

COMMERCIAL EARTH POWER PROGRAM

Geothermal heat pumps

A geothermal heat pump is extremely efficient because it moves existing heat into or out of the ground instead of creating heat by burning fossil fuels or powering an electric element.

Whether constructing a new building or replacing an existing heating and cooling system, consider a geothermal heat pump — one of the most energy efficient and environmentally friendly electric heating and cooling systems available.

A geothermal heat pump moves heat into or out of the earth using water wells or a network of pipes buried in horizontal trenches or vertical boreholes. During the heating season the heat pump draws heat from the earth and pumps it into the building. During the cooling season the system operates in reverse, removing heat from the building and pumping it into the earth.



Did you know?

Energy efficient geothermal technology will heat and cool Manitoba Hydro's new 695 742 sq. ft. office tower in downtown Winnipeg.



Compared with an electric heating system, a geothermal heat pump typically cuts heating costs by 50 – 70 per cent. Staff, tenants and guests in a building with a geothermal heat pump enjoy a much more uniform level of heating and cooling compared with conventional systems.

Choosing geothermal technology for your building is also a green choice. Show your company's commitment to the environment by installing a geothermal heat pump. It will reduce your building's greenhouse gas emissions and harmful impacts on the environment.

How does a geothermal heat pump work?

A geothermal heat pump moves heat into or out of the earth using water wells or a network of high-density polyethylene pipes buried in horizontal trenches or vertical boreholes.

The pipes carry a heat transfer fluid usually comprised of water and antifreeze, which is pumped through the ground loop and geothermal heat pump units within the building. The heat transfer fluid extracts heat (heating mode) from the earth surrounding the ground loop.

The refrigeration system in the geothermal heat pump unit upgrades the heat, which is then distributed throughout the building by way of ductwork or a hydronic (hot water space heating) system. In a heat pump, the refrigeration system can also work in reverse and provide cooling.

A geothermal heat pump system requires the following three components to provide heating and cooling for your building: a ground loop (buried piping system); heat pump furnace units (inside the building); and a heating and cooling distribution system.

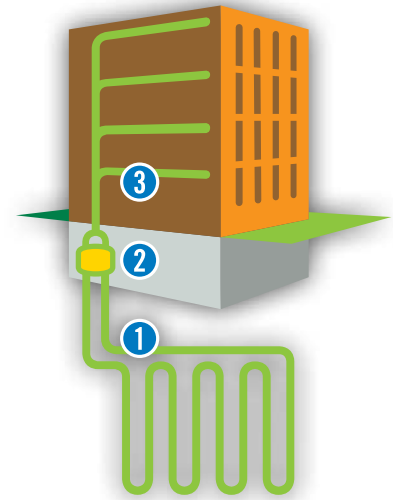
Ground loop configurations

Which one suits your building?

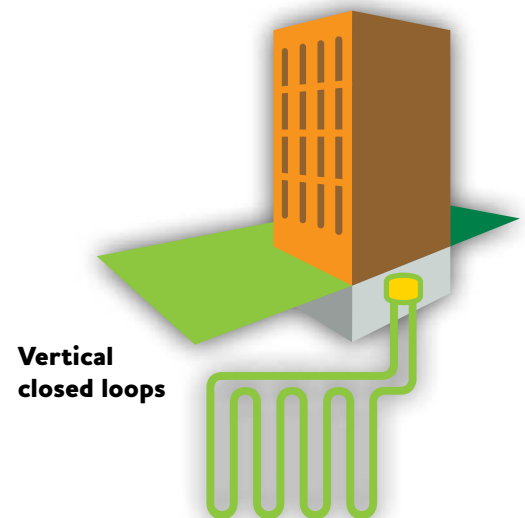
Geothermal heat pump systems use four basic ground loop configurations to turn your property into a source of energy. The design that best suits your situation depends on a variety of factors, including ground conditions, availability and quality of groundwater, the size of your property and the building you are trying to heat.

Vertical closed loops are ideal for use where land area is limited, or where other loop configurations are not cost-effective. Since ground temperatures are more constant at a depth of about 20 feet or deeper, vertical loops require less piping than horizontal loops. The recommended distance between loops is 10–20 feet. Vertical closed loop configuration is the most popular loop configuration for commercial applications.

In Manitoba, vertical loops are normally installed in boreholes measuring 50 to 300 feet deep. A pair of pipes with a U-bend assembly at the bottom is inserted into each borehole. The U-bends are heat fused at the time of installation, with the point of fusing stronger than the pipe itself. After the piping is installed, grout is used to seal the borehole between the earth and piping. Loop length is determined by factors including ground conditions, loop configuration, equipment sizing, design heat loss of the building, and required entering heat transfer fluid temperature. Design is essential in vertical closed-loop systems since pipe length can vary from 300 to 600 feet per 10 000 BTUH of heat output.



1. An electric pump circulates a heat transfer fluid through a system of pipes, and picks up heat from the earth (heating mode) or releases heat to it (cooling mode). This process brings the heat transfer fluid to its required temperature as it enters the heat pump unit to ensure the system will work as designed and achieve the desired efficiency.
2. The heat transfer fluid is circulated through the heat pump unit where the refrigeration system extracts or rejects heat from the fluid and delivers it to a fan coil.
3. A distribution system is required throughout the building. In a forced air system, a fan in the heat pump unit blows air over a fan coil and the heated or cooled air is distributed through your ductwork to regulate the temperature in your building. In a hydronic system, hot water is circulated through radiators or a system of in-floor pipes to provide heat.



Vertical closed loops

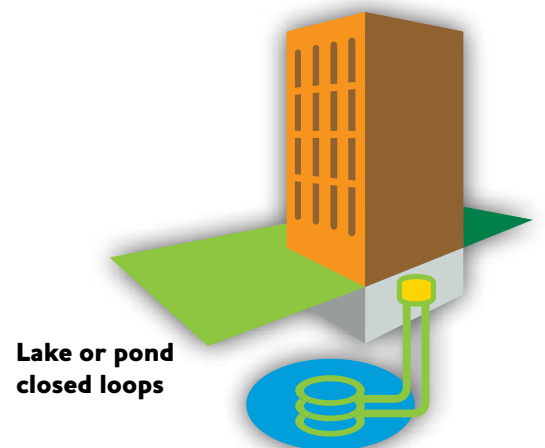
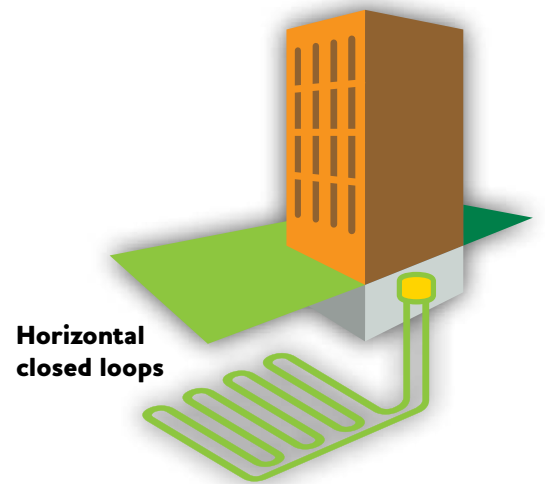
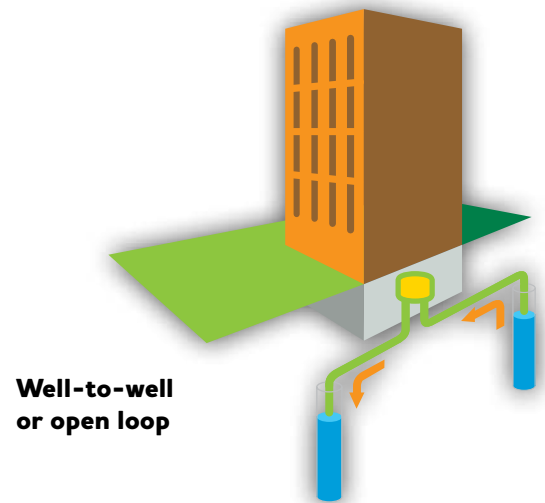
Open loop systems extract heat directly from well water. Well water is pumped to the heat pump system from a supply well, and is then returned to a second well or “return well”. Typically, the entering water temperature of an open loop system is approximately 6°C (10°F) higher than a closed loop system. Higher entering water temperatures can lead to improved efficiency of the geothermal heat pump system.

Water sources with high levels of salt, chlorides or other minerals are not recommended for most units as they can cause premature system failure or inefficient operation. To reduce mineral scaling problems, ask your installer about regular cleaning and maintenance of the heat exchanger(s) in the heat pump units. In addition, pumping power may become an issue in installations that require deep supply wells. Larger pumps may be required to transfer the water from the well to the heat exchanger, which would increase the initial cost of the system. Ensure that your contractor obtains all necessary approvals from the appropriate environmental authorities in your area prior to installation of the system. All open loop geothermal installations are required to obtain a Water Rights Licence through Manitoba Water Stewardship allowing the use of groundwater for heating/cooling purposes. Please contact Manitoba Water Stewardship at 1-800-282-8069 or wsd@gov.mb.ca for more information.

Horizontal closed loops are installed where soils can be easily excavated. Since they take up more land area than any other loop system, they are typically used in rural areas where space permits, however generally are not used for larger commercial applications.

The pipe is buried in a trench, usually six to ten feet deep in one continuous loop or a series of parallel loops. Design is critical since horizontal pipe lengths can vary between 300 and 3000 feet of pipe per 10 000 BTUH of heat output. Horizontal loops are not recommended in dry sands and gravels, but can work well in moist clay and wet sand. The deeper the loop is buried, the more heat there is to harvest. Horizontal loop designs include one-pipe, two-pipe, four-pipe, and slinky coil configurations, although the most common are two and four-pipe configurations.

Lake or pond closed loops are used if a pond or lake is nearby and the loop field can be submerged in water, rather than buried in the ground. The loop field must be properly anchored to remain on the bottom of the body of water; it also must be submerged deep enough under water and must be protected at the shoreline to avoid being dragged away by the movement of spring ice break-up. Before installing this loop type, check with local authorities having jurisdiction over the area to ensure compliance with local laws and regulations.



Benefits

Efficient

Geothermal heat pump efficiency is measured by the Coefficient of Performance (COP), which is based on Canadian Standards Association (CSA) performance standard CSA C-13256.

The COP is equal to the amount of heat provided by the heat pump divided by how much energy it consumes. Properly designed and operating heat pump systems routinely achieve a seasonal COP of 2.5 – 3.0 (or 250 per cent to 300 per cent efficient).

To compare, a high-efficiency natural gas furnace has a COP of about 0.92 (or 92 per cent efficient), and a conventional electrical heating system has a maximum COP of 1.0 (or 100 per cent efficient).

Your contractor can provide you with the design COP of your heat pump unit.

Comfortable

Staff, tenants and guests will enjoy improved comfort compared to conventional heating systems, as geothermal heat pump systems generally stay on longer, warming the air with smaller temperature rises.

Optimize space

Geothermal heat pump systems maximize office, living or retail space because they require less room than traditional mechanical systems.

Reduced structural requirements

In new buildings, heat pump systems can eliminate the need for unsightly smoke stacks and rooftop chillers, reducing the roof's structural requirements and saving money.

Environmental

When combined with hydro electricity, geothermal heat pumps create no greenhouse gas emissions and have been recognized by both Natural Resources Canada and the US Environmental Protection Agency as one of the most environmentally friendly space conditioning options available today.

Did you know?

Manitoba Hydro has assisted over 225 commercial customers install geothermal heat pump systems in their commercial buildings through financial incentives of over \$2 million.



A geothermal heat pump system at the Investors Group office building saves \$17 000 a year on heating and cooling. With the help of a Power Smart incentive, the system paid for itself in just over two years.

Is geothermal technology the right system for your building? The Commercial Earth Power Program offers assistance to help eligible customers determine whether a geothermal heat pump will reduce their electrical consumption. Financial incentives are also available to help offset the cost of a feasibility study and installation. Customers must have their project preapproved by Manitoba Hydro prior to the installation or purchase of a geothermal heat pump system. Contact us to find out more.

For more information on Manitoba Hydro's Commercial Earth Power Program:

Telephone: (204) 360-3676 in Winnipeg

Toll-Free: 1-888-MBHYDRO (1-888-624-9376)

E-mail: earthpowerinfo@hydro.mb.ca • www.earthpowerprogram.ca

Power Smart for Business guidelines and incentive levels are subject to change without notice. March 2010.