

5. Geothermal Heat Pumps

Geothermal heat pumps, also known as ground source or ground water heat pumps, are a highly efficient renewable energy technology. Geothermal heat pumps are used for space heating and cooling, as well as water heating. The greatest advantage is that they work by concentrating naturally existing heat, rather than producing heat through combustion of fossil fuels. For cooling, the reverse process occurs.

The biggest benefit of geothermal heat pumps is that they use 25 to 50 percent less electricity than conventional heating or cooling systems. This translates into a geothermal heat pump using one unit of electricity to move three units of heat from the earth or from geothermal water. According to EPA, geothermal heat pumps can reduce energy consumption up to 44 percent compared to air-source heat pumps and up to 72 percent compared to electric resistance heating with standard air conditioning equipment.

Types of Geothermal Heat Pumps

Geothermal heat pumps are either closed or open loops. The three types of closed-loop system installations include horizontal, vertical, and pond/lake. The fourth type of ground source heat pump is the open-loop system. To determine which option is the best, you must look at the climate, soil conditions, available land, and local installation costs at your site. All of these types of systems can be used for residential and commercial building applications.

Closed-Loop System – Horizontal

Horizontal ground source heat pump 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 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.

Closed-Loop System – Vertical

Vertical systems are often used for large commercial buildings and schools 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. Into these holes go two pipes that are connected at the bottom with a U-bend to form a loop. The vertical loops are connected with horizontal pipe, placed in trenches, and connected to the heat pump in the building.

Closed-Loop System – Pond/Lake

If your site has an adequate water body, this may be the lowest cost option. A supply line pipe is run underground from the building to the water and coiled into circles at least eight feet under the surface to prevent freezing. The coils should only be placed in a water source that meets minimum volume, depth, and quality criteria.

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Open-Loop System

An open-loop system uses a well or surface water body such as a pond or lake as the heat exchange fluid that circulates directly through the ground source heat pump system. Once the water has circulated through the system, it returns to the ground through the well, a recharge well, or surface discharge. This option is only practical where there is an adequate supply of relatively clean water, and all regulations regarding ground water discharge are met.

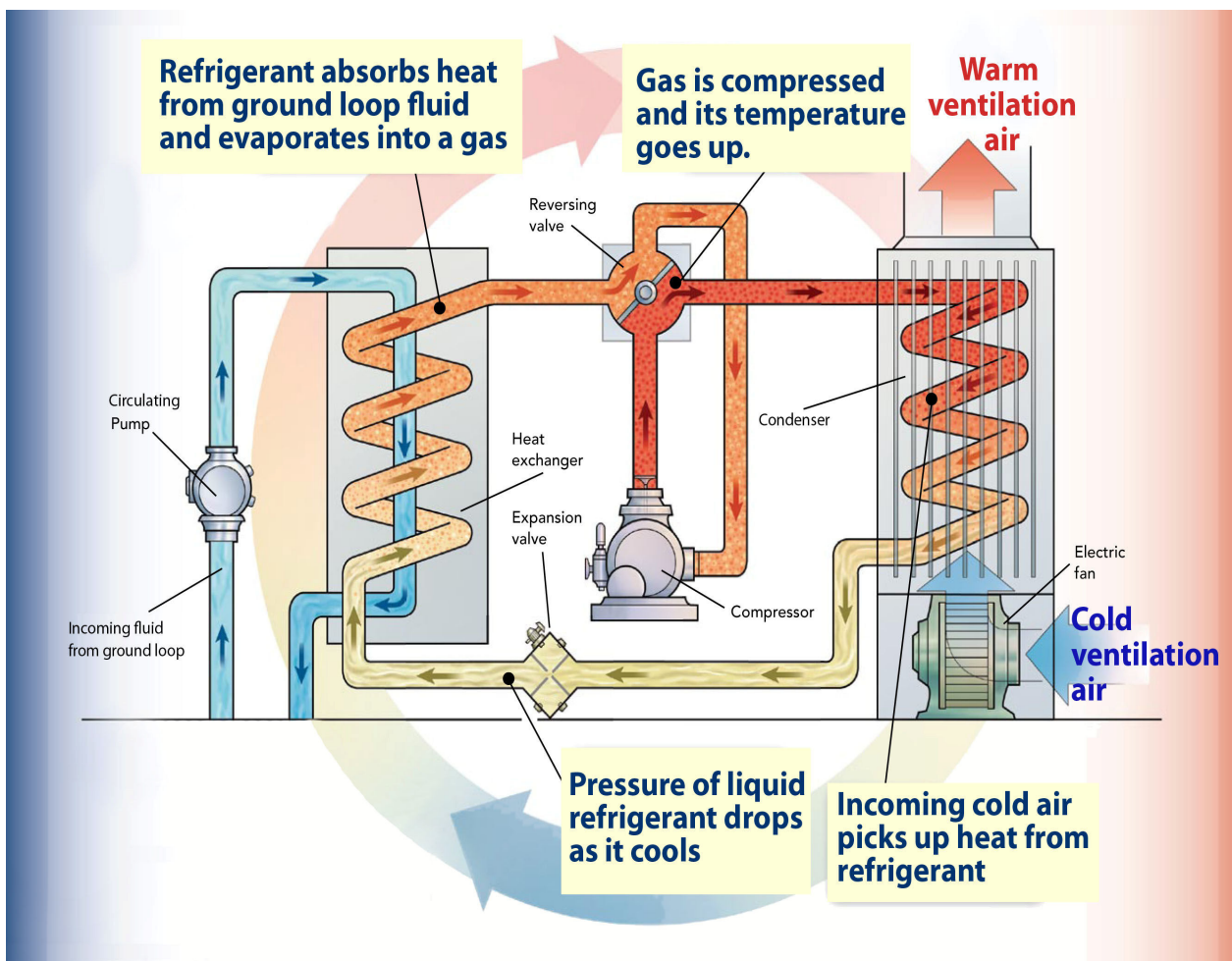


Illustration modified from Fine Homebuilding.

Source: Cold Climate Housing Research Center

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Permitting Information for Geothermal Heat Pumps

The three permitting agencies involved in geothermal heat pump regulation in Montana are the U.S. Environmental Protection Agency (EPA), the Montana Department of Natural Resources and Conservation (DNRC), and the Montana Department of Environmental Quality (DEQ).

The EPA only regulates open-loop ground source heat pumps. As the applicant, you must submit information on your proposed open-loop ground source heat pump by completing the “Site Information Request Fact Sheet – Geothermal Injection Well” located at <http://www.epa.gov/region8/water/uic/FSGeo.pdf>.

Single family residential homes are excluded from this EPA permitting requirement.

If it is determined that your proposed heat pump system does not need a permit, the system will be “rule authorized” and there are no further actions that you must take.

The Montana DNRC requires a Water Right Permit for ground water use (originating after June 30, 1973) over 35 gallons per minute (gpm) or 10 acre-feet per year or any surface water appropriation. A Ground Water Certificate is required for developed ground water use (originating after June 30, 1973) under 35 gpm, not to exceed 10 acre-feet per year.

The Montana DEQ requires a Montana Ground Water Pollution Control System permit if the water used for a ground source heat pump is altered (e.g., additives to the water) and discharged back into the aquifer. If the water is not altered no permit is necessary. Temperature changes typically do not trigger a permit requirement. Contact the Permitting and Compliance Division at (406) 444-3080 to discuss a specific project or for additional information.