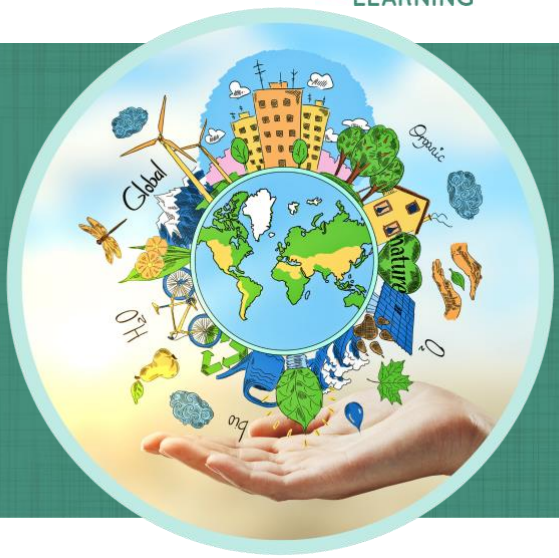
Heat Pumps

Backgrounder



What are Heat Pumps?

Heat pumps are a technology used to provide energy in the form of heating and cooling (and sometimes hot water) around the world. Refigerators and air conditioners are essentially types of heat pumps as they use the same principles and technology of heating and cooling (Natural Resources Canada, 2021).

A heat pump essentially works by extracting heat from a low temperature place, called the source, and delivers it to a high temperature place, called a sink . (Natural Resources Canada, 2021).

As we know that heat naturally flows from a high temperature environment to a low temperature environment, - think about hot coffee getting cold faster if you are outside in freezing temperatures. This is similar to the flow of water running from high elevation to low elevation. However, a heat pump works to counter the natural flow of heat by pumping the heat energy from a colder place to a warmer one where heat is required – for example extracting heat from outside (source) which may be cold and delivering it inside the house (sink) where it is warmer (Natural Resources Canada, 2021). Similarly, if the house needs to be cooled, a heat pump will remove heat from inside the house (source) and deliver it outside the house (sink) (Natural Resources Canada, 2021). Remember, *source* is where the heat is extracted from and *sink* is where that extracted heat is delivered!

Types of Heat Pumps

There are three types of heat pumps:

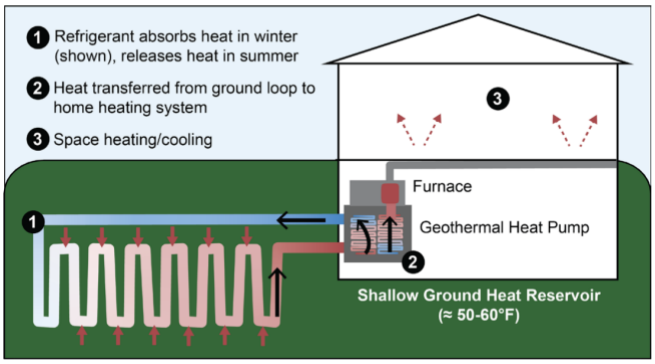
- Ground sourced or geothermal heat pumps
- Air source heat pumps
- Water sourced heat pumps

Ground Source or Geothermal Heat Pumps

Ground source or geothermal heat pumps use the constant heat from the Earth's ground as an exchange medium – when a house needs cooling, it removes heat from the house (source) into the ground (sink) and when a house needs heating, it removeds heat from the ground (source) and delivers to the house (sink) (Center for Sustainable Systems, University of Michigan, 2020). This is because the temperature of the soil below about 2 metres remains constant regardless of the weather or season.

A heat pump functions in the same way as a refrigerator does. Like a fridge, a heat pump uses a compressor, lengths of sealed tubing for farthering and dispersing heat (called heat exchangers), and a gas called the refrigerant.

Geothermal Heat Pump in a Residential Heating Application[10]



(Center for Sustainable Systems, University of Michigan, 2020)

An essential part of a ground sourced heat pump is the network of tubes buried deep in the soil near the home. The compressor motor, located inside the house, circulates refrigerant around this network. Heat from the surrounding soil warms the liquid refrigerant in the buried tubes, changing it to a gas.

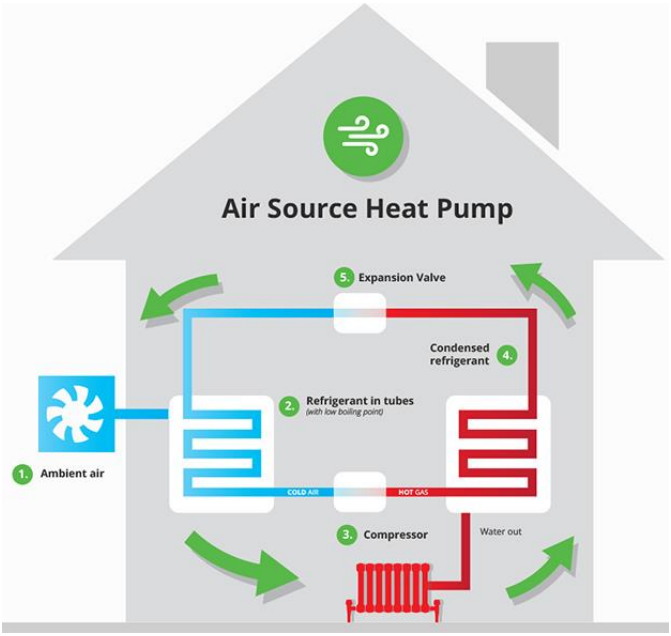
The refrigerant gas enters the compressor, which squeezes it, raising its pressure and temperature. The hot refrigerant circulates through radiators inside the house, releasing the heat collected from the soil to the inside of the house. This process changes the refrigerant back into a liquid and the process starts again.

In most places throughout southern Canada, soil temperatures at this depth hover between 5 and 10ºC. The difference between air and deep soil temperatures can be used for heating and cooling in a very efficient manner, with a ground source heat pump, also called a geothermal heat pump.

By reversing the flow of the refrigerant, the heat pump system can cool the house in summertime. Heat collected from inside the house can be released back into the cool soil, resulting in a highly efficient air conditioning system for the home, A ground source heat pump requires some electricity to run the compressor. In an efficient, well-insulated home, this electricity could be easily supplied by a rooftop solar panel.

Air Source Heat Pumps

Using the same principle as a ground sourced heat pump, an air source heat pump removes heat from outside the house and delivers inside the house for heating purposes. Whereas, for cooling, it removes heat from inside the house and delivers it outside the house. In this way, the heat is exchanged between the two air mediums – inside vs. outside the house.

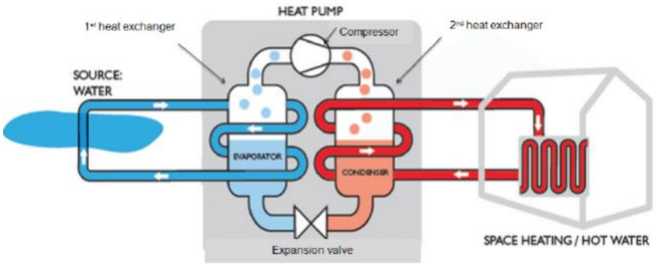


Source: (Miller, n.d)

Similar to a ground sourced heat pump, an air source heat pump contains a refigerations systems consisting of a compressor, two coils made of copper tubing – one for indoors and one for outdoors. These tubes are surrounded by aluminum fins to air help with the heat transfer process. The liquid refrigerant inside the outdoor copper tube extracts heat from air outside the house (source), evaporating into a gas. The indoor coil releases heat inside the house from the refrigerant as it goes through the compressor and condenses back to liquid (U.S. Department of Energy, n.d.).

Water Source Heat Pumps

As we have learnt all heat pumps work with a similar principle, the only difference it where they take the heat from or where it dispose of it. As the name implies, a water source heat pump uses a body of water to extract heat. Much like a ground source heat pump, a water source heat pump cycles water through a network of tubes laid out at the bottom of a body of water. The water inside these tubes carries heat from the body of water – such as a reservoir or a lake, and delivers it inside the house (Carney, 2011).



(McMilan, Hytiris, Emmanuel, Ninikas, & Aaen, 2014)

Discussion Questions

1. Describe the principle of how a heat pump works.
2. What is a source and a sink in a heat pump?
3. What are the three types of heat pumps and what is the main difference between them?
4. What are some possible environmental problems that could occur with ground source heat pumps?