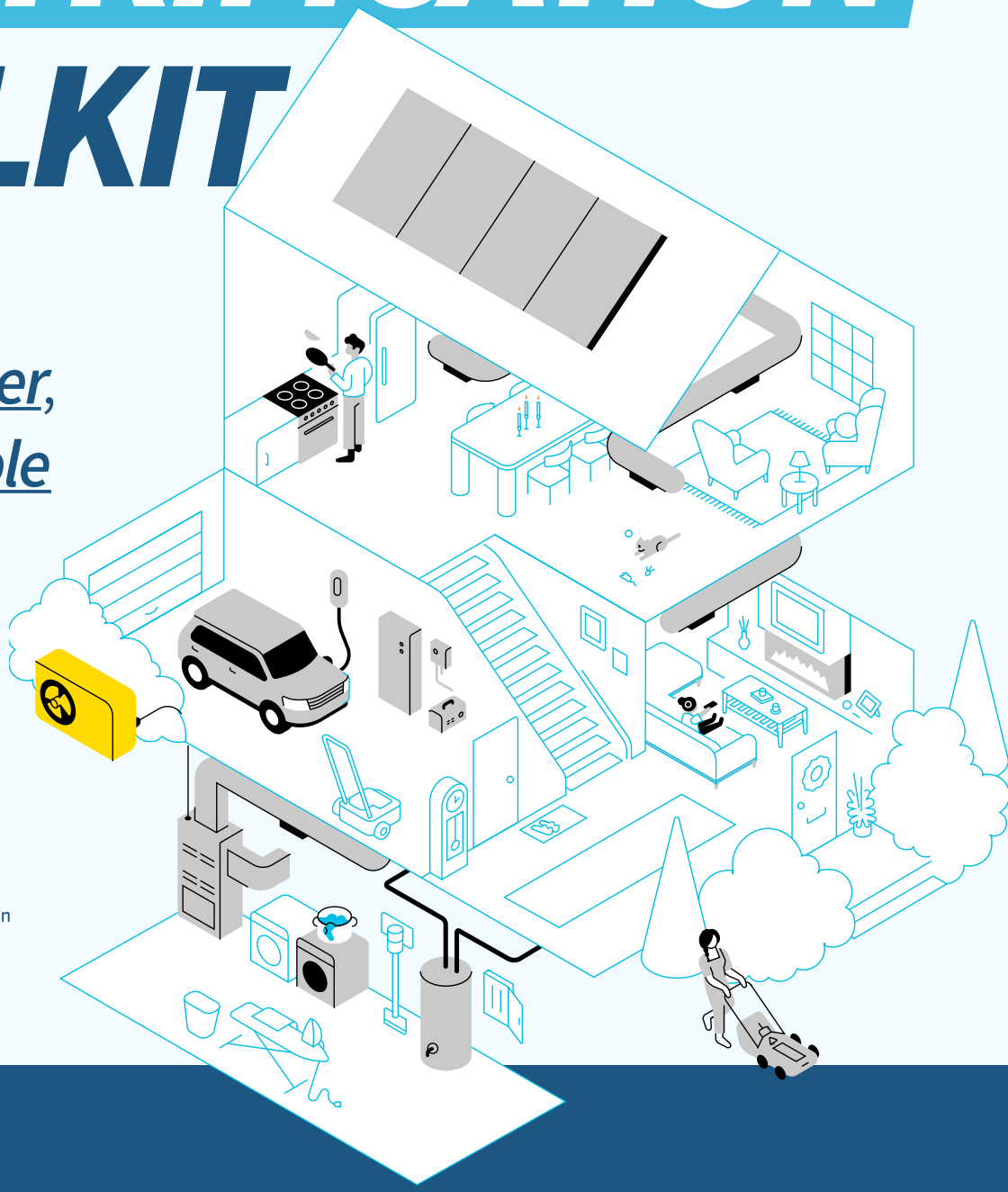
CANADA'S HOME ELECTRIFICATION TOOLKIT

Your guide to a ***cleaner, smarter, more affordable*** home



Building Decarbonization Alliance
pour la décarbonation des bâtiments

ELECTRIFY YOUR:

SPACE HEATING

Space Heating at a glance

COST

Upfront costs:
$$$-$$$$

Annual operating costs:
$$-$$$

EFFICIENCY

200-500%

ELECTRICAL NEEDS

240V*

*amp requirements vary by size and design

EQUIPMENT LIFESPAN

15-20 years

IMPLEMENTATION

Difficult

EMISSIONS REDUCTION IMPACT

Very high

RENTERS

Consider a portable heat pump

BONUS

Improved home comfort

Links to further resources:

- Information on heat pumps
- Information on building envelope improvements
- Canadian Association of Consulting Energy Advisors Directory

Space Heating

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Heat pumps are the now of home heating.

–
Paul Dowsett, Architect
and Pocket Change Project Retrofit Coach

If you’re thinking about replacing your heating or cooling system, consider a heat pump. The most energy efficient option available for heating and cooling, heat pumps offer so many additional advantages (see below) that you might wonder why they aren’t more widely used already. But interest is growing rapidly.

Heat pumps exchange heat energy with the outside air, the ground or even water—a much more efficient process than generating heat from fuels—and they can be configured to work in homes with central ducts, radiators, or no heating distribution system at all.

They’re also a great complement to an existing heating system: If you already have a newer furnace and aren’t ready to replace it, you can opt for a hybrid setup that uses the (more efficient and more cost-effective) heat pump until outside temperatures falls below a set temperature.

Fully electrifying your space heating will require space on your electrical panel, so be sure to check out 'Avoiding an Electrical Panel Upgrade' section on Tips for avoiding an electrical panel upgrade. Also check out 'Electric Thermal Storage' section to learn about add-on thermal storage systems that can save you money and increase your resilience.

WHAT IS A HEAT PUMP?

A heat pump is a remarkable piece of equipment that can heat and cool a home using very little energy. First invented in the mid-19th century, heat pumps use a refrigeration cycle to move heat from one location to another. It is a technology that we rely on every day to operate our fridges, freezers and air conditioners—but the heat pump that you install in your home can move heat in two directions. In winter, it pulls heat out of the air or ground outside and moves it into your home, while in summer, it takes heat from your home and moves it outside.

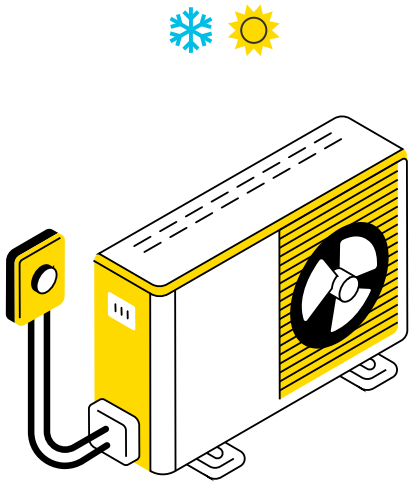
Because it uses energy to move heat rather than to generate heat, a heat pump can be many times more efficient than furnaces, boiler systems and electric baseboard heaters.

HEAT PUMPS IN COLD CLIMATES

You may be wondering if a heat pump can handle our northern climate. The answer is yes: there are a range of heat pump technologies that are up for the task. Just look at Norway, where 60% of homes are heated with a heat pump **despite their cold climate**. Modern cold climate air source heat pumps (ccASHPs) are designed to operate efficiently down to temperatures as low as -30°C (-22° F), and an electric resistance heater can be added into the system to make up any shortfalls. Ground source heat pumps are another option—they'll operate efficiently regardless of the outside temperature because they extract heat from the ground, where temperatures are relatively steady over the year.

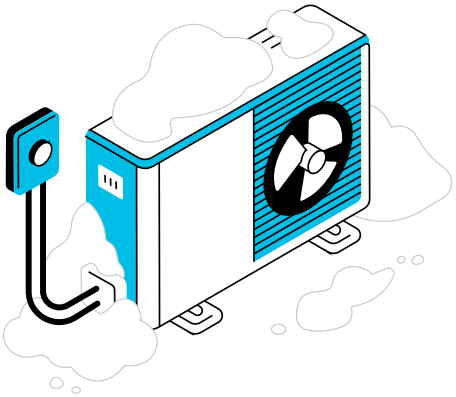
TYPES OF HEAT PUMPS

Air source heat pump (ASHP):



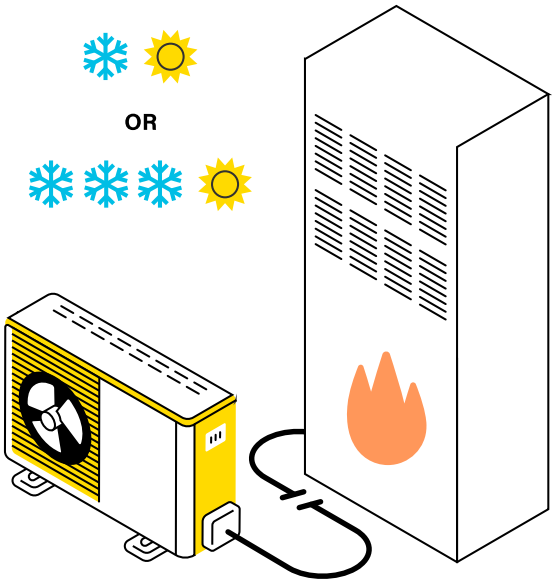
A conventional air source heat pump is the lowest cost option available and can provide all the heat needed in milder climates like Vancouver, or most of the heat needed in much of the rest of the country. ASHPs look like air conditioners—because they are air conditioners that also heat homes. They include an outdoor unit with coils, and a fan that exchanges heat with the surrounding air. To ensure functionality during very cold periods, ASHPs may require a built-in backup electric resistance heater, or they can be paired with an alternative heat source (e.g. hybrid heat pump).

Cold climate air source heat pump (ccASHP):



As the name implies, a cold climate air source heat pump is like a conventional ASHP, but designed to work efficiently and to move a lot of heat even at extremely low temperatures. The more complex design may result in higher upfront costs, but their high efficiency leads to operational savings. It is important for ccASHPs to be properly sized for your home to avoid over-reliance on built-in backup resistance heaters or alternative heating sources (i.e. hybrid model; see our list of questions to ask installers).

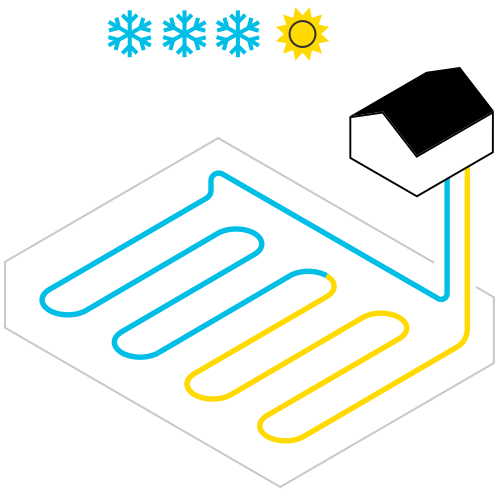
Hybrid heat pump (hybrid ASHP):



Many air source heat pumps can be combined with a conventional fossil fuel heating system (such as a furnace), making it an appealing option if your home is already equipped with a newer heating system. These hybrids, also known as dual-fuel heat pumps, use the heat pump until outside temperatures drop below a set temperature, at which point the system switches to the fossil fuel heating system. To minimize your use of fossil fuels, ask that your heat pump be sized and programmed to optimize heat pump use for heating.

Ground source heat pump (GSHP):

Because ground temperatures are relatively stable over the year, GSHPs (sometimes referred to as geothermal or geoexchange heat pumps) are more efficient than ASHPs and can even provide some of a home's hot water via a "desuperheater". Instead of exchanging heat with the air through an outdoor unit, a GSHP uses underground loops to exchange heat with the ground. Horizontal GSHP loops are placed below the frost line and require sites with large open areas, whereas vertical GSHP loops can be installed in most locations, but require special drilling equipment. GSHPs loops can also be placed in a body of water such as a lake or large pond. The ground loops are a long-term investment, as they can last 75 years or more, and the rest of the GSHP will last longer than ASHPs (20-25 years vs 15-20 years for ASHPs), as well as being far more energy efficient.



ELECTRIC RESISTANCE HEATING

Electric resistance heaters include electric baseboard heaters, electric furnaces and boilers, electric underfloor heating, and electric space heaters. These options typically cost far less to install than a heat pump, but they will cost more to operate because they are far less energy efficient. Some situations where electric resistance heating may be worth considering include:

As a supplemental heating source for spaces that are difficult to heat such as additions, basements, north-facing rooms, or garages.

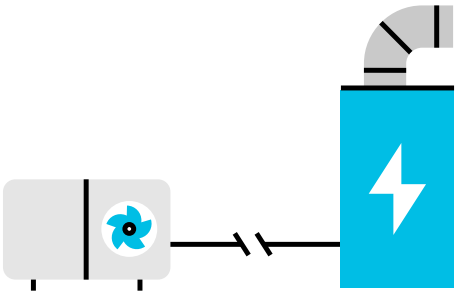
For cottages or other buildings that are rarely used in cold seasons—just be sure to consider how to prevent pipes from freezing.

As a backup to heat pumps without integrated resistance heaters. Ductless heat pumps often require separate backup heaters for very cold days.

When upfront costs are more important than operating costs. However, it is worth looking for heat pump incentives and financing options first to avoid paying more in operating costs or shouldering tenants with high energy costs.

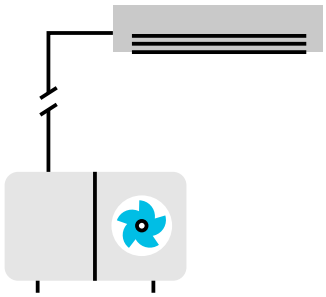
OPTIONS FOR HEATING DISTRIBUTION SYSTEMS

Ducted systems:



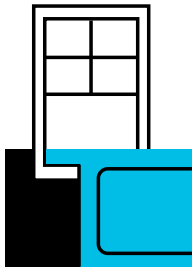
Most homes in Canada have forced air heating systems with ductwork. An ASHP or GSHP will use the existing ductwork and an air handler to circulate warm or cool air. It's important to ask your installer if the ductwork can accommodate the air flow of your desired heat pump, and what options are available if the ductwork is inadequate. Inadequate ductwork can lead to reduced efficiency and increased noise levels.

Ductless systems:



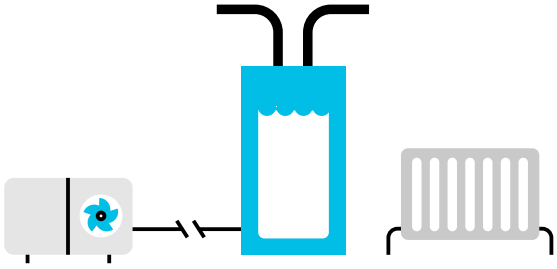
Homes without ductwork can use "mini-split" or "multi-split" heat pumps. These systems have wall- or ceiling-mounted units with a fan to distribute warmed or cooled air. The number of indoor units that a home will need depends on its size, layout, and number of rooms. Sometimes small duct systems are added to allow one indoor unit to serve multiple rooms (sometimes called a ducted mini-split), and one outdoor unit can serve one or several indoor units depending on the configuration. A notable advantage of this type of system is the ability to maintain different temperatures in various parts of your home.

Portable air source heat pump:



Small air source heat pump units with hoses that mount into a window opening are now available, much like existing portable air conditioners. Upcoming versions will include systems that hang like a saddle across a window ledge. These are less efficient than central and ducted systems, but they plug into a regular outlet and can effectively heat or cool a room.

Hydronic systems:



Homes equipped with boiler systems or radiant heating can use an air-to-water or ground-to-water heat pump system, which are already very common in Europe and are increasingly being installed in North America. The water circulating in these systems will be at a lower temperature than with a boiler, which may require upgrades to the radiators and the distribution systems. When these systems are used for cooling, pipe insulation and condensate drains may also be required. The hot water generated by the system can also be used.

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Heat pumps are the most energy efficient way to provide heat.

Electric heat pump features compared to gas equipment with separate air conditioning (AC):

Equipment	Outlet (amp requirements vary)	Upfront cost	Operating cost*	Emissions*
Gas furnace + AC	240V			
Gas boiler + AC	240V			
ASHP	240V	= / △	△	▼
ccASHP	240V	▲	△	▼
Hybrid ASHP	240V	= / ▲	△	▼
GSHP	240V	▲	▽	▼
Air to water HP	240V	△ / ▲	△	▼
Portable ASHP	120V	▼	△	▼

**See appendix for breakdown of cost and emissions outcomes by province and territory*

BENEFITS

In Canada we increasingly need heating and cooling solutions. Heat pumps provide both in one appliance.

Electric heat pumps produce no toxic carbon monoxide or climate-damaging carbon dioxide emissions, making them a safer option for homeowners and for the planet.

Heat pumps are the most energy efficient way to provide heat. Conventional fossil fuel heating systems convert the chemical energy in fuel to heat energy, and therefore cannot be more than 100% efficient. Because one unit of electrical energy can move many units of heat energy, heat pumps can be many times more efficient.

Heat pumps often cost less to operate than fossil fuel heating systems.[1] Their efficiency more than makes up for the higher price of electricity in most regions.

By switching to an electric heat pump, you may be able to disconnect from the gas supply and save fixed connection fees. Just be sure to ask to have the meter removed and to have the gas account permanently closed.

Heat pump efficiency is characterized by two metrics: the seasonal energy efficiency ratio (SEER), which measures cooling performance during the summer months, and the heating system performance factor (HSPF) or seasonal coefficient of performance (SCOP), which evaluates heating efficiency in winter. An ASHP will have an SCOP of 2.08 to 3.87 (HSPF of 7.1 to 13.2), while a GSHP will have an SCOP of 3.2 to 5.0. For comparison, fueled furnaces and boilers have significantly worse SCOPs of 0.82 to 0.98.

Homes with heat pumps are more comfortable. While a furnace blasts hot air into the home then waits until temperatures fall below a set point before blasting heat again, a heat pump provides slow and

steady heat. This results in less temperature fluctuations over the day. It also means that a heat pump will be more efficient if you leave the temperature consistent, even at night or when you are away during the day. As a result, the air, walls, floors and furniture will maintain a steady temperature without cooling off. This apparently subtle difference is one of the reasons why 81% of respondents to an international survey said they were more comfortable in their homes after installing a heat pump.

Some hybrid heat pumps can be programmed to switch between heating systems to optimize operational costs based on outdoor conditions and utility costs.

A GSHP system will last longer than an ASHP system and most fossil fuel heating systems. Whereas ASHP will have a lifetime of 15-20 years, GSHPs generally have a life expectancy of 20-25 years, with the ground loops expected to last for 75 years or more.

A GSHP or an air-to-water heat pump may also provide some of a home's domestic hot water needs.

CHALLENGES

- **ccASHPs** and **GSHPs** have higher upfront costs than fossil fuel heating systems—but in most regions of Canada, they will have lower overall lifetime costs because they are less expensive to operate.
- **Heat pumps** provide slow and steady heat. This can take some getting used to, but most homeowners report being more comfortable in their homes after transitioning to a heat pump.
- For **ducted system**s, you'll need to ask your installer to check the airflow capacity of the ductwork, to avoid noise issues and reduced efficiency.
- With a **GSHP**, installers should estimate both the heating and cooling loads to ensure the heat withdrawn from the ground in winter is balanced by the heat added in summer.
- During a power outage, an electric heat pump will require more battery or backup generator power to operate than fueled heating systems. For safety reasons, even fueled heating systems such as gas furnaces will not operate during a power outage unless connected to a battery or generator.

OTHER CONSIDERATIONS

- By investing in major improvements to the building envelope (insulating, air-sealing and upgrading windows and doors), homeowners can install smaller, less expensive heat pump systems that cost less to operate while also improving home comfort.
- You may want to inquire about **heating-as-a-service options** for heat pumps, where a business pays for and owns all or part of the system and charges for the heating and cooling service.
- It can be worth checking online to see if local businesses or municipalities offer concierge services to help homeowners navigate home upgrades including electrification of heating.
- Heat pump systems can **be paired with systems that store heat during off-peak** times for use during peak hours (see 'Electric Thermal Storage' section). These can save homeowners money, and they are incentivized in many provinces and territories due to the benefits they provide to the electrical grid.

- In some provinces (currently, BC, ON and QC), homeowners with heat pumps or air conditioners can sign up for **programs that offer incentives for reducing electricity use** during peak times. With such programs, the home will be pre-heated (winter) or pre-cooled (summer) in advance of a projected peak demand event so that the home can coast through the peak demand hours without using the heat pump or air conditioner. Ask your local utility if programs are available where you live.

- **ASHPs** and **ccASHPs** accumulate frost on the outside coils in winter. When this happens, a small amount of heat may be pulled from the home to melt the frost. Many heat pumps use a small resistance heater during this time to ensure occupant comfort. Also consider where this melted frost will drip and refreeze when choosing where to put the outside unit.

- The outdoor unit of an ASHP or ccASHP should be mounted off the ground in a location with good air flow.

- Just like furnaces, most heat pumps have air filters. Be sure to replace or clean these regularly. Check the manual for a schedule.

- Modern heat pumps are far quieter than older versions, but it's still advisable to position them away from patios and neighbours whenever possible. Wall-mounted heat pumps can be noisier due to vibrations.

- The outdoor unit of an ASHP or ccASHP should be kept clear of snow, vegetation and debris. Also, keep pets away from the units as their urine can cause corrosion in the coils.

- Installing a heat pump is more complex and can take longer than a fossil fuel heating system. It is best to have an experienced installer replace an older heating or cooling system before it fails.

WHAT ABOUT REFRIGERANTS?

Heat pumps use refrigerants for their operation, and occasional leaks of these substances may occur. Refrigerants can be very potent greenhouse gases, but their environmental impact is estimated to be lower than the impacts of natural gas leaks within homes. Furthermore, thanks to international agreements like the Kigali Amendment, manufacturers are moving towards low global warming potential (GWP) refrigerants.

To reduce the risk of refrigerant leaks, homeowners should work with an experienced and qualified heat pump installer (see our list of questions to ask installers).

HEAT PUMPS AND THE POWER GRID

In many parts of Canada, peak demand for electricity currently occurs during the hottest days, when air conditioners and heat pumps are in high use. As fuel heating systems are replaced with electric heat pumps, those peaks will likely shift to winter times. This has led to concerns about the power demand from heat pumps on cold winter days, and how it will impact the total generation capacity required by a province or territory.

While it is true that we will have to build more power generation capacity (including renewables plus storage), the peak winter demand may not be as high as many people anticipate. Heat pumps are more efficient than fuel heating systems, even at cold temperatures. Beyond that, there are other solutions to help mitigate these peaks, including GSHPs instead of ASHPs, home batteries, thermal storage systems, and EV chargers (for more information, see Sections Electric Thermal Storage, EV Chargers, and Home Batteries and Backup Generators). Improvements to building envelopes that reduce total heating loads will also reduce peak power demand.

Ultimately, utilities and energy regulators are paying close attention to concerns about increased demand, and plans are already underway to address them.

BUILDING ENVELOPE IMPROVEMENTS

Heat pumps and fossil fuel heating and cooling systems work with your building envelope to maintain a comfortable indoor temperature. The building envelope provides insulation and air sealing that prevent heat from moving out of your home in winter or into your home in summer. Improving the building envelope can involve adding insulation to the attic, exterior walls and/or foundation, sealing up air leaks, and upgrading windows and exterior doors. A heat recovery ventilator (HRV) or energy recovery ventilator (ERV) can be added to bring fresh air into your home with very little heat loss in winter or gain in summer.

Often, big improvements can be achieved with simple and low-cost measures such as sealing leaks around vent pipes, replacing the weatherstripping around doors, or adding attic insulation. The greater the improvements to a building's envelope, the more energy and money you'll save, and the more comfortable your home is likely to be. Significant upgrades may even allow you to install a smaller (and less expensive) heating system.

If you are planning upgrades to the building envelope, it can be valuable to get a home energy audit done first. This personalized assessment can help you to identify the most effective strategies for improving the insulation and air quality of your home and can also identify potential concerns such as hidden moisture issues. Many home incentive programs will require a home energy audit before and after home improvements are made.

QUESTIONS FOR INSTALLERS

Investing in a new heating and cooling system can be intimidating. Knowing the right questions to ask can help you to make an informed decision when choosing a contractor and heating system for your home.

- ☐ How much experience do you have installing heat pumps/ccASHPs/GSHPs? Have your installers received manufacturer training to install these units?
- ☐ Can you give me references for similar installs and show me the qualifications of the installers who will do the work? Do you have worker's compensation insurance?
- ☐ Do you use load calculations to determine the size of heat pump needed? (See 'Avoiding an Electrical Panel Upgrade' sectionfor more information on electrical loads)
- ☐ Do you assess the ductwork and air flow to determine if changes will be needed?
- ☐ Will I require any electrical or other upgrades to accommodate the heat pump system?
- ☐ Can I avoid an electrical panel upgrade with a historical load calculation, load share device or a smart electrical panel (see 'Avoiding an Electrical Panel Upgrade' and 'Energy Management Systems' sections)?
- ☐ What is the total cost of the system, and the upfront deposit? What financing options do you offer?
- ☐ Are you aware of any incentives that I qualify for?
- ☐ Where will you install the outside unit?
- ☐ Where will you install the inside units (ductless)?
- ☐ For hybrid heat pumps, at what temperature will the system switch to the backup heater? Will you help me to program the system to maximize the use of the heat pump?
- ☐ Will you show me how to program and use the thermostat?
- ☐ How long will the install process take?
- ☐ What will you do to ensure that the system is set up and working properly?
- ☐ What do the warranties cover and how long do they last? If your company closes, who should I contact about warranties and replacements?
- ☐ How can I maintain and monitor the performance of the system?

NOTE: It is always a good idea to get multiple quotes from multiple installers before signing a contract.

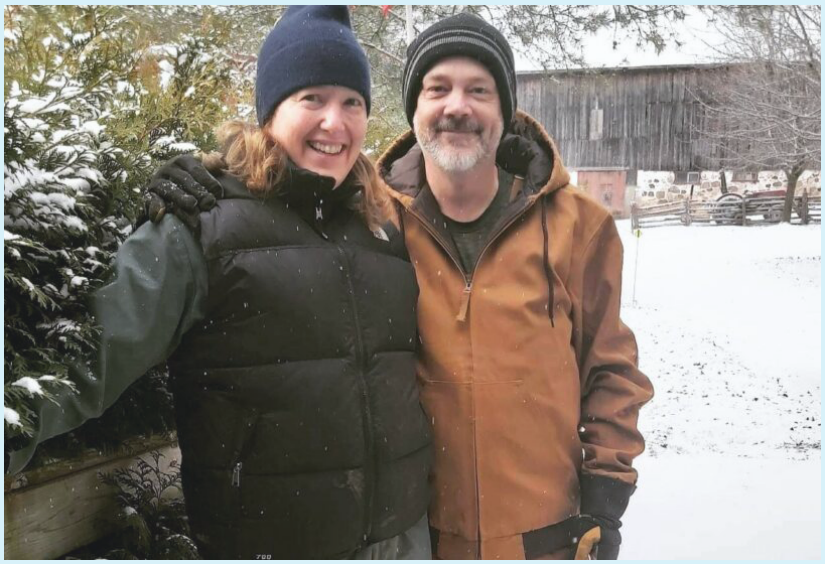
Ground source heat pump:

Karen and Henry were finding that heating with oil was getting very expensive for their central Ontario home, built in 1875.

After a home energy audit and lots of research, they settled on a ground-source heat pump with a horizontal loop paired with an electric tank water heater that uses water pre-heated by the heat pump (desuperheater).

They are very happy with the switch, which is a long-term investment that will help to keep operating costs low well into their retirement years while reducing operational emissions by 94%.

More details can be found at Green Communities Canada.



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The geothermal heat pump is more consistent and gentler than the old oil furnace or air conditioner. I was afraid it wouldn’t be warm enough for my mother-in-law, but it has been great.

–

Karen

This section is part of the Canada's Home Electrification Toolkit. The Toolkit provides clear, concise, and up-to-date information on space heating, cooking, fireplaces, home batteries and backup options, and other household equipment. It also includes tips for renters, strategies for avoiding potentially costly electrical panel upgrades, and case studies from satisfied homeowners.

ADDITIONAL SECTIONS ARE AVAILABLE FOR DOWNLOAD BELOW:

- Electric Thermal Storage
- Water Heaters
- Cooking
- Dryers
- Fireplaces
- Outdoor Equipment
- EV Chargers
- Home Batteries and Backup Generators
- Solar Power
- Avoiding an Electrical Panel Upgrade
- Energy Management Systems
- Options for Renters
- Electrification Incentives
- Amplifying the Impact Through Conversations
- Ways Community Groups Can Help
- Appendices

Symbols and terms in this publication:

Upfront or operating cost (no incentives applied)

Symbol	Description
$	Up to $99
$$	$100-$999
$$$	$1,000-$9,999
$$$$	$10,000 and above

Implementation

Term	Description
Easy	Can be implemented by yourself if no electrical upgrade is required
Medium	Can be implemented by someone with DIY skills
Difficult	Generally requires a qualified electrician or other contractor

Emissions reduction potential (onsite emissions reductions using Canadian averages)

Term	Description
Low	1-9 kg CO2 per year
Medium	10-99 kg CO2 per year
High	100-999 kg CO2 per year
Very high	> 1,000 kg CO2 per year

When comparing electric to gas equipment on upfront costs, operating costs and emissions

Symbol	Description
=	Values differ by 10% or less
▽	Electric version is 10-50% lower
▼	Electric version is more than 50% lower
△	Electric version is 10-100% higher
▲	Electric version is more than 100% higher

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