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Annual Home Energy Review

Home Systems & Technology Explored

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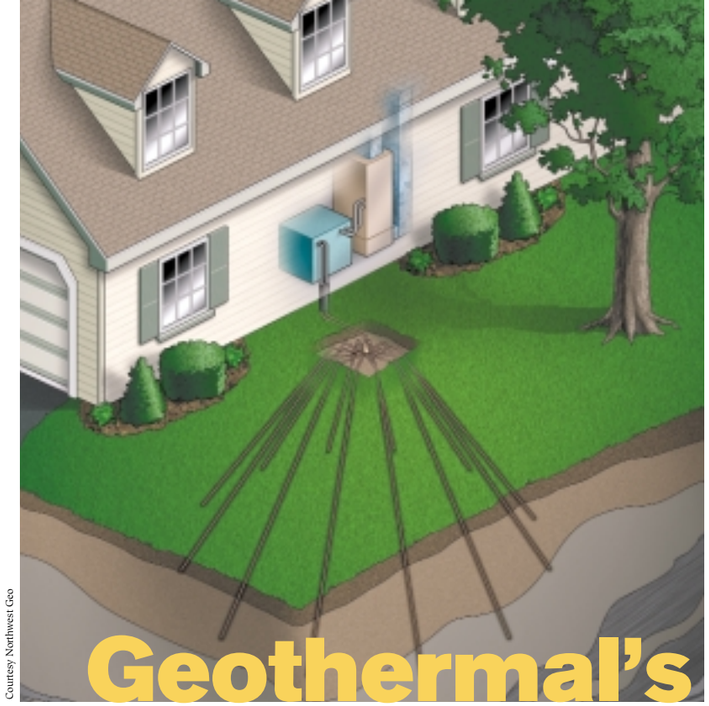


Courtesy Northwest Geo

Geothermal's New Twist

Direct-exchange geothermal systems raise the bar for home-heating and cooling efficiency

BY JOHN VASTYAN

Four years ago, at a time when fuel prices were relatively low and Detroit was kicking out more SUVs than sedans, Del Leese sensed a looming energy crisis. When he and his family constructed their new home in Mechanicsburg, Pa., he made the decision to install a geothermal heating and cooling system. Now, while many of his neighbors are experiencing record-high electric and gas utility bills, Leese and his family are enjoying record savings.

After months of research, which entailed comparing water-sourced and direct-exchange (DX) geothermal systems, and interviewing installing contractors, Leese settled on an EarthLinked direct-exchange heating and cooling system. The type of system he chose — one that's at the cutting edge of heat-pump technology — is offered by only two firms, ECR Technologies Inc. of Lakeland, Fla., and American GeoThermal DX of Murfreesboro, Tenn. Both companies separated themselves from the pack by developing higher-efficiency DX geothermal technology.

Last year, Leese paid only $650 (about $55 per month) for heat, air conditioning and hot water in his 3,200-square-foot home, compared to the average of $220 per month his neighbors paid for these services in homes of about the same size. A quick calculation reveals that Leese is saving more than 70 percent on utility expenses. It's typical of what he's seen during the last three years.

"Our previous home had electric baseboard heat and window air-conditioning units," Leese says. "It was terribly inefficient and rather uncomfortable at that. Today, the comfort is seamless and smooth year-round, and the system is entirely reliable. We're delighted with the geothermal system."

The diagonal method of installing a DX geothermal system disturbs a minimal amount of earth, as drilling takes place from a 6-square-foot pit.

Leese adds, "We decided before moving in that we would separately monitor the system's energy use. For four years now, we've seen how it gives us four to five units of energy for every unit of electricity it consumes."

Manufactured by ECR Technologies, the Leeses' EarthLinked system taps the earth's abundant energy in the most efficient means possible, through direct contact with the earth. It harvests heat directly from the earth, which maintains a constant temperature of about 52° F in central Pennsylvania. This provides a much more favorable source for heating and cooling than the constantly varying ambient air temperature, upon which air-source heat pumps rely.

Jody Hoffman of Hoffman Mechanical installed the 3-1/2-ton (42,000-BTU), 14-loop DX system for the Leese home by drilling 14 2.5-inch-diameter holes at 45° angles to depths of 50 feet. 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, and especially for existing homes with mature landscaping, this configuration is ideal because all of the small-diameter drilling takes place from a shallow 6-square-foot pit, with drill holes radiating outward and down at an angle from the base of the pit.

"Most geothermal systems operate at ranges of 250 percent to 350 percent efficiency," says Hoffman, who has installed many types of geothermal heating and cooling systems during more than 20 years in business. "That means the systems supply up to three-and-a-half units of heat for every unit of electrical energy required to operate them. With the variety of options available for installation of the earth field, and with the highest operational system efficiencies up into the 400 percent range, conservatively, DX is a great choice for many homes or buildings."

> "Even if you have a small patch of land, it's your best hedge against an energy crisis that creeps closer to home each day."

While some geothermal systems rely on plastic piping to transfer water and antifreeze through a plastic loop and an intermediate heat exchanger, DX technology circulates a refrigerant through highly conductive copper earth loops that are inserted into boreholes of 50- or 100-foot depth, then embedded in a protective thermal grout that enables direct transfer of energy with the earth.

Water-Source Systems

While Leese opted for a DX system, water-source geothermal systems are also viable for residential use. "Only a small amount of electricity is needed to power geo systems," says Bruce Ritchey, president and CEO of Fort Wayne, Ind.-based WaterFurnace, a leading manufacturer of water-source geothermal systems. "The rest of the process uses the free, clean and renewable energy that's trapped just below the earth's surface."

There are two basic types of water-source geo systems: open loop and closed loop. An open-loop system typically pumps water out of a deep well, extracts heat from it, and injects it back into another well or a 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.

Comparing the two water-source units, an open-loop system tends to be more efficient because it simply pulls the heat out of a steady stream of water from deep in the ground. It's not recirculated, as with a closed-loop system. But open-loop systems are prohibited in many parts of the country because of water quality and water conservation concerns.

DX and water-sourced geo systems cost about the same to install (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 less invasive to the property, making it possible to retrofit homes with mature landscaping.

Although not yet commonplace, ground-source heat pumps have been installed for more than 30 years and are recognized as the most efficient heating and cooling systems available today. "Geothermal heat-pump technology

Courtesy Northwest Geo

The Decision-Making Process

There's a lot to consider when deciding whether or not to install a geothermal heating and cooling system for your home. To help you out, we've provided the following checklist, which you can refer to as you work through the decision-making process.

1. Research the types of equipment available. Visit websites; make calls.
2. Consider the available location and space for the geothermal system's earth-loop installation.
3. Determine what you want the system to do:
   - heat only
   - heat and cool
   - provide domestic hot water
4. It's also important to consider how the heat will be distributed:
   - by forced air
   - by hydronic baseboard or radiant heat
5. Call some installers and ask questions.
6. Invite installers to assess capacity needs and installation methods, price and cost recovery through energy savings.
7. Discuss loop configurations with dealers, as well as the options between direct exchange and water-sourced.
8. Compare efficiencies and costs.

Industry Sources

Geothermal Resources Council
www.geothermal.org

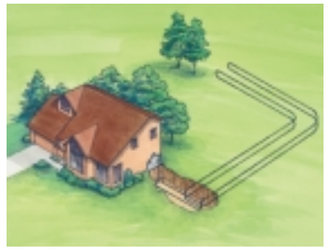
Air Brokers HVAC
www.airbrokershvac.com

American Geothermal DX
www.amgeo.com

ECR Technologies Inc.
www.ecrtech.com

Hoffman Mechanical
www.yourcomfortlink.com

WaterFurnace
www.waterfurnace.com



Courtesy WaterFurnace International

Closed-loop geothermal water source systems (top and middle) use continuous loops of buried plastic tubing as a heat exchanger. Open-source systems (bottom) use ground water as a direct energy source for home heating and cooling.

offers a renewable-energy solution that's right for almost any home," says Gemma Tiller of Air Brokers HVAC in Branson, Mo. "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."

Even if you have a small patch of land, it's your best hedge 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 notes.

A ground-source 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 ground-source pump is that the latter harvests the stable and renewable heat from beneath the earth's surface. The equipment transfers virtually endless thermal energy (heat) 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.

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 conducted by the Geothermal Heat Pump Consortium show that ground-source owners rank their systems higher in comfort than do the owners of other heating and cooling systems. Also, more than 95 percent say they would recommend ground-source systems to friends and family members.

Tiller, whose company installs 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.

> "An open-loop system is more efficient than a closed loop because it simply pulls heat out of water from deep in the ground."

Typically, any geothermal system provides service for up to 30 years, which is twice the life expectancy of air-source heat pumps. This is because the stable heat source helps prevent thermal stress to the compressor, the enclosed unit is out of the weather, and no fossil fuel is burned other than the electricity to operate the system.

An All-in-One System

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 (on demand) water heating uses the heat-pump system to heat water any time of the year. Its initial 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 initial cost is lower, and savings are realized in the cooling season by transferring waste heat to your hot-water 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 by 40 percent to 60 percent, depending on the amount of cooling required.

Return on Investment

To calculate system payback with some accuracy, you must know how much per year you'll save in energy costs with a geothermal system and the difference in costs between it and the alternative heating system and central air conditioner. To calculate your return on investment (payback in number of years), divide the additional cost by the annual savings. When you install a geothermal system in a new home, the monthly savings in operating costs will generally offset the additional monthly cost in the mortgage and result in a positive monthly cash flow from the first month. That's a return on investment any homeowner can appreciate. When you factor in the environmental benefits, geothermal seems like an alternative energy source whose time has come. ■

Manheim, Pa.-based John Vastyan is a journalist and communications professor whose work focuses on the plumbing and mechanical, radiant heat, and geothermal industries.

Operational Efficiencies and Cost

To help determine payback periods, we'll compare geothermal system efficiencies and operating costs. This chart is an at-a-glance reference for the annual and monthly costs of operating several different home comfort systems. Using one of the most widely accepted professional software platforms available (Audit by Elite), we plugged in some data for a typically insulated 2,436-square-foot new home in Chicago (read: c-c-cold winters and hot, muggy summers). We also assumed that a family of three is in the home 12 hours a day. The cooling load came in at 24,717 BTU an hour, and the heating load is 43,668 BTU per hour. Also included in the calculation is heating domestic hot water for clothes washing, bathing, etc.

This representative example assumed $.09 per kwh for electricity, $1.30 per therm for natural gas, $1.62 per gallon for propane (LP) and $1.55 per gallon for fuel oil. For hot water, we assumed the need for 60 gallons of full-temperature (125° F) hot water, calculating a 75° F rise in temperature if the entering water temperature (from the ground) is 50° F.

System Description	Annual Heating Cost	Annual Cooling Cost	Annual Water-Heating Cost	Total Annual Operating Cost	Average Monthly Cost
Direct-exchange geothermal	$463	$135	$225	$823	$69
Closed-loop, water-source geothermal	$602	$156	$512	$1,270	$106
Air source 12-SEER* heat pump	$737	$193	$512	$1,441	$120
12-SEER A/C w/80% nat.-gas furnace	$1,301	$193	$515	$2,009	$167
12-SEER A/C w/80% fuel-oil furnace	$1,421	$193	$330	$1,945	$162
12-SEER A/C w/80% propane furnace	$1,733	$193	$512	$2,437	$203

*SEER: seasonal energy efficiency ratio