EAC Agenda November 3, 2021

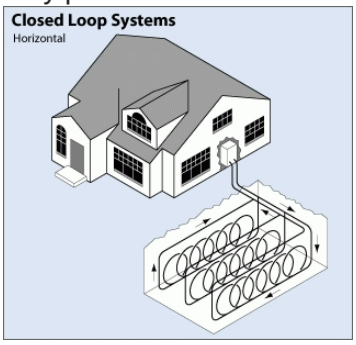
1. Take attendance.
2. Approve minutes from October 6, 2021.
3. Recap Fair Oaks event. Plantings in the basin has been postponed until spring.
4. Geothermal information given to township commissioners (see below).
5. Progress on middle school sign at bioswales.
6. Update on OEEC.
7. Plastics education.
8. Tree City/Earth Day event for April 2022.
9. New business.
10. Adjourn.

Geothermal Heat Pump Information
Heating/Cooling

Closed-Loop Systems

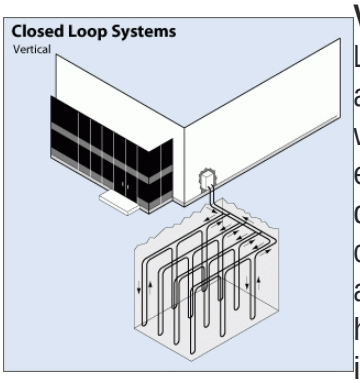
Most closed-loop geothermal heat pumps (GHP) circulate an antifreeze solution through a closed loop -- usually made of a high density plastic-type tubing -- that is buried in the ground. A heat exchanger transfers heat between the refrigerant in the heat pump and the antifreeze solution in the closed loop. This is the most common type of system.

A less common type of closed-loop system, called direct exchange, does not use a heat exchanger and instead pumps the refrigerant through copper tubing that is buried in the ground in a horizontal or vertical configuration. Direct exchange systems require a larger compressor and work best in moist soils (sometimes requiring additional irrigation to keep the soil moist), but you should avoid installing in soils corrosive to the copper tubing. Because these systems circulate refrigerant through the ground, local environmental regulations may prohibit their use in some locations.



Horizontal

This type of installation is generally most cost-effective for residential installations, particularly for new construction where sufficient land is available. It requires trenches at least four feet deep. The most common layouts either use two pipes, one buried at six feet, and the other at four feet, or two pipes placed side-by-side at five feet in the ground in a two-foot wide trench. The Slinky™ method of looping pipe allows more pipe in a shorter trench, which cuts down on installation costs and makes horizontal installation possible in areas it would not be with conventional horizontal applications.



Vertical

Large commercial buildings and schools often use vertical systems because the land area required for horizontal loops would be prohibitive. Vertical loops are also used where the soil is too shallow for trenching, and they minimize the disturbance to existing landscaping. For a vertical system, holes (approximately four inches in diameter) are drilled about 20 feet apart and 100 to 400 feet deep. Two pipes, connected at the bottom with a U-bend to form a loop, are inserted into the hole and grouted to improve performance. The vertical loops are connected with horizontal pipe (i.e., manifold), placed in trenches, and connected to the heat pump in the building.

The ground heat exchanger in a GHP system is made up of a closed or open loop pipe system. Most common is the closed loop, in which high density polyethylene pipe is buried horizontally at 4 to 6 feet deep or vertically at 100 to 400 feet deep. These pipes are filled with an environmentally friendly antifreeze/water solution that acts as a heat exchanger. In the winter, the fluid in the pipes extracts heat from the earth and carries it into the building. In the summer, the system reverses and takes heat from the building and deposits it to the cooler ground. Ground temperature usually remains steady at about 50°F.

The heating efficiency of ground-source heat pumps is indicated by their coefficient of performance (COP), which is the ratio of heat provided in Btu per Btu of energy input. Their cooling efficiency is indicated by the Energy Efficiency Ratio (EER), which is the ratio of the heat removed (in Btu per hour) to the electricity required (in watts) to run the unit.

Geology

Factors such as the composition and properties of your soil and rock (which can affect heat transfer rates) require consideration when designing a ground loop. For example, soil with good heat transfer properties requires less piping to gather a certain amount of heat than soil with poor heat transfer properties. The amount of soil available contributes to system design as well -- system suppliers in areas with extensive hard rock or soil too shallow to trench may install vertical ground loops instead of horizontal loops.

Land Availability

The amount and layout of your land, your landscaping, and the location of underground utilities or sprinkler systems also contribute to your system design. Horizontal ground loops (generally the most economical) are typically used for newly constructed buildings with sufficient land. Vertical installations or more compact horizontal "Slinky™" installations are often used for existing buildings because they minimize the disturbance to the landscape.

Benefits of Geothermal Heat Pump Systems

The biggest benefit of GHPs is that they use 25% to 50% less electricity than conventional heating or cooling systems. This translates into a GHP using one unit of electricity to move three units of heat from the earth. According to the EPA, geothermal heat pumps can reduce energy consumption, and corresponding greenhouse gas emissions, up to 44% compared with air-source heat pumps and up to 72% compared with electric resistance heating with standard air-conditioning equipment. GHPs also improve humidity control by maintaining about 50% relative indoor humidity, making GHPs very effective in humid areas.

Geothermal heat pump systems allow for design flexibility and can be installed in both new and retrofit situations. Because the hardware requires less space than that needed by a conventional HVAC system, the equipment rooms can be scaled down, freeing space for productive uses. GHP systems also provide excellent "zone" space conditioning, allowing different parts of your home to be heated or cooled to different temperatures.

GHP systems have relatively few moving parts and those parts are sheltered inside a building, so the systems are durable and highly reliable. The underground piping often carries warranties of 25 to 50 years, and the heat pumps often last 20 years or more. They usually have no outdoor compressors, so GHPs are not

susceptible to vandalism and weathering. In addition, the components in the living space are easily accessible, which increases the convenience factor and helps ensure that the upkeep is done on a timely basis.
GHPs have no outside condensing units like air conditioners, so there's no concern about noise outside the home. A two-speed GHP system is so quiet inside a house that users usually do not know it is operating.

For further savings, GHPs equipped with a device called a "desuperheater" can heat household water. In the summer cooling period, the heat that is taken from the house is used to heat the water for free. In the winter, water heating costs are reduced by about half.

Overall, geothermal heat pumps are much more energy efficient than other systems and their components tend to last longer. The main drawbacks are higher initial installation costs, the need for an area of land for the wells, damage to yard, and mud/mess during installation. The amount of land needed depends on the size of the system installed. Need to make sure hire a certified installer with experience.

Costs

Most residential heat pumps range in size from 1 (12,000 BTU/HR) to 5 tons (60,000 BTU/HR). Homes with larger heating and cooling loads require larger heat pumps -- and sometimes even more than one. While the precise heat pump size is dictated by the home's heating and cooling needs, a standard single-family 2,000 square foot home usually requires a 5 ton heat pump ($7,500 to $12,500).

A **horizontal ground loop** is installed over a wide area of ground and requires enough space to dig trenches hundreds of feet long and 6-10 feet deep.

The average **direct** cost to install a horizontal ground loop typically ranges between $1,000/ton to $2,000/ton. If a typical 2,000 sq. foot home requires a 5 ton heat pump, it might be $5,000 to $10,000 to install the ground loops. This cost includes only materials, labor, equipment, and supplies and **is not** the same as the price paid by the customer.

A **vertical ground loop** is installed in one or more boreholes about 200 to 500 feet deep in the ground. Each hole is 6 to 8 inches in diameter, and if you have more than one, they're about 20 feet apart.

The average direct cost to install a vertical ground loop typically ranges between $1,600/ton to $4,250/ton. If a 2,500 sq. foot home typically requires a 5 ton heat pump, it might be $8,000 to $21,250 to install the ground loops. This cost includes only materials, labor, equipment, and supplies and **is not** the same as the price paid by the customer.

Hank Sokolowski has had a geothermal heat pump system for his house for about eight years. It has two vertical loops that go down about 225 feet. He is very happy with the system's performance and money savings.

Sources

Department of Energy
https://www.energy.gov/energysaver/geothermal-heat-pumps
International Ground Source Heat Pump Association
https://igshpa.org/
Geothermal Exchange Organization
https://www.geoexchange.org/directory/