Part 1

Understanding the System Which Heats and Cools Your Home at Wills Creek

Ground-Source Heat Pumps (Earth-Energy Systems)

Heating and Cooling with a Heat Pump

A ground-source heat pump uses the earth or ground water or both as the sources of heat in the winter, and as the "sink" for heat removed from the home in the summer. For this reason, ground-source heat pump systems have come to be known as earth-energy systems (EESs). Heat is removed from the earth by using a liquid, such as ground water or an antifreeze solution; the liquid's temperature is raised by the heat pump; and the heat is transferred to indoor air. During summer months, the process is reversed: heat is taken from indoor air and transferred to the earth by the ground water or antifreeze solution.

Earth-energy systems can be used with forced-air and hydronic heating systems. They can also be designed and installed to provide heating only, heating with "passive" cooling, or heating with "active" cooling. Heating-only systems do not provide cooling. Passive-cooling systems provide cooling by pumping cool water or antifreeze through the system without using the heat pump to assist the process.

How Does an Earth-Energy System Work?

All EESs have two parts: a circuit of underground piping outside the house, and a heat pump unit inside the house. Unlike the air-source heat pump, where one heat exchanger (and frequently the compressor) is located outside, the entire ground-source heat pump unit is located inside the house.

The outdoor piping system can be either an open system or closed loop. An open system takes advantage of the heat retained in an underground body of water. The water is drawn up through a well directly to the heat exchanger, where its heat is extracted. The water is discharged either to an above-ground body of water, such as a stream or pond, or back to the same underground water body through a separate well.

Closed-loop systems collect heat from the ground by means of a continuous loop of piping buried underground. An antifreeze solution, which has been chilled by the heat pump's refrigeration system to several degrees colder than the outside soil, circulates through the piping and absorbs heat from the surrounding soil.

Design Considerations

Unlike air-source heat pumps, EESs require that a well or loop system be designed to collect and dissipate heat underground.

Closed-Loop Systems

A closed-loop system draws heat from the ground itself, using a continuous loop of special buried plastic pipe. The pipe is connected to the indoor heat pump to form a sealed underground loop through which an antifreeze solution or refrigerant is circulated. While an open system drains water from a well, a closed-loop system recirculates its heat transfer solution in pressurized pipe.

The pipe is placed in one of two types of arrangements: vertical or horizontal. A vertical closed-loop arrangement is an appropriate choice for most suburban homes, where lot space is restricted. Piping is inserted into bored holes that are 150 mm (6 in.) in diameter, to a depth of 18 to 60 m (60 to 200 ft.), depending on soil conditions and the size of the system. Usually, about 80 to 110 m (270 to 350 ft.) of piping is needed for every ton (3.5 kW or 12 000 Btu/h) of heat pump capacity. U-shaped loops of pipe are inserted in the holes.

The horizontal arrangement is more common in rural areas, where properties are larger. The pipe is placed in trenches normally 1.0 to 1.8 m (3 to 6 ft.) deep, depending on the number of pipes in a trench. Generally, 120 to 180 m (400 to 600 ft.) of pipe are required per ton of heat pump capacity. For example, a well-insulated, 185 m^2 (2000 sq. ft.) home would probably need a three-ton system with 360 to 540 m (1200 to 1800 ft.) of pipe.

Regardless of the arrangement you choose, all piping for antifreeze solution systems must be at least series 100 polyethylene or polybutylene with thermally fused joints (as opposed to barbed fittings, clamps or glued joints), to ensure leak-free connections for the life of the piping. Properly installed, these pipes will last anywhere from 25 to 75 years. They are unaffected by chemicals found in soil and have good heat-conducting properties. The antifreeze solution must be acceptable to local environmental officials.

Neither vertical nor horizontal loops have an adverse impact on the landscape as long as the vertical boreholes and trenches are properly backfilled and tamped (packed down firmly).

It is important that horizontal and vertical loops be installed by a qualified contractor. Plastic piping must be thermally fused, and there must be good earth-to-pipe contact to ensure good heat transfer, such as that achieved by Tremie-grouting of boreholes. The latter is particularly important for vertical heat-exchanger systems. Improper installation may result in less than optimum heat pump performance.

Wills Creek Vertical Ground Loop System

Each homeowner has their own independent ground loop system

Vertical Ground Loop

A vertical ground loop is installed in one or more boreholes about 100 to 300 feet deep in the ground. Each hole is 5 to 6 inches in diameter, and if you have more than one, they're about 20 feet apart. This configuration is ideal for homes where yard space is limited, when rock formations are very close to the surface.

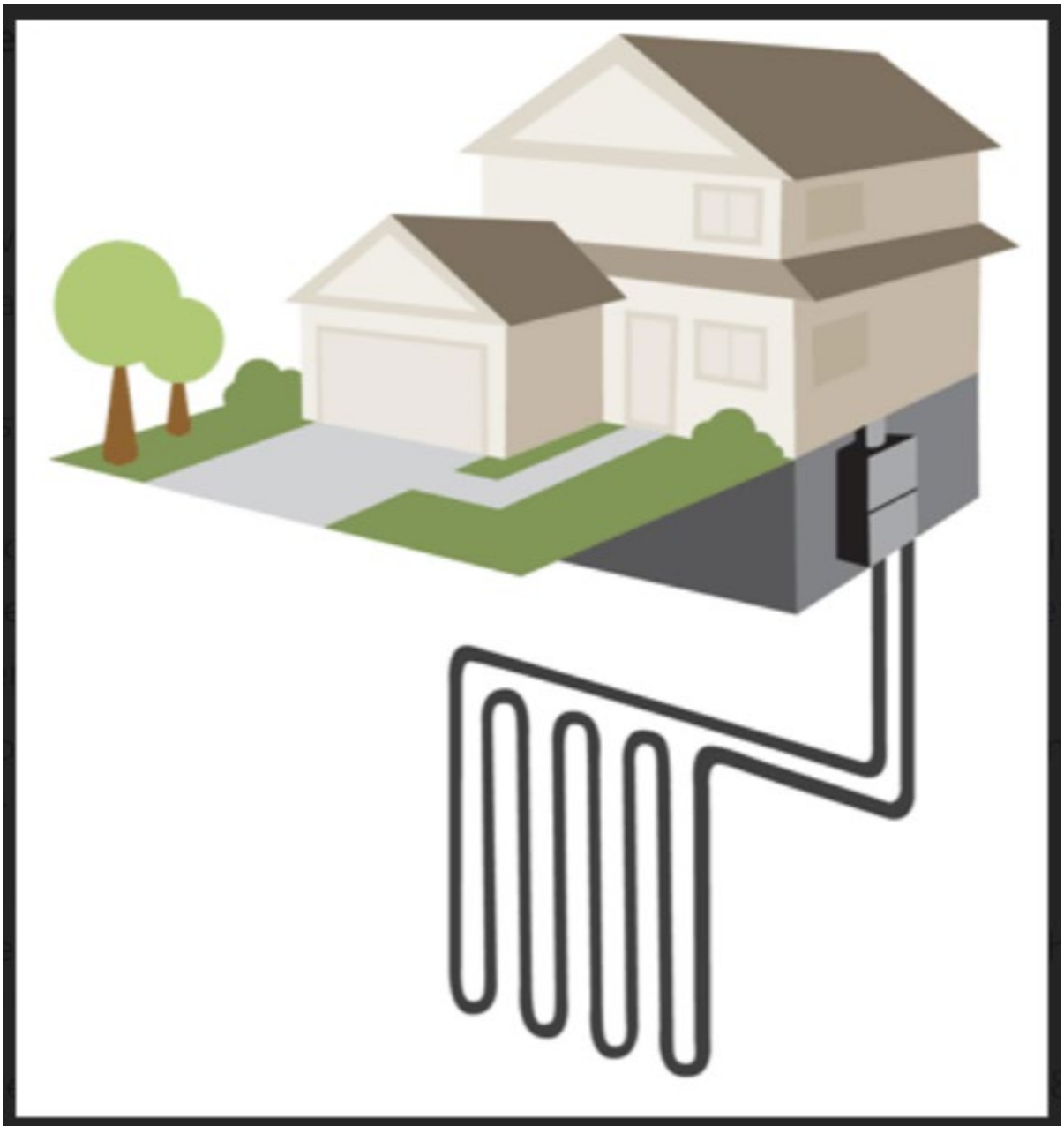
Vertical Ground Loop Installation

To install a vertical loop, a contractor will use well-drilling equipment to bore a 6-8 inch diameter vertical hole in the ground 100-300 feet deep. Next, a single pipe loop with a U-bend at the bottom is inserted in the hole. After the pipe is inserted, the hole will be grouted, filling it from bottom to top.

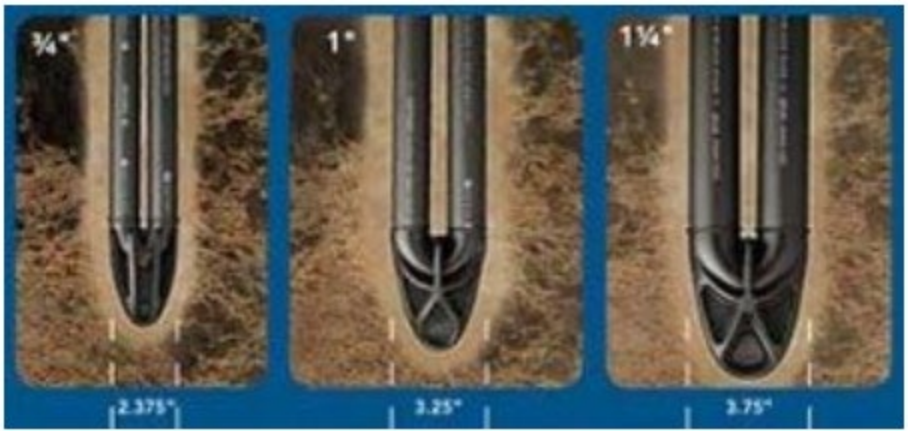
The grout serves two primary functions:

1. Ensures contact between the pipes and the earth to promote heat transfer.
2. Seals the hole off from any aquifers or groundwater supplies that may have been penetrated during the drilling process. Protecting the deep earth environment with a proper grouting material is just as important as providing heat transfer between the piping system and the surrounding earth.

Vertical loops are generally more expensive to install but require less piping and less land area than horizontal loops.



Example of a vertical closed loop system.



Typical Horizontal well loop connections

Maintenance

EESs require little maintenance on your part. Required maintenance should be carried out by a competent service contractor, who should inspect your unit once a year.

- As with air-source heat pumps, filter and coil maintenance has a dramatic impact on system performance and service life. A dirty filter, coil or fan can reduce airflow through the system. This will reduce system performance and can lead to compressor damage if it continues for extended periods.
- The fan should be cleaned to ensure that it provides the airflow required for proper operation. The fan speed should be checked at the same time. Incorrect pulley settings, a loose fan belt or incorrect motor speed can all contribute to poor performance.
- Ductwork should be inspected and cleaned as required to ensure that airflow is not restricted by loose insulation, abnormal buildup of dust or other obstacles, which occasionally find their way through the grilles.
- Be sure that vents and registers are not blocked by furniture, carpets or other items that would impede airflow.
- In open systems, mineral deposits can build up inside the heat pump's heat exchanger. Regular inspection and, if necessary, cleaning by a qualified contractor with a mild acid solution is enough to remove the buildup. Over a period of years, a closed-loop system will require less maintenance because it is sealed and pressurized, eliminating possible buildup of minerals or iron deposits.