Heating and Cooling from "Down Under"

The phone at South Mississippi Electric (SME) is ringing many more times a day than usual, with questions concerning the obvious drilling and black pipe emerging from 270-foot-deep boreholes in the ground.

What is all the digging about? South Mississippi Electric is in the process of installing a geothermal heating, cooling and water heating system. "With prices rising on all forms of energy, we feel it's our responsibility to demonstrate energy efficient solutions on a corporate level as well as to promote energy efficient home products," said Jim Compton, CEO and General Manager of SME.

This is South Mississippi Electric's second geothermal project. The first was installed at the organization's newly-built Field Operations Center to serve all the buildings on the 60-acre campus, including offices, a warehouse, cooking pavilion and vehicle maintenance shop.

What is a Geothermal Heat Pump System?

Geothermal heat pump systems are sometimes called geoexchange systems, ground source heat pumps, water source heat pumps, or earth coupled heat pumps. By any name, these electric systems use the earth's constant temperature to provide ultra-efficient heating, cooling, and water heating for homes and buildings. Geothermal heat pumps should be differentiated from the type of geothermal heating which uses steam from underneath the earth's surface.

How Does Geothermal Work?

Geothermal heat pump systems have four basic components: the ground loop (heat exchanger), the inside pumps/piping, the indoor heat pump unit, and the air delivery system (ducts).

The ground loop is a system of pipes usually buried in the ground near the building. The closed loop system, like the one at South Mississippi Electric, re-circulates the same water continually from the building to the ground. Closed loops of high density polyethylene pipe can be placed in vertical boreholes, in horizontal trenches, or in a body of water.

Geothermal Heating, Cooling, and Water Heating System being installed at South Mississippi Electric in Hattiesburg

Geothermal Components

Ground Loop
Water Pumps & Piping
Indoor Heat Pump Unit
Air Distribution (Ducts)

Geothermal Benefits

Greatest Energy Savings
Long Loop Life
No Noisy Outdoor Units
Greater Comfort

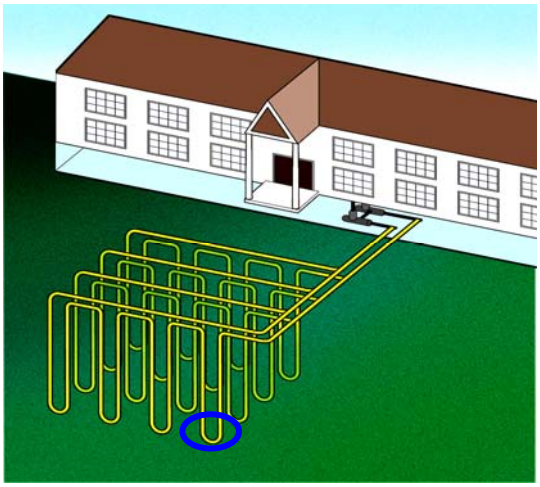


Figure - courtesy of the Geothermal Consortium

The U-bend of high density polyethylene pipe is a prefabricated and factory pressure tested heat fusion, which will be placed at the bottom of a 270-foot-deep borehole. This roll of pipe will fill one of 172 boreholes at SME's headquarters facilities and will carry a 55-year warranty.

By contrast, an open loop typically uses water from an underground source and dumps the water back to the source once it has circulated through the system. Open loop systems, often called "pump and dump" systems, have a small efficiency advantage. However, maintenance due to water mineral deposits may offset open loop efficiency gains. Closed loop systems remain the most popular choice of heat exchanger for new systems in our state.

In winter, the indoor geothermal heat pump unit receives water that has been warmed by the underground temperature. The unit uses a conventional vapor compression refrigerant cycle, extracting heat from the water and concentrating the heat until the temperature rises. Air blows over the heated coil and ducts deliver the warmed air to the heated space. The cooled water is then returned to the ground loop to be warmed again.

The process works in reverse for cooling. Water cooled by earth's underground temperature is delivered indoors to the geothermal heat pump unit. As indoor air blows across the coil, heat is absorbed by a refrigerant and transferred to the loop water. The heated loop water re-circulates to deposit heat into the earth.

In short, the earth is the heat sink in summer and the building is the heat sink in winter. Heat removed from the ground in winter is returned to the ground in summer. Some commercial geothermal systems are hybrids, using a cooling tower to regulate loop temperatures in summer.

Where Goes the Grout?

Loop installers pump a grout mixture into the borehole to fill voids between the earth and the pipe. The grout enables more efficient transfer of heat to and from the ground. Any voids in contact between the earth and the loop mean less heat transfer and fewer dollars saved for the owner. Boreholes should be grouted from bottom to top. A dozen or so pallets of bagged grout are currently on the site to be used in SME's loop installation.

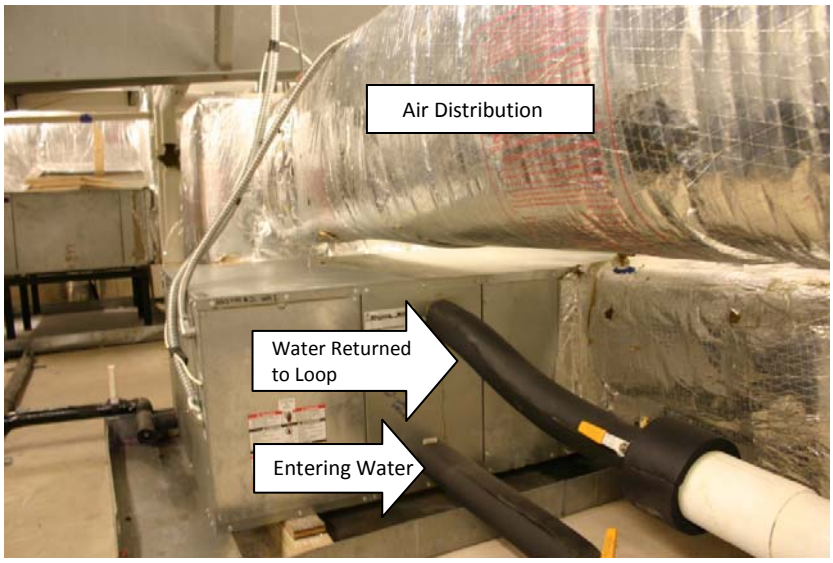
Is Geothermal Cost Effective for Commercial Buildings?

The percentage cost differential between a new commercial geothermal installation and a new traditional chiller/boiler is relatively small considering the potential for energy savings. In many cases, a positive cash flow can be expected from day one, given the rising cost of electric power. Drilling costs vary widely regionally, as do the experience and qualifications of installers. If a site has expansive land area or a body of water, builders may find a pricing advantage with different loop alternatives.

South Mississippi Electric's cost comparison study indicated that the purchase cost for the geothermal system would be 14% greater than a traditional system. Based on today's retail electric rates, SME calculated that the payback for the project's high initial cost will be five years. If electric rates increase, as many expect, the payback will be quicker.

Comparing Efficiency Ratings

Like air-source heat pumps, geothermal systems are rated for efficiency by the Air Conditioning Heating and Refrigeration Institute (AHRI). Geothermal systems are rated under a different standard because weather is not a large issue for performance of ground loops. Geothermal efficiency is rated at a steady state according to EER (Energy Efficiency Ratio) and COP (Coefficient of Performance).



There are NO outdoor units. This indoor geothermal heat pump unit at SME's Henry Thomas Field Operation Center receives water from a ground loop and returns it to the loop.

The higher the efficiency rating number, the greater the energy savings will be. COP is the ratio of energy delivered to energy consumed. A geothermal system rated at 4.5 COP can deliver 4.5 BTUs of heat from the loop to the building for every one BTU of electric energy consumed under stated conditions.

For comparison, electric strip heat has a COP of approximately 1, meaning one unit of energy consumed equals one unit of energy delivered to the heated space.

Natural gas boilers can deliver around .79 to .95 BTUs of heat for every BTU consumed.

The EER (Energy Efficiency Ratio) of a system, as a measure of cooling efficiency, is the ratio of BTUs per hour (heat) removed from the building to watt-hours consumed. A four-ton geothermal system rated at 20 EER can remove 48,000 BTUs (heat) from the building per hour consuming around 2.4 kilowatt-hours (or 2400 watt hours).

Be sure to compare equipment ratings for your loop type only. These ratings are at steady state conditions and serve as a basis of comparison among systems. Geothermal ratings are not to be compared to EER or COP for air source heat pumps because ground temperatures and geothermal performance are steady, while air source unit performance fluctuates with outdoor air temperature.

Vertical Closed Loop (Geothermal Consortium)

Horizontal Closed Loop

What About Geothermal for my Home?

As energy costs rise, geothermal heating and cooling units are growing in popularity in the new home construction market and in the replacement market. According to U. S. DOE, geothermal systems reduce heating and cooling costs by 44% when compared to air-source heat pumps and by 72% compared to an electric resistance heating with a standard air conditioner. When one compares first cost of geothermal to traditional systems, the difference in cost is the loop. For a typical geothermal in new construction, there is a positive cash flow from the first month when the loop cost is added to the mortgage.

Some factors that determine savings are the efficiency of the unit, loop design, installation practices, duct sealing, local labor costs, and financing options.

The loop—meeting certain standards—can carry a 55 year warranty, so system replacement, if needed, will mean only the inside unit. If a large open land area or lake is available, loop costs may be reduced.

Geothermal comfort is superior as supply air temperatures don't vary with the weather. Since the ground loop is the heat exchanger, most geothermal systems have no outdoor units. Families can enjoy outdoor activities avoiding noise typically associated with traditional systems.

Fast Facts and Resources:

Selection of a qualified contractor and a qualified loop installer may be the most important decisions!

Select a geothermal equipment brand that has a local manufacturer representative in your geographic area.
Ask the manufacturer's representative about dealers in your area who have attended and passed certified training.
Ask if the loop designer is accredited by IGSHPA or by the manufacturer.
Request that the contractor use an IGSHPA accredited driller/loop installer who can provide local service.
Upon contracting the job, ask the HVAC contractor for a copy of the ACCA load calculation.
Make sure that all ducts are to be sealed and insulated.
Select high efficiency geothermal equipment. (Ratings are increasing so be sure to get the latest numbers.)
Ask for a copy of the technical specifications sheet for your equipment. See specific ratings for closed loops.
ENERGY STAR® requirements, at least, should be met.

Information sources addressing geothermal systems:

U.S. DOE Consumer's Guide:
http://apps1.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12640
A resource by the Geothermal Consortium: http://www.geoexchange.org
International Ground Source Heat Pump Association: http://www.igshpa.okstate.edu

Tax credits are available to homeowners and to businesses for installing geothermal systems through the Emergency Economic Stabilization Act of 2008 H.R. 1424:

A 10% tax credit is available to businesses installing geothermal systems.
A 30% (maximum $2,000) credit for homeowners installing residential ground loop or ground water systems.
Complete the Renewable Energy Credits subsection of tax forms for 2008.
For tax credit, the geothermal equipment must meet or exceed ENERGY STAR standards.
The credit is available from October 3, 2008 to December 31, 2016.
Geothermal systems put in place after October 3, 2008 will be subject to a five year depreciation period.
See http://www.energytaxincentives.org/consumers
Any state incentives that become available will be posted at: http://www.dsireusa.org