Geothermal Heat Source Wells

A geothermal heating and cooling system transfers thermal energy between the earth (including groundwater) and a heat pump or heat exchanger, to heat or cool the interior of a building. At some distance below land surface, the temperature of the earth or groundwater is stable and runs between 45° to 55°F year-round. In winter, the relative warmth from the ground or groundwater is transferred to the building, and in summer the process is reversed and the heat of the building is transferred to the earth or groundwater.

The transfer of heat between the occupied space and the ground is accomplished by either passing a heat transfer fluid through piping, in a loop or series of loops buried underground, or by pumping groundwater across a heat exchanger and discharging the water afterwards. Geothermal heating and cooling systems can be divided into two broad classes: open-loop systems and closed-loop systems.

Open-loop systems

An open-loop system withdraws groundwater from an extraction (supply) well, passes it through a heat exchange system, and discharges the temperature-altered water either back to the ground in a return well (Figure 1) or to surface water (Figure 2)

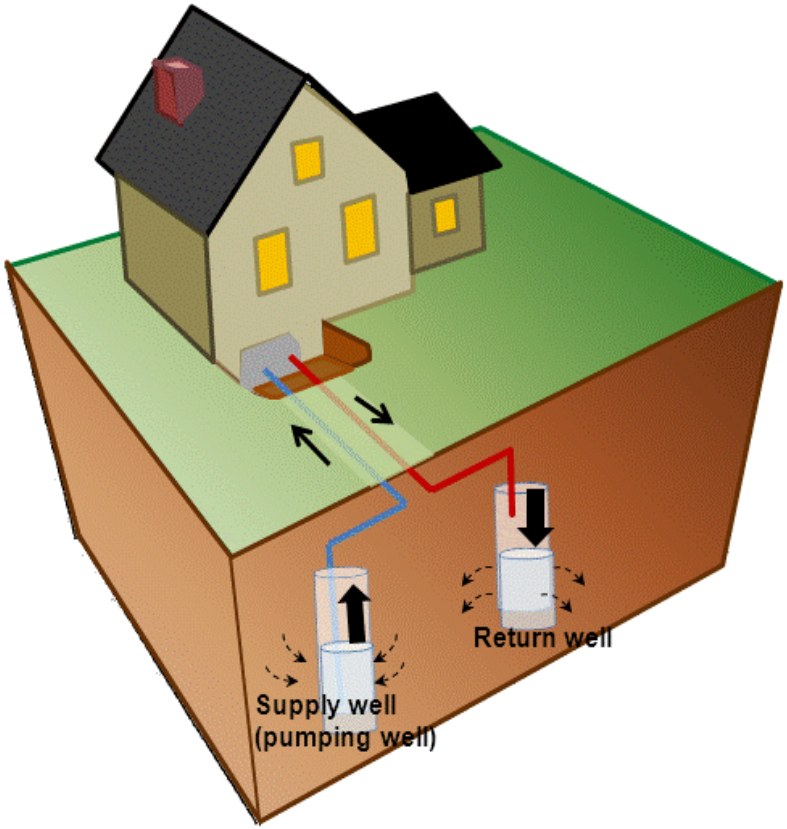

Figure 1 - An open-loop heating and cooling system discharging to groundwater.

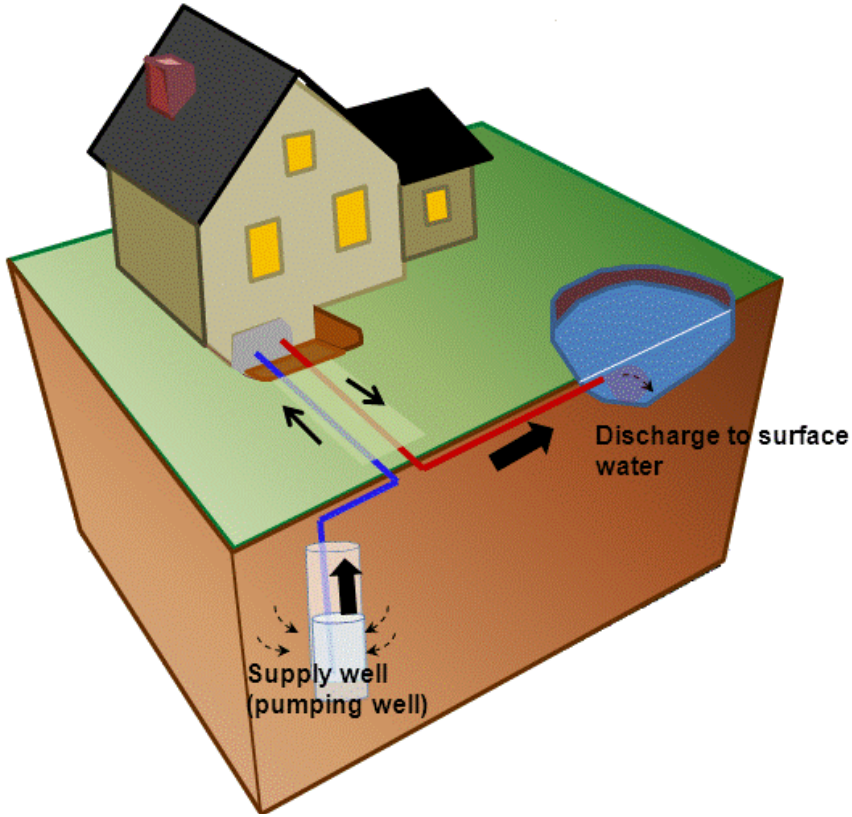

Figure 2 - An open-loop heating and cooling system discharging to surface water,

Closed-loop systems

Closed-loop geothermal heating and cooling systems (Figures 3 and 4) circulate a heat transfer fluid, usually water with an antifreeze additive, through a loop or multiple loops of piping installed below ground or within a surface water body. A closed-loop system does not involve the withdrawal of groundwater. In the winter, the earth's heat is absorbed by the heat transfer fluid within the piping and transmitted to the unit's heat exchanger and compressor to provide heating. In the summer, the cycle is reversed and the system removes heat from the building and transfers it into the earth to provide cooling.

Direct exchange systems are a type of closed-loop geothermal heating and cooling system that uses loops of piping through which a refrigerant is circulated. The piping is installed in pits, trenches, or vertical borings.

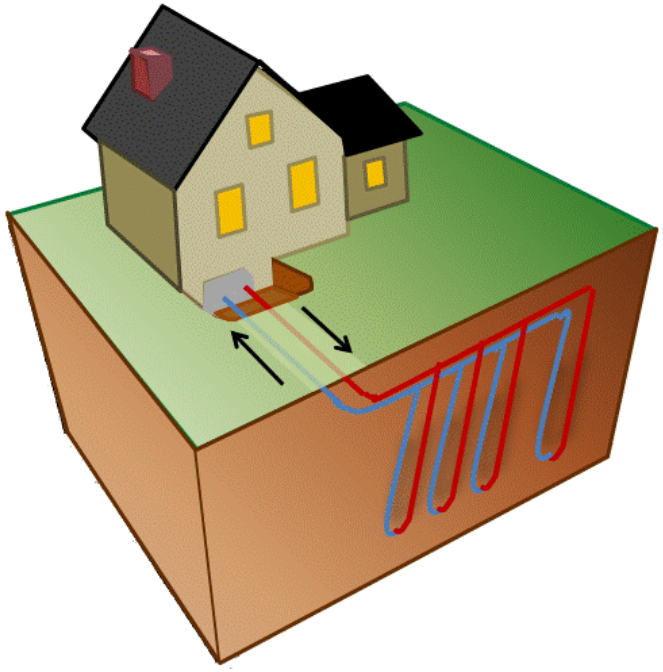

Figure 3 - A closed-loop heating and cooling system with vertical loops. Arrows indicate the flow direction in the summer, when the system removes heat from the building and transfers it into the earth. In winter, the flow direction is reversed.

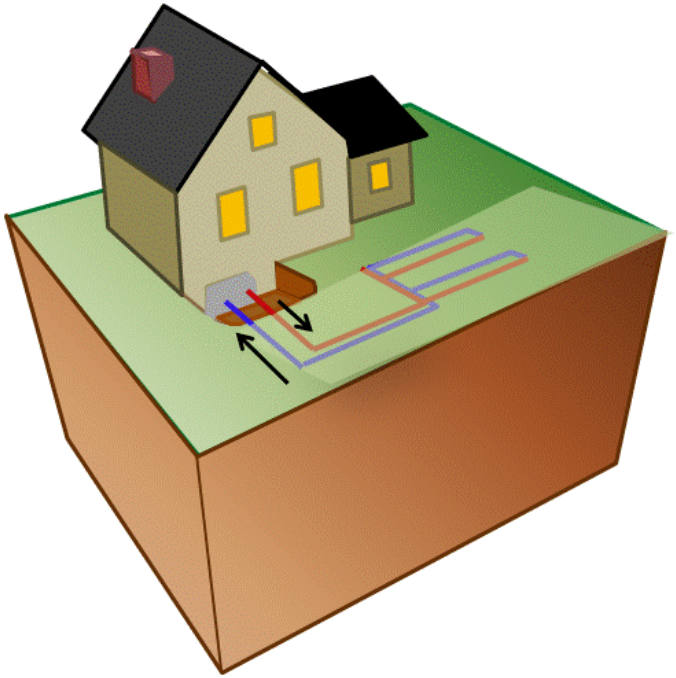

Figure 4 - A closed-loop heating and cooling system with horizontal loops. Arrows indicate the flow direction in the summer, when the system removes heat from the building and transfers it into the earth. In winter, the flow direction is reversed.