source unit saves energy, which reduces greenhouse gas emissions and can cut utility bills by up to 70 percent. And very little maintenance is required. Surveys of ground-source owners conducted by the Geothermal Heat Pump Consortium show they rank their systems higher in comfort than do the owners of other heating and cooling systems. And more than 95 percent of owners say they would recommend ground-source to friends and family members.

Operational Efficiencies and Cost

Let's compare system efficiencies and operating cost. Using one of the most widely accepted professional software platforms available (Audit, by Elite), we plugged in some data for intelligence on a typically-insulated, new home of 2,436 square feet in Fresno, Calif. Also this: a family of 4 is in the home 12 hours a day. The cooling load came in at 35,184 BTUs an hour, and the heating load needed is 32,094 BTU/hr. Also included in the calculation is the heating of all domestic hot water for clothes washing, bathing, etc.

=Tiller, who has experience installing all types of geo systems, prefers DX technology because the refrigerant lines are placed in direct contact with the heat source without the need to pump water through an intermediate heat exchanger. These systems are ideal for new construction and retrofit installations with earth loops installed vertically, diagonally or horizontally.

Typically, any geothermal system provides service for between 25 and 30 years, which is twice 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

In addition to interior heating and cooling, many geothermal 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 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 preheating to the water heater, reducing the work required of the electric resistance elements.

A desuperheater provides free water heating throughout the summer season, and typically reduces water heating costs between 40- and 60 percent depending upon the amount of cooling required.

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