CANADIAN HEAT PUMP MYTH BUSTER

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Efficiency Canada's Canadian Heat Pump Myth Buster

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Introduction

Buildings are the third largest source (18 per cent) of greenhouse gas (GHG) emissions in Canada[1] and are an even larger share in major cities. For example, in 2021, buildings were the largest source (61 per cent) of GHG emissions in Toronto[2]. Space and water heating account for the majority of building emissions, both residential and commercial[3]. This offers a unique opportunity and challenge. With the abundance of low-carbon electricity in Canada[4], electrifying buildings will be essential in meeting 2050 net-zero emissions targets[5]. Heat pumps are an integral part of this solution, due to how efficiently they use electricity to heat and cool buildings while replacing fossil fuels. Additionally, heat pumps offer building owners and occupants many benefits — including increased comfort[6], often lower utility costs[7] and access to efficient cooling — increasingly essential due to climate change.

Between 2005 and 2020, the number of Canadian homes with a heat pump more than doubled from 414,000 to 842,000[8], contributing about 6 per cent of home heating[9]. According to modelling done by the Canadian Climate Institute, residential heating supplied by heat pumps will need to almost double again between now and 2030 to align with Canada's climate targets.

What is a heat pump?

Heat pumps work like an air conditioner — absorbing heat from inside your house into a refrigerant and rejecting it outside. With the addition of a small component, heat pumps are reversible. By moving heat in both directions, it both cools and heats effectively.

- While fossil fuel-based heating systems can only release the energy stored in the fuel they consume, by burning, heat pumps concentrate and move more energy than they consume. As a result, heat pumps can be 200-540 per cent efficient[10], providing 2 to 5.4 kWh of heat for every 1 kWh of electricity they consume.
- By comparison, new natural gas boilers or furnaces are typically rated at 82[11,12] to 98 per cent[13] efficient in Canada. Electric boilers or baseboards are, at a maximum, 100 per cent efficient[14].
- Advanced versions work even in very cold conditions — down to around -30 °C[15].

There are two main categories of heat pumps, air-source and ground-source:

Air-Source Heat Pumps (ASHPs)[16]

The most popular heat pump in Canada, with over 700,000 installed to date[17]. The outdoor compressor draws heat in the winter and discharges it in the summer using a refrigerant. They can either be ducted – heating and cooling is distributed using a building's existing ventilation system – or ductless – where an outdoor condenser is connected to indoor heads that circulate the conditioned air. ASHPs can reduce electricity consumption for space heating by at least 50 per cent compared to electric resistance heating[18].

Conventional air-source heat pumps can typically work without a supplementary system to temperatures as low as 5°C – -10 °C[19], depending on the model. Due to advancements in refrigeration circuits and variable speed compressors, Cold-Climate Air-Source Heat Pumps (CC-ASHPs) maintain high heating capacity at very low temperatures. In climates as cold as Whitehorse, YT, CC-ASHPs have been found to efficiently supply heat at temperatures as low as -28.9 °C. To be classified as Cold Climate by ENERGY STAR®, a heat pump must be able to maintain a coefficient of performance (COP)[20] of at least 1.75 at -15 °C[21].

The lower the temperature, the more moisture in the air freezes on the outdoor heat exchanger[22]. Some heat pumps have a small coil to defrost the outdoor unit or they may temporarily operate in reverse to do so. This requires more energy (i.e. the heat pump has a lower COP as temperature decreases), but still uses less energy than electric resistance and fossil fuel heating systems to low temperatures[23].

Air-to-Water Heat Pumps are a subcategory of ASHPs designed for use in buildings with hydronic (water-based) distribution systems such as radiators, radiant floors, or fan coil units[24]. Throughout the colder months, they absorb heat from the outside air similarly to the air-source heat pump, but instead of transferring heat to the indoor air, it's transferred to the building's hydronic circuit.

Ground-Source Heat Pumps (GSHPs)

There are three types of GSHP: closed loop, open loop, and direct expansion.
A closed loop GSHP consists of a continuous loop of underground piping, filled with liquid that can absorb (or reject) heat from (or into) the ground or a body of water. A heat exchanger then transfers the thermal energy to the heat pump[25].

An open-loop GSHP exchanges heat with a body of water, like a lake or an aquifer, drawing water directly into the heat exchanger[26], where heat from the water is extracted.

With direct expansion, a refrigerant circulates through copper tubing, allowing the thermal energy extracted to be used directly by the heat pump, reducing installation costs.

Since underground temperatures are warmer and more stable than air temperatures in the winter, ground-source heat pumps operate more efficiently than other types of heat pumps at lower temperatures[27]. As a result, ground-source heat pumps use up to 44 per cent less energy than ASHPs[28]. They also have the greatest longevity[29], but have the highest installation cost. GSHPs are more popular in rural and suburban settings, since horizontal loops dug near the ground's surface are the least expensive configuration but usually require at least a quarter acre of land[30]. Vertical loops are more expensive as they are bored deep into the ground (30 - 120 m[31]), but require no space once installed, making them possible in urban settings, like this project in Montreal. GSHPs are also a great option for new build communities, when drilling the boreholes for vertical installations or trenches for horizontal installations is less disruptive, less costly, and when the drilling rig has easiest access to the site. GSHPs in new-build developments are becoming increasingly popular, as they can have paybacks of only 5 -7 years[32]. Research funded by The Atmospheric Fund enabled a community GSHP project connected to 312 new-build homes in Markham.

Supplementary Systems

In climates where the temperature drops below what the installed heat pump is rated to, a supplementary heating system is required. Some examples of supplementary systems are electric resistance built into the heat pump, electric baseboards, or an existing gas system. When an ASHP is combined with a gas system, it becomes a hybrid heat pump.

Industrial heat pumps can be used in district energy systems, which may be more economical for large multi-unit residential buildings (MURBs) with many small apartments, as each unit doesn't require its own heat pump[33]. There are many innovative heating sources heat pumps extract and amplify heat from, such as waste heat from sewage, for example this district energy system in the False Creek neighbourhood of Vancouver. Heat pumps have other high efficiency applications in buildings, like water heaters and clothes dryers.

What is the role of heat pumps in net-zero emissions?

According to the IEA (2022) electrifying heating with heat pumps can reduce global GHG emissions by more than 500 million tonnes in 2030[34]. In their The Big Switch report, the Canadian Climate Institute presented a net-zero emissions scenario where electricity as a share of household energy consumption increased from 23 per cent in 2020 to 39 per cent in 2035 and 96 per cent in 2050. Electrification paired with renewable electricity can enable Canada to achieve its climate targets. As renewable electricity becomes cheaper[35] heat pumps are an excellent and highly efficient use of clean electricity.

A recent report by NRCan's CanmetEnergy research centre modelled the GHG savings of an archetypical post-1980s two storey home across sixteen Canadian cities from switching to a CC-ASHP from electric resistance, gas, or oil heating. The CC-ASHP reduced emissions by more than 95 per cent in two-thirds of the fossil fuel replacement scenarios, and from 49 - 77 per cent compared to electric resistance[36], as heat pumps use far less electricity to move the same amount of heat. This MURB retrofit project that installed CC-ASHPs in each apartment of a 12-storey, electric resistance-heated, 1965-built apartment building in Mississauga, Ontario resulted in a 46 per cent reduction in heating energy consumption.

Policy momentum for heat pumps in Canada

Heat pumps are gaining momentum in Canada, with some help from new policies and programs.

The Canada Greener Homes Initiative grants and loans program provides homeowners incentives for heat pumps alongside building envelope upgrades, with no incentives for fossil fuel systems, for their primary residence.

For larger commercial and multi-unit residential buildings, The Canada Infrastructure Bank's Building Retrofits Initiative encourages efficient electrification by requiring that projects achieve a "minimum of 30 per cent GHG emissions reductions"[37] and providing preferential interest rates for better GHG reduction performance.

Additionally, Canada has committed to develop a net-zero emissions building code by 2025. As stated in Efficiency Canada's *What Municipalities Need to Know about Canada's Net-Zero Emissions Building Codes* guide, "building codes offer a one-time opportunity in the buildings life cycle to lock in the high levels of energy and emissions performance in buildings in a cost-effective way, and in ways that would be cost-prohibitive in future retrofits,"[38]. However, current tiered building codes that focus on energy efficiency do not guarantee emissions reductions, as electric heating systems in Step 1 (minimum efficiency) homes had substantially lower emissions intensities than Step 5 (Net-Zero Energy Ready) homes with gas heating.

In British Columbia, as part of the *CleanBC Roadmap to 2030*, after 2030, "all new space and water heating equipment sold and installed in B.C. will be at least 100 per cent efficient",[39] effectively banning stand-alone fossil fuel-based heating systems.

Vancouver has moved quickly on regulating home heating. Zoning amendments have required all "new low-rise residential buildings require zero emissions equipment for heating and additional roof insulation" since January 1st, 2022[40], and all new and replacement heating and hot water systems must be zero emissions by 2025[41]. Additionally, renovations of 1-2 dwelling homes costing more than $250,000 to construct must electrify space and water heating[42].

Common myths

Canadians and policymakers are interested in heat pumps. Yet, a few common myths exist. Below we discuss 10 myths that might hinder heat pump promoting policies in Canada and the facts behind them.

Myth 1: Heat pumps are a new and untested technology.

Reality: Heat pumps operate using the same technology as everyday refrigerators and air conditioners and are widely used in the Maritimes and Europe.

The facts:

- A heat pump transfers heat using the same technology as refrigerators and air conditioners, with more recent technology advancements enabling them to work in colder climates.

- Heat pumps are popular in climates as cold or colder than Canada's. For example, Estonia, Norway, and Finland are colder than Canada and have heat pump penetration rates 3-6x higher per capita than Canada[43]. In Norway, 60 per cent of buildings have a heat pump[44].
- Heat pumps are common in the Maritime provinces and are growing in popularity throughout Canada.

If you own a refrigerator or air conditioner, you are familiar with the ability of heat pumps to move heat from one area to another. The technology behind heat pumps is very old. Artificial refrigeration was first demonstrated in 1850[45], and the first documented heat pump followed shortly after in 1856[46]. Heat pumps have been used in Canada since at least 1948[47]. Older generations of heat pumps were best suited for temperate climates. What makes modern heat pumps different is their ability to maintain capacity and heat during cold outdoor temperatures due to major efficiency improvements, advancements in inverter technology, and the addition of variable speed motors[48], resulting in highly effective cold climate models.

Heat pumps are common in many parts of the world, particularly Northern Europe. Northern European nations make extensive use of heat pumps. Norway has the highest share of home heating by heat pump in the world (60 per cent)[49]. In Sweden, where more than 40 per cent of homes have heat pumps, home heating emissions have decreased 95 per cent, as the nation has replaced oil heating with heat pumps and district heating[50] since the 1990s.[51]

The preference for heat pumps is growing here in Canada. According to sales data from the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI), heat pump sales surpassed gas furnaces for the first time in 2021, with over 300,000 units shipped[52]. They are the most common primary home heating system in New Brunswick (32 per cent) and Prince Edward Island (27 per cent)[53], and a close second to furnaces in Nova Scotia (21 per cent vs 23 per cent)[54]. Heat pumps are also gaining popularity in Quebec (11 per cent) and British Columbia (7 per cent), at least partially due to their abundant clean, affordable electricity.

Myth 2: Canada would be alone if requirements for cleaner and more efficient heating were introduced.

Reality: Policymakers taking climate change seriously are introducing clean heating requirements.

The facts:

- Several jurisdictions in Europe and the United States are creating rules that prevent the installation of stand-alone fossil fuel heating systems.
- The U.S. proposes no longer recognizing residential furnaces and air conditioners as energy efficient under its ENERGY STAR® program, signaling a potential path for future regulations.

Europe, Austria, France, Ireland, the Netherlands, and Norway[55] all have bans on oil and gas boiler installation in new buildings by 2023. As of January 1, 2026, the Netherlands will have higher minimum efficiency standards for replacement boilers in single-family homes, essentially banning stand-alone fossil-fuel based boilers and furnaces in favour of hybrid or fully electric heat pumps[56]

In the U.S., New York State legislature recently approved a state budget prohibiting natural gas and other fossil fuel heating and cooking equipment in new buildings shorter than seven stories by 2026 and by 2029 for taller buildings[57]. This type of policy has been gaining traction due to high upfront costs of adding new developments to the natural gas distribution system, as well as the risk of additional stranded gas distribution assets[58].

San Francisco will require all new water heaters and furnaces to have zero emissions of nitrogen oxides (NOx), effectively banning fossil fuels in buildings, excluding cooking appliances[59]. The new rulings will come into effect for water heaters in single-family homes in 2027, furnaces in 2029, and multifamily and commercial water heaters in 2031. The rest of the State of California will follow suit with a ban on the sale of gas furnaces and water heaters by 2030[60].

ENERGY STAR®, the most widely used energy efficiency label in the United States and Canada, has proposed sunsetting ENERGY STAR® certification for residential furnaces and central air conditioners effective December 30, 2024[61]. They justified the decision by emphasizing “the potential for electric heat pumps to deliver energy-efficiency gains, pollution reduction and cost-savings to consumers,” and cite estimates, “if all [central air conditioners] were replaced by heat pumps, about 50 Mt of CO_2 would be avoided over 10 years and billions of dollars in heating costs would also be saved” in the U.S..

Myth 3: Canada is too cold for heat pumps.

Reality: Cold-climate heat pumps work across Canada.

The facts:

- CC-ASHP technology works in northern climates, with the newest prototypes heating down to –31 °C.
- Heat pumps alone can heat more than 90 per cent of the time in Canada’s coldest cities.

Cold Climate Air Source Heat Pumps (CC-ASHP) are specifically designed to work in northern climates. The Northeast Energy Efficiency Partnerships (NEEP) has a list of CC-ASHPs that meet or exceed federal requirements for energy efficiency, as well as a minimum operating standard in cold climates that is used by the Governments of The Yukon, PEI and Quebec.

While fossil fuel-based and electric resistance heating systems have constant efficiencies, heat pump efficiencies vary depending on the outdoor air temperature. At lower temperatures, there is less heat to extract and concentrate yet -18 °C air still contains around 85 per cent of the heat it contained at 21 °C, which leaves usable heat, even at low temperatures. The second year of a Government of Yukon pilot project of five homes retrofitted with CC-ASHPs in Whitehorse measured energy savings of up to 43.2 per cent and a COP of 2.41 over the heating season, maintaining a COP of over 1 to -28.9 °C for the best performing heat pump in the pilot.

Heat pump technology is continuing to improve substantially. Natural Resources Canada (NRCan), in partnership with the U.S. Department of Energy and U.S. Environmental Protection Agency, launched a Residential Cold Climate Heat Pump Technology Challenge[62] in 2021 to improve the efficiency and performance of CC-ASHPs. Trane, an HVAC manufacturer, has already passed the challenge with a prototype that performed in temperatures as low as -31 °C[63].

In parts of Canada where winters reach temperatures below what a CC-ASHP can handle, back-up systems offer supplemental heat. It is common for CC-ASHPs to have built-in electric resistance heating. Heat pumps can also be tied into an existing electric baseboard or natural gas furnace systems and be programmed to switch to the back-up source during extreme cold snaps. However, heat pumps can work without back-up more than 90 per cent of the heating season in Canada's coldest cities. Even if a fossil-fuel based system is kept for the coldest periods, switching to a heat pump for the majority of heating hours has enormous gains in terms of energy consumption and emissions[64]. In fact, in the past five years (2018-2022) only 0.3 per cent of heating hours had a minimum temperature below -20 °C in Toronto, Canada's most populous city. Even in a much colder city like Saskatoon, less than 10 per cent of heating hours were below -20 °C[65].

Myth 4: Using a heat pump costs more than a fossil fuel-based heating system.

Reality: The utility costs associated with heat pumps are less, in almost every scenario[66] due to their higher efficiency. There are also federal, provincial, and municipal incentive programs to help lower the upfront costs.

The facts:

- Electric heat pumps replace both aging heating and cooling equipment, providing cost savings in most cases along with less volatile energy costs.
- Rental and other "efficiency as a service" programs can eliminate up-front costs.

This 2022 NRCan report found that homeowners switching from an oil furnace to a CC-ASHP could expect to save $1000-$3500 in annual utility costs. Similarly, switching from electric resistance heating to a CC-ASHP generated $700-1900 in savings, depending on electricity rates and the climate they were operated in. Additionally, savings from switching from natural gas, ranged from $50-150 per year in most regions of Canada, including the fixed natural gas charges ($150-300/year) eliminated by going fully electric. As both natural gas and oil prices have increased significantly compared to the August 2020 prices used in the study, current cost savings would be even higher. With the federal carbon tax increasing annually by $15/tonne CO_{2e} to $170/tonne in 2030, the relative savings from a heat pump would also continue to grow[67].

With comparatively higher efficiencies at cold temperatures and longer lifespans, GSHPs can offer greater cost savings. This study calculated installing a horizontal loop ground-source heat pump paired with an electric water heater would save an average rural Southern Ontario home $24,193 over its 20-year lifespan compared to an equivalent gas-fueled heating and hot water system.

Due to greater interaction with international markets, oil and natural gas prices are far more volatile than electricity prices. For example, according to Statistics Canada , fuel oil and other fuels' prices were up 73.4 per cent[68] in November 2022 compared to the same month the year prior and natural gas 23.7 per cent more, while electricity prices increased only 1.6 per cent on average in Canada. Electricity is more tightly regulated and suffers less from geo-political concerns — increasingly so as the Canadian electricity supply includes more domestic renewable energy sources.

When comparing the cost, keep in mind a heat pump doubles as a more efficient air conditioning, resulting in savings in upfront capital costs, maintenance costs and energy costs. Heat pumps available in Canada are also up to 50 per cent more efficient at cooling than a typical window air conditioning unit[69]. Additionally, as of January 1, 2023, the Minimum Seasonal Energy Efficiency Rating (SEER), demonstrating cooling efficiency, of heat pumps is 15.0, whereas it's only 14.0 for central air conditioners. Therefore, a heat pump meeting minimum requirements would cool a building more efficiently, while using less electricity, than an air conditioner also meeting minimum requirements[70].

A barrier to heat pump adoption is the larger upfront cost. Saint John Energy in New Brunswick has been renting CC-ASHPs to customers for about $50 per month since at least 2016[71], including installation and maintenance. Renting the equipment, at a fair price, can allow homeowners to take advantage of the benefits of a heat pump without having to finance the upfront cost. Renting heat pumps is also beneficial for the utility, since they can install higher efficiency heat pumps than customers may have chosen, lowering the additional electrical demand from the heat pump, and reducing their costs.

Heat pumps can also increase the value of your home and lower the mortgage loan insurance premium. A study in the U.S. found "[r]esidences with an air source heat pump enjoy a 4.3–7.1 per cent (or US$10,400–17,000) price premium on average"[72].

Additionally, the CMHC Eco Plus program provides purchasers of highly energy efficient or low emission homes 25 per cent back on their mortgage loan insurance premium.

Myth 5: Electric grids don't have the capacity for heat pumps.

Reality: Electricity grid operators can manage the transition to electric heat through a variety of strategies, including more energy efficiency, smarter timing of electricity demands, and backup fuels.

The facts:

- Electrification will not occur “all at once” but over time, giving electricity system planners the ability to plan ahead and respond.
- Some regions of Canada use a lot of electric heat, and heat pumps will save electricity by replacing less efficient electric heating systems.
- Peak demand during extreme cold periods can be managed with better building envelopes, smart demand side management, and hybrid heating.

Heat pumps are not going to go onto the electricity system all at once. About 7 per cent of heating systems are replaced every year[73], giving electricity system managers time to manage this upcoming demand with strategies like energy efficiency and “demand flexibility”.

Yet, it is important to recognize more heat pumps can save electricity during peak and off-peak periods, especially in Canada where approximately 40 per cent of household primary heating systems are the less efficient non-heat pump electric systems[74]. As heat pumps operate, on average, three times more efficiently than electric resistance or electric boiler heating, adding a heat pump would save electricity over 90 per cent of the heating season, when the electric resistance backup heating isn’t needed. According to this report by The Atmospheric Fund, adding an ASHP to an electric resistance-heated MURB in Ontario can reduce electricity consumption by almost two-thirds.

Electricity planners should look to various “demand-side management” strategies to save electricity and shift the timing of electricity demand. There are a large number of solutions available.

First, Canadian utilities should increase electricity savings through measures such as improved insulation and air sealing, energy-efficient appliances, and smart lighting systems. Saving electricity is often more cost-effective than building energy infrastructure while creating societal benefits such as improved comfort and reducing energy poverty[75]. Canada's leading province (Nova Scotia) saved less than 1 per cent of incremental electricity savings compared to 2021 sales, which is less than half of the savings of the top American state (California)[76]. By catching up to leading American states in electricity savings we will create more room for heating electrification. This study by Power Advisory for The Atmospheric Fund modelled Ontario's electricity grid reaching net-zero by 2035, calculating that using energy efficiency to reduce expected demand by 11 per cent would cut "the need for incremental build outs of wind, solar, and storage by almost half".

Additionally, Efficiency Canada's 2021 *Canada's Climate Retrofit Mission* report found that a strategy that combines comprehensive building envelope improvements with "the replacement of fossil fuel heating with electric heat pumps can actually result in net annual electricity savings of 50 TWh" within Canada's building sector[77].

Demand-side management can directly reduce peak demand periods on the coldest days by changing the timing of different energy demands. Smart home electrification allows non-essential systems to be turned down or shut off. Hilo by Hydro-Québec is an example of demand-side management through a "Smart Hub" managing Wi-Fi-enabled home devices, such as thermostats, water heaters and lighting, allowing customers to opt-in to have those appliances turned down or off during peak demand events, and be financially compensated for doing so.

Installing GSHPs rather than ASHPs where possible can minimize the impact on the electrical grid of electrifying home heating. As GSHPs are more efficient than ASHPs, especially at low temperatures, this report by Dunsky Energy + Climate Advisors calculated the higher upfront cost of GSHPs is more than offset by "the peak load and electric consumption benefits"[78].

Other demand-side management strategies can involve the use of hybrid heating systems, where a heat pump is added to the existing fossil-fuel-based heating system, which can use smart controls to switch to the backup system when the grid is strained. While the emissions reductions from hybrid systems are lower, hybrid heat pumps can virtually eliminate the increase in winter peak demand that fully electric systems experience[79]. In 2021, Quebec's two largest utility providers, Hydro-Québec (electricity) and Énergir (natural gas), signed a dual energy agreement to replace standalone natural gas heating systems with hybrid electric heat pump-natural gas systems[80]. As Québec has abundant low-carbon hydroelectricity, electrifying heating with heat pumps can greatly reduce energy consumption and GHG emissions. To lessen the impact of peak heating during extreme cold events on the electrical grid, the system is designed to switch back to the natural gas system.

These hybrid systems could eventually be decarbonized through the use of renewable natural gas (RNG)[81] in existing natural gas infrastructure[82]. However, this resource should be used sparingly, as current natural gas consumption levels could not be maintained with RNG alone. According to the Canada Energy Regulator, "Canada's 2021 total end-use demand for natural gas was 4,254 PJ"[83]. However, this 2022 paper found that exploiting all of Canada's organic waste streams could only produce 1388 PJ of RNG, about a third of current consumption[84]. Thus, RNG is not a suitable substitute for building electrification, but could serve a role in the clean energy transition during peak demand periods. Just 5 per cent of currently used natural gas (~15 per cent of RNG potential) would be enough for load peaking[85], leaving additional RNG for high-value use in other industries.

Of course, electricity grid managers must plan for heat pumps. These managers have time and a very large suite of solutions at their disposal. Policymakers should thus be focused on exploring and deploying these solutions and not allowing fears about electricity grid capacity to hold up the benefits of using electric heat pumps for the vast majority of our heating needs.

Myth 6: In provinces with dirty grids, heat pumps don't lower emissions.

Reality: Heat pumps can lower emissions even on dirty grids because they are very energy efficient.

The facts:

- All Canadian provinces have clean enough electricity grids for heat pumps to lower emissions.
- Coupling heat pumps with other renewable energies or strategic use of fuels can shift away from peak demand.

There's no benefit to waiting for the grid to be fully clean to significantly ramp up heat pump adoption. Heating systems are generally only replaced every 15-20+ years, so a fossil-fuel based heating system installed now would continue to be a source of direct emissions until about 2040.

The greenhouse gas intensity of the electricity grid varies greatly between Canadian provinces and territories, ranging from 2.0 g CO_{2e}/kWh in Manitoba to 730 g CO_{2e}/kWh in Saskatchewan[86], which has fueled debate as to whether switching to a heat pump from a high efficiency gas furnace lowers emissions in provinces where electricity production is dominated by fossil fuel combustion. According to the IEA, "[h]eat pumps still reduce greenhouse gas emissions by at least 20 per cent compared with a gas boiler, even when running on emissions-intensive electricity"[87]. Similarly, a 2020 study in Nature concluded that the average heat pump would have lower lifecycle emissions than an average new gas boiler, as long as the electricity grid's emissions intensity was less than 1,000 gCO_{2e}/kWh — significantly higher than any province or territory in Canada.

The emissions intensity of electricity generated in Canada has fallen 45 per cent between 2005 and 2019[88]. With the federal government targeting net-zero emissions electricity by 2035[89], the emissions savings achieved by heat pumps will continue to improve as the grid becomes increasingly cleaner. In provinces that still have dirty grids, adding on-site renewables like rooftop solar photo-voltaic (PV) can further reduce emissions and costs[90], while the grid is decarbonized and/or hybrid systems can switch to fuels such as natural gas or wood during times when electricity systems would use their most carbon-intensive fuels.

Myth 7: Heat pumps are not climate friendly because of their refrigerants.

Reality: While most heat pumps in Canada currently contain higher global warming potential (GWP) refrigerants, emissions savings are still positive and low GWP refrigerants are gaining traction.

The facts:

- Even with today's refrigerants, emissions are reduced by 20-80 per cent compared to fossil fuel heating systems.

- Canada has committed to lower impact refrigerants through the Kigali Amendment to the Montreal Protocol, but Canada is falling behind the United States and Europe.

Good maintenance and installation practices reduce refrigerant leaks. Most heat pumps in Canada use hydrofluorocarbon (HFC)-based refrigerants, which are a growing source of emissions in Canada[91]. For example, R410A, the most popular heat pump refrigerant[92], has a GWP 2088 times that of CO_2[93]. Despite this, according to the [IEA](), a heat pump using current refrigerants would still reduce emissions 20-80 per cent compared to a gas boiler, depending on how clean the electricity source is. Air-conditioners use many of the same refrigerants as heat pumps. Thus, if a heat pump is replacing an air conditioner as well as displacing a fossil fuel-based heating system, the amount of refrigerant being used in that building would likely stay the same or increase only slightly while reducing combustion emissions substantially through electrification and the heat pump's increased efficiency.

The refrigerant charge in a home heat pump is usually only 1-2 kilograms per ton of capacity[94], and with leak checking at installation[95], along with recommended annual service for cleaning and inspection of the heat pump, leakage can be minimized[96]. Heat pumps are already a net benefit in terms of emissions, but building codes need to be updated to allow heat pumps with lower GWP-refrigerants, already available in Europe and the United States, into more Canadian buildings. Canada has signed on to the Kigali amendment of the Montreal Protocol, which is phasing down HFCs 85 per cent by 2036[97] from a baseline of approximately 18 million tonnes of CO_{2e} per year[98]. However, enabling policies are needed. While Europe and the United States have committed to limiting the GWP of refrigerants in heat pumps to 750 and 700 respectively by 2025, Canada has yet to announce any GWP limits. When contacted by the National Observer, Environment and Climate Change Canada, "indicated that the next planned review of HFC regulations won't happen until 2027-28"[99], a missed opportunity to reduce emissions when air conditioners and heat pumps using climate disrupting HFCs installed before then will be in use for the next 15-20 years.

While more difficult to find in Canada than in the U.S. or Europe, low GWP refrigerant heat pumps do exist. R-32, with a GWP of 677[100], is gaining traction in heat pumps in Canada[101]. Additionally, natural refrigerants that have been used for centuries[102] are making a resurgence. For example, a new CO_2-based air-to-water heat pump with smart controls and thermal battery storage called Harvest Thermal has recently entered the Canadian market[103]. While CO_2 is famously a GHG, it is one of the lowest GWP natural refrigerants. Its GWP is only one, acting as the benchmark for all other refrigerants.

Refrigerants do not provide a reason for slowing down heat pump adoption. Canadian policymakers should focus on encouraging good maintenance and installation practices as well as meeting international obligations to transition to lower impact refrigerants.

Myth 8: A gas furnace can still heat if there is an electrical power outage.

Reality: Natural gas furnaces also need electricity to operate.

The facts:

- Improved building envelopes are a better way to promote resilience when faced with power outages.
- Smart home electrification systems can introduce the ability to use electric vehicle batteries during emergencies and heat pumps can increase resilience to extreme heat through air conditioning.

Canadians and policymakers are concerned about resilience in the event of power outages, which might make some people want to stick with fossil fuels. However, a furnace fuelled by gas is dependent on electrical fans that push the waste products from the combustion process out the flue. Without this, occupants could experience carbon monoxide poisoning. Therefore, “the furnace’s built-in safety system does not allow for it to turn on during a power outage”[104]. The only home heating source that does not require some electricity is a heating stove, which is the primary heating system in only 2 per cent of Canadian homes[105].

Power outages underscore the importance of a high-performing building envelope, as indoor temperatures would drop more slowly, increasing the amount of time occupants have safe temperatures known as *Hours of Safety*[106]. Homes with Passive House standard building envelopes were able to maintain safe indoor temperatures (defined as 40 °F or 4.4 °C) for over six days[107].

Smart home electrification can include other resilience measures, such as using electric vehicle batteries to power home systems[108]. Policy makers should be developing the proper standards and safety protocols to give Canadians this resilience option.

Resilience must also include access to services that heat pumps and/or new heating systems can provide. This includes air conditioning during extreme heat events and higher levels of air filtration to guard against forest fire smoke and smog which can be integrated into heating system upgrades[109].

Myth 9: Heat pumps will not work in old homes without extensive upgrades.

Reality: Heat pumps can work in older homes and should be chosen over stand-alone fossil fuel systems even with minimal existing insulation and air sealing, with plans for future envelope upgrades considered when sizing the heat pump.

The facts:

- Better building envelopes help heat pumps work better for building owners and electricity grids. They still work in less insulated homes and should be chosen over a fossil fuel system when a new system is required, since opportunities to decarbonize heating systems are infrequent.
- Promoting longer-term energy plans, instead of emergency replacements, is the best way to optimize building envelope and heat system upgrades.

Heat pumps are an excellent choice in home retrofit projects, as there are many different types that work with different existing HVAC designs. The building envelope is part of the heating, ventilation and air conditioning system because better insulation and air sealing can reduce the size and cost of the heating system and ducts. With more heat staying inside, a heat pump can rely less on back-up systems and decrease demand on electricity grids. If a heat pump is over-sized it will work less efficiently as it could "short cycle" on and off instead of operating consistently. Policies and programs should aim to coordinate building envelope upgrades with heat pumps as much as possible. This includes working with energy advisors and contractors to plan for a heating system matching the reduced energy needs coming from better building envelopes and removing financial barriers and coordination failures that miss out on opportunities for extensive retrofits.

Yet, many new heating systems are purchased on an emergency basis due to a system failure and it is not possible to plan for an extensive retrofit. In these cases, a heat pump can still provide efficient and low-emission heat, avoiding locking into a new heating system with a lifespan that can last up to 15 years. This report by McDiarmid Climate Consulting estimated impressive cost and emissions savings from heat pumps compared to gas furnaces, even in older and poorly insulated homes in Ontario.

The Sustainable Technologies Evaluation Program has case studies and testimonials from successful heat pump projects in older homes. For example, one TAF homeowner who owns an older home has found a heat pump improved comfort and costs, even with minimal air sealing and insulation upgrades[110]. Their gas furnace and hot water heater were approaching end-of-life, so they replaced them with a CC-ASHP with electric resistance back-up and a hot water heat pump. Even though their home was poorly insulated, they were worried their furnace would fail if they waited to insulate and seal the home first. As they plan to replace their windows and doors and add further insulation to the home in the future, they worked with a HOT2000 energy modeller to size the heat pump "to meet 100 per cent of the heating needs of the future house," using electric resistance to supplement. The retrofit resulted in a 50 per cent energy savings and 79 per cent emissions reduction, in the first year, while utility costs stayed about the same. Once the building envelope improvements are complete, energy and utility savings should be substantially higher as the more efficient heat pump will take on the full heating load, with the electric resistance only for backup.

Insulation and air-sealing are important factors for properly sizing heat pumps and can significantly lower energy consumption and cost[111], not doing so before electrifying doesn't have to impede the success of the retrofit. Policymakers should think about how to recommend planned upgrades before furnace systems fail, by promoting regular maintenance and encouraging traditional HVAC contractors to add home performance services to their business models.

Myth 10: HVAC contractors do not support heat pumps.

Reality: Contractor associations support heat pumps, as it means better work and customer experiences.

The facts:

- Associations that represent HVAC contractors have written in support of the transition to net-zero emissions.
- Heat pumps present a new business opportunity for HVAC contractors and can attract those looking for environmentally friendly jobs within the trades.
- Lists of the many certified heat pump installers are available from heat pump manufacturers' websites.

A recent research report by HRAI, a trade association representing Canada's HVAC industry, recognizes that HVACR[112] contractors need to play a leading role for Canada to meet its international carbon emission reductions obligations regarding building-generated emission targets. The report finds a "broadly held desire, and a willingness, among HVAC contractors and business owners to do more to mitigate climate impacts" through solutions such as whole-home retrofits and heat pumps. The report concludes, with the right technical, business and policy supports in place, HVAC contractors in Canada are poised to take a leadership role in the transition to a low-carbon future.

HRAI has a guide and FAQs on heat pumps and has a portal where you can find qualified contractors for air source and ground source heat pumps. Additionally, many well-known heat pump manufacturers have lists of qualified contractors that install and service their products, such as Daikin, Mitsubishi, Rheem, Carrier, Lennox, and many others.

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In Canada the savings could be even greater due to our colder climate.

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