GREEN Employment Program
Developed by Greenplanet Energy Analytics for Athabasca Chipewyan First Nation
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ALL ABOUT Heat Pumps

What is a heat pump?

A heat pump is an energy-efficient alternative to other types of home heating systems, such as natural gas/oil furnaces or electric baseboards.

It is basically a device that uses a small amount of energy to move heat from one location to another. Heat pumps pull heat out of the air or ground to heat a home or office building and they can be reversed to cool the building. If you know how an air conditioner or refrigerator works, then you already understand how a heat pump works.

Heat Pumps are Greener

Heat pumps don't actually generate heat – instead, they move warm and cool air around. ***This makes them 300-400% more efficient than fossil fuel furnaces or electric baseboards.***

While a gas furnace is always less than 100% efficient (newer models are usually 92–95%), a heat pump can be 300–400% efficient. That means for every 1 unit of energy used, a heat pump can produce 3–4 units of heating. You get more out of it than you put into it! They're also up to 50% more energy efficient for cooling compared to a typical window AC unit.

How Does a Heat Pump Work?

It is easier to understand how heat pumps work by learning about the individual parts (see Figure 1 below):

Refrigerant - the fluid that circulates through the heat pump, absorbing, transporting and releasing heat. Depending on where it is in the system, the fluid may be a liquid, gas, or gas/vapour mixture.

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Reversing Valve - controls the direction of flow of the refrigerant in the heat pump and changes the heat pump from heating to cooling mode or vice versa.

Coil - loops of tubing where heat transfer between the environment and refrigerant takes place. The tubing may have fins to increase the surface area to release more heat.

Evaporator - a coil in which the refrigerant absorbs heat from its surroundings and boils to become a low-temperature vapour. The refrigerant then passes from the reversing valve to the compressor.

Compressor - squeezes the molecules of the refrigerant gas together, increasing the temperature of the refrigerant. This device helps to transfer the heat energy between outside and indoors.

Condenser - a coil in which the refrigerant gives off heat to its surroundings and becomes a liquid.

Expansion Device - lowers the pressure created by the compressor. This causes the temperature to drop, and the refrigerant becomes a low-temperature vapour/liquid mixture.

Outdoor unit - where heat is transferred to/from the outdoor air in an air-source heat pump. This unit generally contains a heat exchanger coil, the compressor, and the expansion valve. It looks and operates in the same manner as the outdoor portion of an air-conditioner.

Indoor coil - where heat is transferred to/from indoor air in certain types of air-source heat pumps. Generally, the indoor unit contains a heat exchanger coil, and may also include an additional fan to circulate heated or cooled air to the occupied space.

Figure 1 **AIR SOURCE HEAT PUMP**

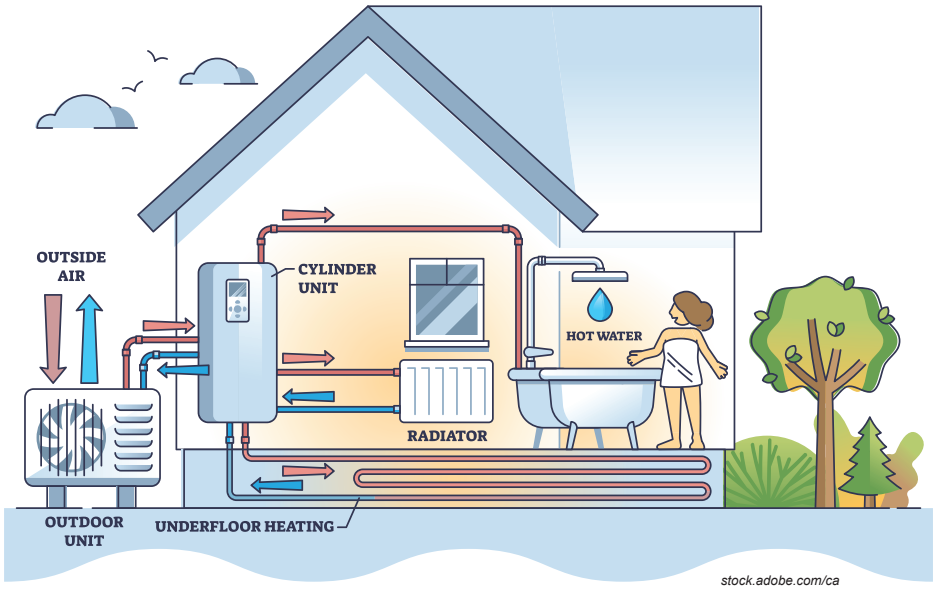

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Figure 1: How a Heat Pump Works

Types of Heat Pumps

Air-Source

(See Figure 1 on page 1) This heat pump draws heat from the outside air during the heating season and rejects heat outside during the summer cooling season.

- Even when outdoor temperatures are cold, a good deal of energy is still available that can be extracted and delivered to the building. For example, the heat content of air at -18°C is equal to 85% of the heat contained at 21°C. This allows the heat pump to provide a good deal of heating, even during colder weather.
- Air-source systems are the most common on the Canadian market, with over 700,000 installed units across Canada.

There are different systems for air-source heat pump to move heat:

- *Mini-split heat pump:* (also known as ductless heat pumps- see Figure 2) don't require ducting. They feature an outdoor unit that gathers heat from the air and transfers it via refrigerant lines to one or more heads mounted inside, offering multi-zone heating or cooling. Mini split systems are easy to install but can become less efficient with each head that you add.
- *Central heat pump:* has an outdoor unit connected to an indoor unit and uses ducts to move warm or cool air throughout the home. This is useful if you are updating an existing central heating system.
- *Ducted mini-split heat pump*: work in the same way as mini-splits except that they also feature a hidden head (usually in the attic) with ducting running to vents in two or more rooms.

Ground-Source

(See Figure 2 below) A ground-source heat pump uses the earth, ground water, or both as the source of heat in the winter, and as a reservoir for heat removed from the home in the summer.

These heat pumps are less common than air-source units but are becoming more widely used in all provinces of Canada. Their primary advantage is that they are not subject to extreme temperature changes, using the ground as a constant temperature source, resulting in the most energy efficient type of heat pump system.

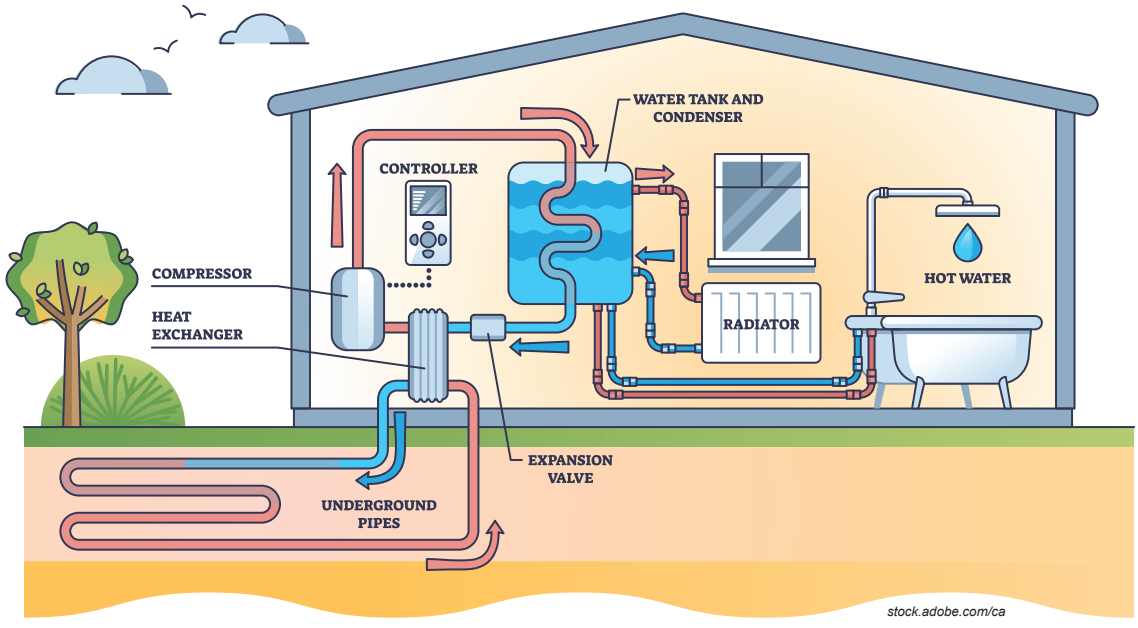
Ground heat exchanger designs can be classified as either:

- Closed Loop: collect heat from the ground using a continuous loop of piping buried underground. An antifreeze solution (or refrigerant), 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 soil. Common piping arrangements include horizontal, vertical, diagonal and pond/lake ground systems.
- Open Loop: take 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 then 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.

What About Very Cold Winters?

Cold weather affects heat pump efficiency. When the outside air is cold, there is very little heat to extract; therefore, air-source heat pump heat extraction becomes more difficult and uses more electricity. The opposite is true with heat pumps in cooling mode during the summer months. With ground and water source heat pumps, although they are more expensive to install, they are more efficient during the winter months as the ground and water temperature does not drop nearly as low as air temperature.

Figure 2 **GROUND SOURCE HEAT PUMP**



Another Answer - Hybrid Heat Pump Systems

In most cases, it is most economically and environmentally beneficial to operate a hybrid heating system. This consists of:

- A heat pump being the primary heating source.
- A natural gas furnace acting as a secondary heating source that operates during extreme cold (when heat pumps are less efficient) or during peak heat demand where the heat pump is not large enough to handle the load.

With this system, a Natural Resources Canada (NRCan) study measured a 30% drop in emissions in one complete heating season. The system used a wi-fi enabled, smart thermostat system that automatically switched heating to the least expensive mode of operation at the time.

The NRCan study involved a natural gas and heat pump hybrid system, but a heat pump can be paired with all fossil fuel furnaces or combination systems powered by natural gas, propane or heating oil.

Pros and Cons of Heat Pumps

PROS	CONS
• Lower operating costs – saves over time • Less maintenance • High efficiency • Reduces carbon emissions • Provides both heating and cooling • Long lifespan • Eligible for funding • Quiet • Better safety	• Higher initial cost • Requires a cold climate variant in northern regions • Reliance on electricity • (Ground source systems require higher levels of planning/expense)

Prices

Depending on location, type of heat pump, climate, size of house, condition of house and local market the cost of purchase and installation of a heat pump will vary. A summary of the price ranges is demonstrated in the table below:

Type	Unit Cost	Installation Cost
Air-source	$2,500 - $7,000	$1,700 - $2,500
Geothermal	$3,800 - $7,700	$13,000 - $38,000

Savings

Many factors will affect both cost and greenhouse gas emissions savings, such as:

- The size of your home
- Your local climate
- How energy efficient your home is
- How you currently heat your home

The table below demonstrates savings (calculated in 2022) achieved through transitioning to an air-source heat pump from select heating methods over a 10-year period with an annual heat load of 20 GJ/year:

Fuel	System	Cost Savings (CAD)
Heating Oil	Conventional Burner	$6,640
Natural Gas	Conventional Furnace	$2,484
Propane	Conventional Furnace	$14,615
Electricity	Baseboard	$6,785

Funding

Canada Greener Homes Grant from the Government of Canada

Eligibility

- Home cannot be used for renting.
- An EnerGuide home evaluation must be completed before completing retrofits.
- Home must be at least 6 months old.
- Must be the owner's primary residence.

Value

- $4,000 for adding an eligible air-source heat pump.
- $5,000 for adding an eligible cold climate air-source heat pump.
- $600 for pre and post installation energy evaluations.

Plan Ahead - Insulation and Ducting

Before looking into installing a heat pump, consider upgrading your home's insulation. The more insulated your home is, the more efficient your heat pump will be. Be sure to do this before getting your heat load measured so you can accurately determine the size of the heat pump you need. Proper insulation may allow you to install a smaller, less expensive system.

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If you're planning to use existing ducting for a central heat pump, have your contractor determine if it'll work with a heat pump, or if changes are needed.

How Heat Pumps Are Used In Your Home

Space Heating

Heat pumps are primarily used for space heating and cooling.

Heating with Ducts

- Both air- and ground-source heat pumps can be integrated with existing heating systems (forced-air ductwork, hydronic radiators, or in-floor heating) to transfer heat into a building.
- Ducted systems: same concept as a forced-air furnace, whereby warm air is distributed via ductwork throughout the building, then discharged through vents, typically on the floor or walls

Ductless Heating

- Another way is to use ductless air-handlers. These can be mounted on the floor, wall, or ceiling to disperse warm or cool air from the heat pump unit.
- Individual air-handling units are mounted in each room or heating “zone”. Up to 4 or 5 indoor units can be connected to the same outdoor heat pump.

Hot Water Heating

- Heat pumps, known as heat pump water heaters, are used to provide hot water to a building
- Some high-end heat pumps are able to provide both space- and water-heating

Hydronic Heating

- In-floor heating: warm water is distributed through plastic tubing installed underneath the floor
- Base-board heating: hot water is distributed through baseboards located on the external walls of the building

EMPLOYMENT

Refrigeration and Air Conditioning Mechanic

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Refrigeration and air conditioning mechanics install, maintain, repair and overhaul industrial, commercial and residential refrigeration and air conditioning systems and their component parts.

Do mechanical problems have you reaching for your tools? Can you deal well with people? Are you great with your hands? Then becoming a refrigeration and air conditioning mechanic could be a cool career for you.

The term of apprenticeship in Alberta is 4 years (12-month periods) that include 1,560 hours of on-the-job training and 8 weeks of classroom instruction in each year.

Apprentices must find suitable employers who are willing to hire and train apprentices.

For more information, visit:

https://alis.alberta.ca/occinfo/certifications-in-alberta/refrigeration-and-air-conditioning-mechanic/

For More Information:

ARTICLES

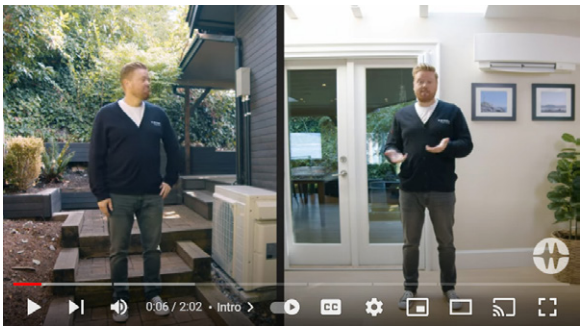
Heating and Cooling with a Heat Pump - Natural Resources Canada
https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817

Ductless heating and cooling - Natural Resources Canada
https://www.nrcan.gc.ca/energy/products/categories/heating/heat-pumps/air-source/ductless/21316

What’s a heat pump and how does it work? - BCHydro
https://www.bchydro.com/powersmart/residential/building-and-renovating/considering-heat-pump-info-tips.html

VIDEOS

Adapting heat pumps to our Canadian climate – Natural Resources Canada
https://www.youtube.com/watch?v=-wTRGbDY7Kk



How Do Heat Pumps Work? | Heat Pumps Explained - BCHydro
https://www.youtube.com/watch?v=iQaycSD5GWE

Heat Pumps:

The Future of Home Heating – Technology Connections
https://www.youtube.com/watch?v=7J52mDjZzto