# Heat Pumps Pay Off

## Unlocking lower-cost heating and cooling in Canada

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*This work was updated in March 2024 to make corrections related to more recent modelling assumptions. These changes do not materially affect the report's conclusions or recommendations. The main change in results is that hybrid heat is now found to be the most cost-competitive technology option in Edmonton and Toronto in most cases.*

# Executive summary

**Heat pumps are a uniquely well-suited technology for addressing both the causes and impacts of climate change. The role of heat pumps in limiting the release of heat-trapping gasses is well-known: switching from the burning of fossil fuels in boilers and furnaces to electricity-powered heat pumps can lead to nearly zero emissions in regions powered by clean electricity, and even in places with relatively emissions-intensive electricity, heat pumps result in less emissions than gas furnaces (International Energy Agency 2022). Heat pumps can also provide protection from extreme heat, making them a valuable and lifesaving source of resilience in a time of increasingly frequent heat waves, which are becoming more frequent and intense as climate change worsens. As recent extreme heat events have demonstrated, access to space cooling can be a matter of life and death. For example, only one per cent of the 619 people who died from extreme heat exposure during the 2021 heat wave in B.C. had space cooling on in their homes at the time of death (B.C. Coroners Service 2022).**

Despite the benefits of heat pumps, household uptake across the country is lagging behind what's required to be consistent with Canada's emissions and resilience targets. Providing greater clarity on the costs of different heating and cooling technologies is a key aspect of accelerating uptake, because it can help improve the information available to consumers and help to determine the areas where further government policy is needed—either to drive down costs or address other barriers.

The status quo inertia of gas-powered systems results from a lack of accessible and credible information on heat pumps, and from incomplete or inaccurate information on the cost of gas relative to other options. To help address this information gap, we assess the lifetime costs of different heating and cooling combinations in different ages and types of housing across five Canadian cities to determine how heat pumps stack up against the status quo combination of gas heating and air conditioning. We find that installing a heat pump is already the lowest-cost option for most households over the lifetime of the system. We also examine what additional barriers may be slowing heat pump adoption given their cost competitiveness, including lack of consumer confidence, high upfront costs, the complexity of navigating existing government rebate and loan programs, and systemic barriers that reduce access for some parts of the population.

Our analysis concluded the following:

1. **Heat pumps are the lowest-cost option for most households.** Heat pumps are the lowest-cost heating and cooling option for most households, generally offering a cheaper option than gas-fired heating with air conditioning. This is particularly the case for single family homes and townhouses, across building vintages, in most of the cities we modelled. Despite higher upfront costs, the high efficiency of heat pumps and the fact that they double as cooling as well as heating technology supports their cost competitiveness.

2. **The biggest drivers of differing cost competitiveness are regional energy prices and climate conditions.** In places with low electricity prices relative to gas (such as Montreal and Halifax) and relatively temperate climates (such as Vancouver and Halifax), heat pumps outperform gas heating even under the worst-case assumptions (high equipment costs, high electricity prices, and low gas prices) in most home types. In contrast, Edmonton's low gas prices and cold climate mean that either heat pumps with gas backup or a gas furnace with air conditioning are the most cost competitive options.

3. **Policy and programming support the cost competitiveness of heat pumps.** Existing federal and provincial rebate programs, as well as the price of carbon, support the cost competitiveness of heat pumps. This is true across the country, but in some regions, heat pumps are the lowest-cost option even absent existing programming, while in others, heat pumps being the lowest-cost option depends upon the current policy mix, particularly under high upfront cost and electricity price assumptions.

4. **In most cases, the cheapest backup for heat pump heating is electric, not gas.** The all-electric scenario — where a heat pump is paired with electric backup instead of gas backup — tends to be the cheapest option for most households, particularly in Vancouver, Montreal, and Halifax.

5. **Despite the lifetime cost advantage of heat pumps, their relatively low uptake points to other barriers preventing households from choosing heat pumps when they replace their heating or cooling system.** These barriers are behavioral, economic, and structural in nature. They include information gaps regarding heat pump performance and cost that undermine consumer confidence, households' tendency to heavily weigh up-front costs and discount future benefits when making purchase decisions, the administrative burden of navigating complex and cumbersome rebate programs, and structural barriers that limit access for parts of the population.

Based on these findings, we make five recommendations for what governments can do to accelerate heat pump uptake across the country.

1. **All orders of government should maintain current policies and rebates that support heat pump adoption, even as uptake accelerates.** The existing policy mix makes heat pumps the lowest-cost heating and cooling option for households in most of the cities we modelled. There may eventually be a case for sunsetting some programming as the market matures and costs fall further in the future, but supports that are targeted to lower-income households will likely need to be maintained over the long term.

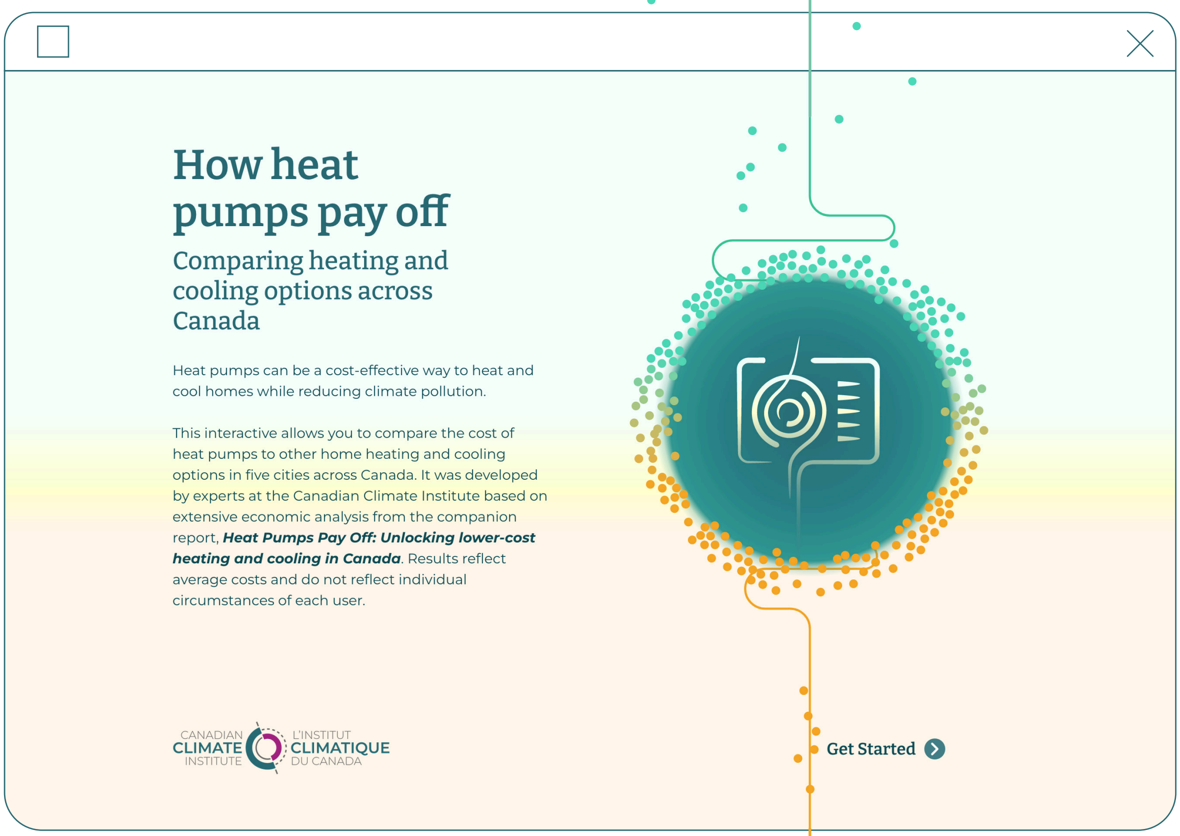
2. **All orders of government should streamline existing programming and improve equity of access.** Improvements to the design and coordination of existing programs could include loosening requirements for home energy audits as a condition of eligibility; harmonizing equipment eligibility and other eligibility criteria across jurisdictions; and improving access for renters, including through broadening eligibility for landlords to access rebates for rental properties. In addition, governments should consider streamlining programs to reduce or eliminate up-front costs for consumers—for example, through point-of-sale rebates and on-bill financing.

3. **Provincial governments should support the establishment of one-stop shop energy and efficiency services.** This involves having one centralized organization serving as the single point of entry for consumers seeking information, support, funding, and program services for home heating and cooling, including heat pump installation, efficiency retrofits, and access to funding and/or financing. Doing so can help build consumer confidence and better support households through the program application and installation processes.

4. **To protect Canadians from increasingly frequent extreme heat and improve equity of access to life-saving space cooling, governments should establish maximum indoor temperature limits and active and passive cooling requirements.** Provinces should update their building codes to require that safe maximum temperature limits be maintained through a combination of active and passive cooling. The federal government should ensure that the forthcoming resiliency considerations in the national building code also include cooling requirements and safe maximum indoor temperature limits.

5. **Provincial and municipal governments should require non-polluting and high-efficiency heating and cooling in new buildings in regions where the all-electric heating scenario is already the lowest-cost option, to avoid creating lock-in of fossil infrastructure and equipment.** Doing so avoids extending gas infrastructure to new housing developments—infrastructure that may end up stranded and/or contribute to elevated energy bills as the country decarbonizes.

## See our online interactive platform for a deeper dive into the cost analysis reported here.




## Check out the interactive at *www.heatpumpcalculator.ca*

# 1. Introduction

**Heat pumps are a crucial technology for addressing both the causes and consequences of the climate emergency. Because they generate heat and cooling from electricity rather than the burning of fossil fuels, and because they are highly efficient, they represent an effective tool for reducing emissions from homes and buildings. And since they provide both heating and cooling in one unit, they can increase the number of Canadian households with access to cooling technology, thus helping to keep Canadians safe from the worsening impacts of climate change.**

To realize this potential, however, the adoption of heat pumps for home heating and cooling in Canada will need to accelerate more quickly. While there are currently many policies and programs at the federal, provincial, and in some cases municipal levels intended to support heat pump adoption, there is a gap between actual uptake of this technology across the country so far and the level of uptake that is needed to meet Canada's emissions and resilience targets (Kanduth 2022; see Section 2).

This report investigates how best to increase uptake of this crucial efficiency- and resilience-building technology over the coming years. Consumer choice can be a critical driver in shrinking the gap between our targets and actual heat pump uptake, and cost is of central importance in shaping consumer choice. Therefore, we conduct a cost comparison to determine whether and in what cases heat pumps are more costly than other heating and cooling options, and we then look at what additional barriers may be slowing the transition to heat pumps.

We assess the lifetime costs of heat pumps compared to the most common conventional heating and cooling technologies: a gas furnace and central air conditioning. In order to provide a nuanced picture relevant to a wide range of Canadian households, we model different housing types and ages across five cities — Vancouver, Edmonton, Toronto, Montreal, and Halifax — enabling us to assess the effects of the range of climates, fuel prices, electricity rates, and available rebate programs.[1]

While there is some variation across the country and across different housing types, our results show that installing a heat pump is already the lowest-cost option for most households over the lifetime of the system. This means that other barriers are likely restricting uptake across Canada. We review existing research and case studies on consumer adoption to better understand these barriers, and conclude that a number of barriers exist to switching to a heat pump, many of which are related to the fact that the heat pump market is still in a relatively early stage, and the technology remains relatively unfamiliar for most Canadians. A lack of consumer confidence stemming from an absence of clear and trusted information on heat pump cost and performance is an important psychological barrier to making the switch. In addition, while our analysis shows that heat pumps are usually the lowest-cost option over the lifetime of the equipment, households tend to more heavily weigh upfront costs, which remain higher for heat pumps, than lifetime and operating costs (Kaufman et al 2019). The government rebate and loan programs that are available, while effective at bringing down costs, are often complex and challenging to navigate, particularly in the time-constrained environment in which households often make heating replacement decisions. Finally, we identify some structural barriers that create inequitable access across the country and restrict the ability of many households to access this technology.

*Installing a heat pump is already the lowest-cost option for most households over the lifetime of the system.*

While some of these barriers may recede over time as the market matures, costs continue to decline, and comfort with the technology improves, this is unlikely to happen at the speed and scale required for Canada to meet its emissions and resilience targets absent further policy interventions (see Section 2). In other words, there is a role for policy now and in the coming years to directly target the behavioral, structural, and upfront-cost barriers to accelerate heat pump adoption across the country.

The remainder of this report is organized as follows:

- Section 2 describes the decarbonization and resilience benefits of heat pumps;
- Section 3 presents the results of our modelling on the cost competitiveness of heat pumps compared to alternatives;
- Section 4 examines barriers to household uptake that impede adoption; and,
- Section 5 presents policy recommendations to overcome these barriers and accelerate heat pump adoption across Canada.

1. For further detail on our approach and modelling assumptions, see Section 3 below and the accompanying technical report. Recent studies have also helped to shed light on the cost competitiveness of heat pumps compared to alternatives, including Ferguson and Sager 2022; IEA 2022; Kaufman et al. 2019; Billimoria et al. 2018; and Gard-Murray et al. 2023.

## Box 1. How heat pumps work

Heat pumps are a proven technology that have been efficiently used for decades, but as a result of recent innovations and falling prices, they are increasingly competitive with other, dirtier, and less efficient heating and cooling options. Different types of heat pumps exist, but they all share similar principles. Simply put, heat pumps use electricity to move heat from one space to another. Heat pumps provide heat in the winter by drawing heat from the outside air and pumping it into indoor spaces. This is possible even in cold outdoor temperatures, as there is a significant amount of thermal energy available in cold air that can be extracted and moved indoors (Natural Resources Canada 2022). Heat pumps are fully reversible and operate the same way in warm weather, removing heat from an indoor space, thereby cooling it.

The fact that heat pumps simply move heat, rather than generating it, is a large part of why they are so efficient. For each kilowatt hour (kWh) of electricity heat pumps use to operate, they can produce two to five kWh of heat, meaning they can provide heating at two to five times the efficiency of even the most modern and efficient gas furnaces (McKenna et al. 2020; Natural Resources Canada 2022).[2] Heat pumps can also provide cooling as efficiently as central air conditioning systems, and more efficiently and effectively than window and portable air conditioners (Carrier 2023; BC Hydro 2022). The efficiency of older heat pumps tends to drop in colder temperatures, though this is less true of newer heat pump models, which perform efficiently in a wider range of temperatures.

Central air-source heat pumps, ductless mini-split air-source heat pumps (also known as “mini-splits”), and ground-source heat pumps are the most common heat pump types in Canada (Natural Resources Canada 2022). *Central air-source heat pumps* take heat from the outside air to a central unit, which subsequently pushes that heat to the rest of the indoor space via heating ducts (HRAI 2023). *Mini-splits*, unlike central air-source heat pumps, do not push heat through air ducts, making them more suitable for buildings without duct systems installed. Instead, mini-splits warm or cool a liquid that carries that heat or cooling to several “indoor heads,” which are wall-mounted units similar to single-room air-conditioning units (Rocky Mountain Institute 2022). Each indoor head, in turn, then warms or cools a single room or indoor space zone. A standard mini-split heat pump has the potential to warm or cool up to four rooms or zones, meaning that larger buildings require additional heat pumps.

*Ground-source heat pumps*, finally, draw heat from below the earth’s surface instead of drawing it from the air. Ground-source heat pumps are highly efficient and able to perform well in extreme temperatures; however, the installation of ground-source heat pumps is more complex and expensive, given that it involves drilling and excavation next to the buildings where they are installed (Turner 2023). As a result, ground-source heat pumps are not as common as other types of heat pumps. We have chosen to focus our modelling on air-source heat pumps because they are much more prevalent across Canada and easier to deploy quickly.

2. Estimates of performance in different climates vary. Natural Resources Canada estimates a coefficient of performance of 2.2 to 5.4 at 8 degrees celsius; the Rocky Mountain Institute estimates that heat pumps are 2.2 to 4.5 times more efficient than Energy Star gas furnaces on an annual basis, depending on climate.

# 2. Benefits of heat pumps

Heat pumps can provide a wide array of benefits both at the societal and household levels. As will be discussed below, they are an important tool for decarbonizing space heating and cooling in homes and buildings, and their uptake needs to be accelerated in order for Canada to reach its emissions reduction targets. In addition to their broad benefits for mitigating climate change, heat pumps can play a crucial role in protecting Canadians from extreme heat in a worsening climate emergency. As heat waves become more frequent and intense across the country, heat pumps are the space cooling solution that is best poised to protect Canadians, alongside the deployment of other necessary measures to improve heat resilience.

*As heat waves become more frequent and intense across the country, heat pumps are the space cooling solution that is best poised to protect Canadians.*

## 2.1 Heat pumps are an essential tool for freeing homes from fossil energy

Meeting Canada's greenhouse gas emissions targets requires a widespread switch from fossil gas and heating oil to electric, efficient heat pumps, as well as other measures to improve the efficiency of heating and cooling homes. Currently, the burning of fossil fuels for space and water heating in Canada's homes and buildings accounts for 10 per cent of Canada's total emissions (Environment and Climate Change Canada 2020; Natural Resources Canada 2023a).[3] Building emissions need to be reduced by 26 per cent below

[3] Canada's homes and buildings account for 13 per cent of national greenhouse gas pollution, due largely to the burning of fossil fuels for space and water heating, which make up over 78 per cent of building emission. Fossil gas is the primary driver of these emissions: it made up 53 per cent of the energy used in Canadian households in 2019 and accounted for the majority of the emissions from fuel use within the home (Statistics Canada 2022a).

2005 levels by 2030 in order to align with Canada's 2050 net zero pathway, but actual reductions are not yet on track (Canadian Climate Institute 2023a; Canadian Climate Institute 2023b).

Heat pumps are a powerful tool in the effort to decarbonize residential space heating (International Energy Agency 2022). Switching from the burning of fossil fuels in boilers and furnaces to electricity-powered heat pumps creates immediate decarbonization benefits in regions where electrical grids are already powered by clean energy. In other regions, homes and businesses with electrified heating will automatically see their Scope 2 emissions decline towards zero as the grid gets cleaner. But even when running on relatively emissions-intensive electricity, heat pumps emit between 20 and 30 per cent less carbon emissions than gas furnaces because of their high efficiency (International Energy Agency 2022; Kevin Dorma Consulting 2021). And they are by far the most efficient form of electric heat: heat pumps use up to 65 per cent less energy than standard electric resistance heating (baseboards) (Natural Resources Canada 2022), meaning anyone switching from baseboard heating to a heat pump will see significant cost savings on their power bill.

There are already indications that heat pumps can consistently meet the needs of households across Canada in a cost competitive way, but uptake so far is uneven (IEA 2022; Natural Resources Canada 2022). There are pockets of high uptake in some parts of the country, particularly where targeted programs have increased consumer confidence and helped to drive capital costs down. The Maritime provinces are a success story, with heat pumps now serving as the primary heating source in 32 per cent of households in New Brunswick, 27 per cent of households in Prince Edward Island, and 21 per cent of households in Nova Scotia (Turner 2023).[4] The rate of uptake has increased substantially in these provinces in recent years, with the number of heat pumps being installed in New Brunswick tripling over the last eight years, and Prince Edward Island tripling its share of households using heat pumps in just three years (Zhang 2023). On Gabriola Island in British Columbia, a dedicated program initiated and run by local residents to provide heat pumps at wholesale prices has resulted in nearly half of homes on the island having a heat pump installed (Sustainable Gabriola 2022). First Nation communities have been ahead of the curve: on Haida Gwaii, the Skidegate Band had already installed heat pumps in almost all of their 350 homes as of 2018, while the Heiltsuk Nation on Bella Bella set a goal of switching off of fossil fuels and has secured funding to install heat pumps for every community member who wants one (Gilpin 2018; CBC News 2022; Ecotrust Canada 2019).

In contrast with these pockets of very high uptake, penetration is only two per cent in Ontario and seven per cent in British Columbia, and while the rate of uptake across the country has been increasing in recent years, it remains generally low (Statistics Canada 2023a; Poirier and Cameron 2023). The total

4. In addition to effective programming, the expense and inconvenience of heating oil, a major heating source in these provinces, has been a major motivator of the shift to heat pumps. For more details on the key drivers of high heat pump adoption in the Maritimes, see Turner 2023.

number of heat pump installations in Canada has only increased from 400,000 to 850,000 over the last 20 years, with heat pumps' share of heating technologies over that time period increasing by 2 percentage points, from 3 per cent in 2000 to just over 5 per cent in 2020 (Natural Resources Canada 2020). Meanwhile, the share of heating provided by fossil gas has remained steady, from 46.5 per cent (5.7 million installations) in 2000 to 45 per cent (or 7.2 million) in 2020 (Natural Resources Canada 2020).

*The amount of heating provided by heat pumps must accelerate rapidly, with heat pumps' share of total heating at least doubling by 2030.*

For the sector to align with Canada's 2030 climate targets, the amount of heating provided by heat pumps must accelerate rapidly, with heat pumps' share of total heating at least doubling by 2030, so that they provide more than 10 per cent of home heating (Kanduth 2022).

## Box 2. Heat pump performance in cold weather

One of the most significant concerns that consumers have about installing a heat pump is whether they can perform adequately in cold weather. This concern stems in part from early adopters who installed a previous generation of heat-pump technology that didn't provide effective heating in cold temperatures. Cold weather no longer presents the same barrier that it once did, however.

There have been major technological improvements in heat pump design in recent years. Modern standard heat pumps can perform well at temperatures as low as -8 to -10 degrees Celsius (Manitoba Hydro 2023; Government of British Columbia 2023). Cold climate heat pumps, which have become more prevalent in the marketplace over the last five to ten years, are designed to maximize heating capacity at colder temperatures and can perform well at temperatures as low as -25 degrees Celsius (Natural Resources Canada 2022). These heat pumps have higher upfront costs but reduce the need for backup systems because of their effective performance in cold temperatures. And experience in peer countries with similarly cold climates shows that cold weather need not be a barrier to heat pump adoption: Norway, with similar average temperatures to Canada, leads the world in heat pump penetration, with Finland and Sweden not far behind, and multiple studies have confirmed high real-world performance in these jurisdictions (Rosenow et al. 2022; Energy Systems Catapult 2023; Fraunhofer 2020; EnergieSchweiz 2021).

Despite improved technology and performance in cold weather, a backup system may still be required in some parts of Canada to keep a home warm during the coldest periods of the year, and insurers often require such a system (see Table 1 for a description of equipment modelled including backup systems). While it may not be necessary in more moderate climates, such as southwestern British Columbia, to be conservative and to ensure our results were comparable across jurisdictions, we included backup requirements for heat pumps in all cities in our model. Without this backup requirement, the cost competitiveness of heat pumps would improve even further.

## 2.2 Heat pumps can protect Canadians from extreme heat

Extreme heat is among the deadliest consequences of climate pollution from the burning of fossil fuels and is a growing threat in Canada: the number of fatally hot days is set to increase substantially over the coming decades, even if further global emissions are sharply reduced (Ballester et al. 2023). As recent extreme heat events have demonstrated, access to space cooling in an era of increasingly extreme heat can be a matter of life and death (Beugin et al. 2023). Increasing space cooling uptake across the country is essential to meeting the resilience targets set out in Canada's first *National Adaptation Strategy*, including the target of eliminating deaths due to extreme heat waves by 2040 (Environment and Climate Change Canada 2023).

***The resilience benefits of increasing access to space cooling are particularly pronounced in regions that have historically had more moderate climates.***

The resilience benefits of increasing access to space cooling are particularly pronounced in regions that have historically had more moderate climates and therefore have relatively low rates of space cooling uptake, such as British Columbia, but they are not limited to these regions.[5] The 2021 B.C. heat wave was the deadliest weather event in Canadian history, and a lack of space cooling in homes and residential buildings was a major cause of the 619 direct heat-related deaths: 98 per cent of deaths and hospital visits during the heat wave were due to extreme temperatures that people experienced in their homes or residences, and only one per cent of those who died from heat-related illness had space cooling that was turned on at the time (B.C. Coroners Service 2022).[6,7]

Across the country, renters and people who live alone have significantly less access to space cooling than the general population (Quick and Tjepkema 2023). The 2021 B.C. heat wave drove home the inequitable impacts of extreme heat: seniors living alone, seniors with chronic health conditions, people with lower-incomes, and people living with mental illness were disproportionately impacted (Lee et al. 2023). These unequal impacts highlight the urgency of expanding access to space cooling in order to avoid worsening socio-economic inequities in an era of increasing extreme heat.

While air conditioning remains the most common space cooling technology for homes and buildings across Canada, heat pumps offer a number of advantages over air conditioning and are increasingly being adopted to meet

5. Rates of access to space cooling vary across the country. Sixty-four per cent of households nationally had some form of air conditioning in 2021, while in British Columbia only 36 per cent of homes had air conditioning, compared to 63 per cent of homes in Quebec, 84 per cent of homes in Ontario, and 90 per cent of homes in Manitoba (Statistics Canada 2023b). However, even in regions with very high rates of uptake, there remain many people without access. In the Greater Toronto Area, for example, over 300,000 households — mostly lower-income households and renters — do not have any type of space cooling (Statistics Canada 2023b; Statistics Canada 2023c).

6. Seven per cent of those who died had air conditioning units at the time, but they may have been used improperly or been in another room (B.C. Coroners Service 2022).

7. The 2021 B.C. heat wave is not the only recent example of deadly extreme heat in Canada. For example, the 2018 heat wave in Quebec resulted in 210 excess deaths (INSPQ 2019).

***Heat pumps offer a number of advantages over air conditioning and are increasingly being adopted to meet both heating and cooling needs.***

both heating and cooling needs. The fact that heat pumps double as both a clean heating and cooling technology makes them lower-cost in most cases than traditional air conditioning, and enables households to reduce their reliance on fossil fuel-based heating technology as they improve their resilience to extreme heat (see Section 3 below) (Gard-Murray et al. 2023; Tan and Fathollahzadeh 2021). This clean heating ability is also essential to reduce emissions from home heating, whereas increased adoption of air conditioning paired with gas heating would drive Canada's emissions targets further out of reach (Gard-Murray et al. 2023).

In addition, heat pumps offer comfort and energy savings benefits over some types of air conditioning because they provide cooling throughout a home, unlike the limited reach of window and portable air conditioning units. The inefficiency of portable units and the frequent requirement for multiple units in different rooms increases electricity bills for users and can dramatically increase summer electricity demand (BC Hydro 2020; BC Hydro 2022; Moliere 2023; Hydro Quebec 2023). The higher operating costs of portable air conditioners have implications for renters in particular. Renters who cannot compel their landlords to install central systems may feel the need to purchase new or use existing window or portable air conditioning equipment, despite its higher operating costs.[8]

## Box 3. The coolest way to protect Canadians from climate change

While space cooling technologies should not be the only adaptation intervention undertaken to reduce extreme heat risk, they are an effective intervention that can be deployed quickly and at scale, and can protect the most vulnerable people, such as older adults. For example, a recent Climate Institute report found that if the rate of space cooling uptake in British Columbia were to double, there would be a 12 per cent reduction in heat-related deaths and a 40 per cent reduction in heat-related hospitalization in the 2030s (Beugin et al. 2023).

Other interventions, such as modernizing building design requirements to include passive cooling measures, and community design choices such as increased urban greening, are also extremely important to improving heat resilience. Expanding urban greening in particular could reduce heat-related deaths across B.C.'s Lower Mainland by 12 per cent in the 2030s, and could prevent even more deaths in the longer term (Beugin et al. 2023). To reduce the impact of extreme heat on people's health and the economy, these policy measures should be expanded and strengthened alongside efforts to increase access to space cooling.

[8] As will be discussed in Section 4, renters face unique barriers to accessing space cooling and there is a role for improved policy to overcome these barriers and improve equity of access.

# 3. Cost competitiveness of heat pumps compared to alternatives

**Cost is a predominant concern for households making heating and cooling system replacement decisions, yet these households face significant information gaps in accurately assessing the cost competitiveness of heat pumps compared to gas systems (Kaufman et al. 2019).[9] There are many reasons for this, including that consumers often don't know what energy costs to expect years or decades into the future, or what effect carbon pricing, clean electrification, and other climate and energy policies will have, making it difficult to factor ongoing operating costs into replacement decisions (Howarth and Andersson 1993; Hesselink and Chappin 2019).**

To help fill this information gap, we compared the costs of heat pumps to alternative heating and cooling technologies for households making replacement decisions today (see box 4 for a description of our approach). Creating greater clarity on lifetime costs of different technologies is particularly important to overcome the status quo inertia favouring gas-powered systems, which results both from a lack of accessible and credible information on heat pumps and from incomplete or inaccurate information on the affordability of gas relative to alternatives.

9. While cost is one of the most important factors, it is far from the only factor at play as households make these decisions. As will be discussed in Section 4, a tendency to weigh upfront costs more heavily than operating costs, a lack of clear information about the performance and comfort level provided by different technologies, the urgent nature of many replacement decisions, and the administrative burden of navigating complex rebate programs are also major factors in determining consumer choice.

## Box 4. Our approach

The modelling for this report was developed in partnership with Dunsky Energy + Climate Advisors, using their Heating Energy Decarbonization Model (HEAT). The HEAT model is specialized in assessing energy and end-user impacts by modelling hourly heating load and equipment performance across different technology mixes. The model can assess end-user costs associated with different heating technologies in detail and perform sensitivity analyses based on granular data, such as energy prices and technology performance curves under specific climate conditions. Using the HEAT model, we assess average annual cost for four space heating and cooling technology combinations across different housing archetypes and vintages in five cities across the country. This approach enables us to build a nuanced understanding of how the costs of heat pumps compare to other heating and cooling technologies in different types of housing and different regions of Canada.

Modelling inputs include:

- Climate conditions in five Canadian cities: Vancouver, Edmonton, Toronto, Montreal, and Halifax
- Four residential building archetypes: single detached (1770 sq ft), townhouses (1450 sq ft), multi-unit residential buildings with in-unit heating, ventilation, and air conditioning (HVAC) systems, and multi-unit residential buildings with central HVAC systems (both with 20 units, at 1040 sq ft per unit).
- Three building vintages: 1940, 1980, and new construction (2023)
- Four equipment configurations, including four different types of space heating and cooling equipment: gas heating with air conditioning, standard heat pump with gas backup, standard heat pump with electric backup, and cold climate heat pump with electric backup.[10]

For comparison purposes, we present lifetime costs as annual average costs, which include a range of costs averaged over the lifetimes of different technologies. This metric allows for a clear comparison of technologies with different up-front costs, operating costs, and life spans.

We applied various sensitivities — what-if assumptions to model different outcomes — to the model to capture a wide range of upfront installation and equipment cost possibilities, as well as high and low energy prices. For upfront costs, the low and high capital cost sensitivities for heat pump technologies represent 75 per cent and 125 per cent of the medium cost assumption, and include installation and equipment costs. Although low- or zero-interest financing options for heat pump technologies are available, such as the Greener Homes Loan, we make the conservative assumption that all upfront costs are financed at varying interest rates starting at 7 per cent and slightly decreasing to 5.5 per cent over a 10-year payback period.[11]

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10. See Table 1 for a description of the equipment configurations.

11. The Greener Homes Loan provides interest-free loans of up to $40,000 for eligible retrofits. While we assume financing beginning at 7 per cent interest, we have included the impact of interest-free financing in our online heat pump cost calculator. Interest-free financing produces savings of approximately $50 to $300 per year, depending on housing type and age.

To compare energy costs, we assessed all combinations of high to low electricity prices and high to low gas prices, as well as the impact of carbon pricing and scheduled increases out to 2030. The range of electricity prices was based on prior analysis in our *Big Switch* report (see Dion et al. 2022) and varies based on jurisdiction. Projections for gas prices also vary by jurisdiction. Details on the modelled gas prices can be found in the accompanying technical report.

In scenarios that model heat pumps as the primary heating system, we apply additional costs to cover the installation of a backup heating system. We also include additional costs for panel upgrades in homes built in 1940 or in 1980 where they are likely applicable, including for all scenarios that model heat pumps with electric backup. Our default assumptions include the effect of existing policies such as rebate programs and carbon pricing, unless stated otherwise (see accompanying technical report and the Appendix for a description of the programs included in the model).

The underlying assumptions in the model are intentionally conservative about the potential cost competitiveness of heat pump technologies. For example, we include additional costs such as panel upgrades to older buildings for heat pumps with electric backup where panel upgrades are likely applicable; we also assume only a slight decrease in current interest rates over time, and assume that a backup heating system is always installed, even in milder parts of the country and with cold climate heat pumps. We also don't include the benefits of avoiding fixed gas service fees in the all-electric heating scenario, which would save households who disconnect from the gas network hundreds of dollars extra per year. To account for the variation in heat pump equipment costs, we include high cost sensitivity for heat pumps, but do not include a similar sensitivity for gas. And because our model assumes a 2023 replacement decision, we do not account for the falling costs of heat pumps over time, a trend that is likely to continue as the technology improves and the market expands (Delta-EE 2021). Due to these combined conservative assumptions, heat pumps are therefore likely to be even more cost competitive than our results indicate.

Scope and limitations:

- The intentionally conservative assumptions made in the model likely underestimate the cost competitiveness of heat pumps (see above).
- Our analysis does not look at the costs of different building heat decarbonization pathways from a system perspective (for example, the implications of different technology choices for the electricity or gas networks). Forthcoming research from the Canadian Climate Institute will address this topic.
- We focus only on residential homes, not commercial buildings.
- Our model is limited to four technology configurations for heating and cooling needs and does not include other technologies, such as ground source heat pumps.

For more details on the modelling approach and underlying assumptions, see the accompanying technical report.

### Table 1. Heating and cooling systems modelled

| Reference | Description |
| --- | --- |
| Gas heating with air conditioning | Gas-fired space heating equipment, with air conditioning providing space cooling. In most cases, gas equipment pairing consists of a gas furnace with traditional central air conditioning.[12] |
| Standard heat pump with gas backup | Standard heat pump as the primary heating system and a gas-fired backup heating system (this is often referred to as a "hybrid" system). The heat pump doubles as space-cooling equipment. |
| Standard heat pump with electric backup | All-electric configurations, with a standard heat pump as the primary heating system and an electric resistance backup system. This backup could be new, efficient electric baseboards or an electric resistance furnace. The heat pump doubles as space-cooling equipment. |
| Cold climate heat pump with electric backup | All-electric configurations, with a cold climate heat pump as the primary heating system and an electric resistance backup system. The heat pump doubles as space-cooling equipment. |

## 3.1 Heat pumps are the lowest-cost option for most households

Our modelling finds that heat pumps are the lowest-cost heating and cooling option for most households, lower than gas-fired heating with air conditioning (Figure 1).[13] Despite heat pumps having higher upfront costs, their efficiency and the fact that they double as a cooling as well as heating technology supports their cost competitiveness.

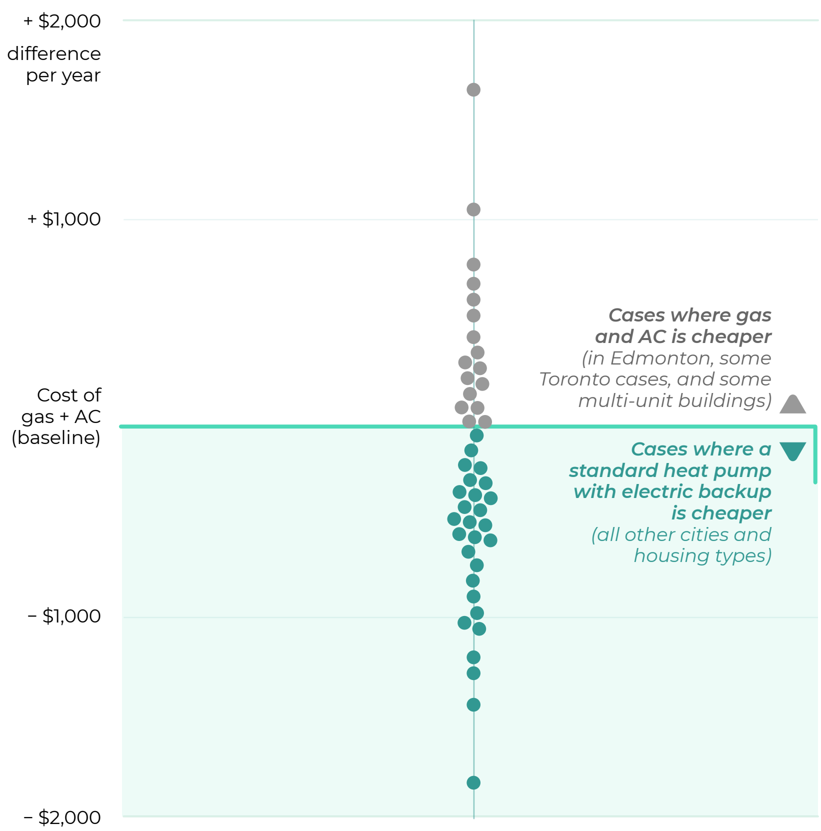
12. The exception is for multi-unit residential buildings with in-unit HVAC systems and multi-unit residential buildings with central heating paired with make-up-air systems, which model portable air conditioners and chillers, respectively.

13. These are similar to the results in other recent studies, notably Natural Resources Canada 2022; IEA 2022; and Kaufman et al. 2019.

## Figure 1. Heat pumps are more cost competitive than gas furnaces and air conditioning for most households

Annualized cost difference between a standard heat pump with electric backup and gas heating and air conditioning

*Each dot represents a household type (combination of building type, build year and city), arranged by annual cost differences.*




*This figure is based on mid-range assumptions for energy prices and equipment and installation costs, as well as our default assumptions regarding panel upgrades, financing, gas service fees, and existing programming (see box 4). This figure does not capture cases where heat pumps with gas backup are cheaper than gas with air conditioning, as in Edmonton and Toronto.*

More specifically, heat pumps with electric backup tend to be the lowest-cost options, particularly for single-detached homes and townhouses, in Vancouver, Halifax, and Montreal across building ages (Figure 2). In general, townhouses mirror the findings for single-detached homes at slightly lower cost across all technology mixes. Regional differences play a larger role in determining the differences in cost competitiveness than building type or age, as will be discussed below.

Higher upfront costs for cold climate heat pumps make cold climate heat pumps with backup a costlier option for households than standard heat pumps in the cities we modelled in most cases. As these relatively new technologies continue to improve and their upfront costs fall, cold climate heat pumps are likely to become more cost competitive, particularly where they may not require backup heating systems because of their improved performance in cold temperatures.[14]

***As these relatively new technologies continue to improve and their upfront costs fall, cold climate heat pumps are likely to become more cost competitive, particularly where they may not require backup heating systems because of their improved performance in cold temperatures.***

14. Because our modelling assumes a 2023 replacement decision, we do not capture the likelihood of falling costs in the future (see box 4).

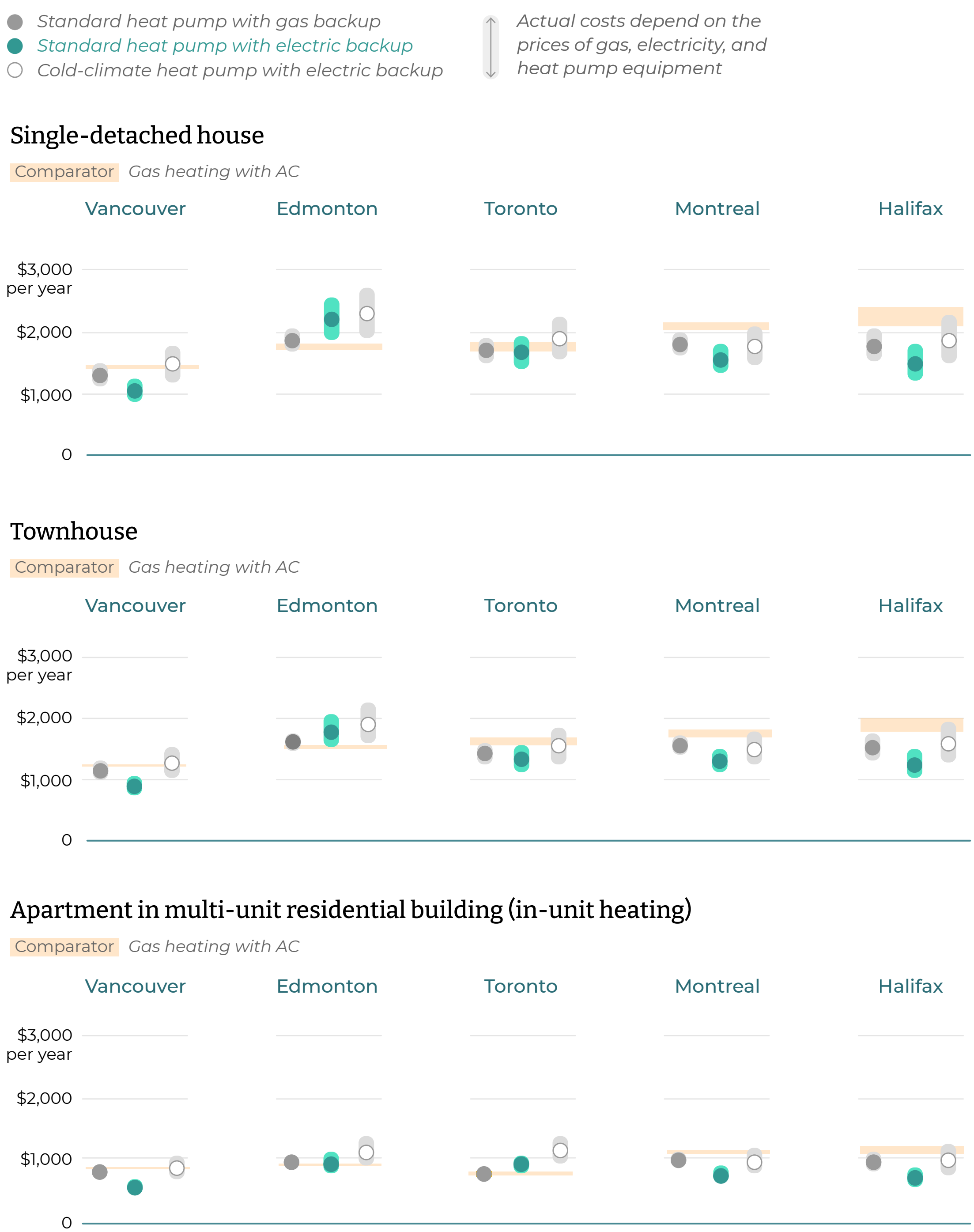
## Figure 2. Heat pumps are the lowest-cost option for most households throughout Canada

Annualized cost of space heating and cooling with various heat pump configurations for homes built in 1980


*This figure displays the range of potential costs, incorporating low, medium, and high energy prices and equipment and installation costs, as well as our default assumptions regarding panel upgrades, financing, gas service fees, and existing programming (see box 4)*

## Figure 3. Heat pumps are the lowest-cost option for most *new builds* throughout Canada

Annualized cost of space heating and cooling with various heat pump configurations for homes built in 2023




*This figure displays the range of potential costs, incorporating low, medium, and high energy prices and equipment and installation costs, as well as our default assumptions regarding panel upgrades, financing, gas service fees, and existing programming (see box 4).*

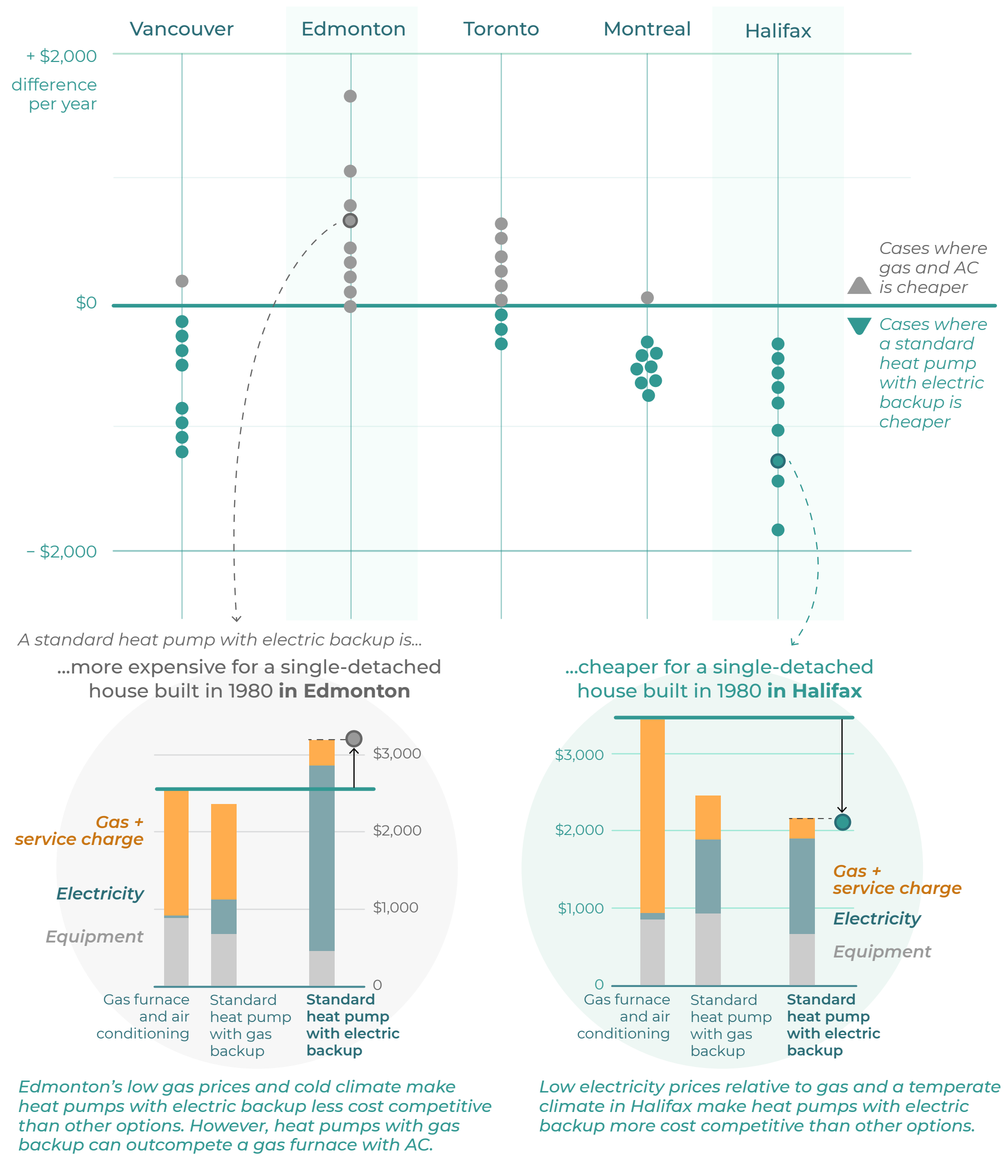
## 3.2 The biggest drivers of differing cost competitiveness are regional energy prices and climate conditions

Regional differences, in particular regional energy prices and climate conditions, are a significant determinant of the differences in the cost competitiveness of heat pumps that can be seen across the cities we modelled (Figure 4).

### Figure 4. Heat pump cost savings depend significantly on local gas and electricity costs

Annualized cost difference between a standard heat pump with electric backup and gas heating and air conditioning

*Each dot ● represents a household type (building, build year, city), arranged by annual cost differences.*




*This figure is based on the mid-range assumptions for energy prices and equipment and installation costs, as well as our default assumptions regarding panel upgrades, financing, gas service fees, and existing programming (see box 4)*

In nearly all cases in Montreal, Halifax, and Vancouver, heat pumps outperform gas heating and air conditioning even under the worst-case assumptions for heat pumps—of high upfront cost, high electricity prices, and low gas prices (see box 4 for a description of sensitivities). In these jurisdictions, heat pumps are consistently more cost competitive than gas heating and traditional cooling, primarily due to relatively low electricity prices compared to gas (particularly in Montreal and Halifax) and relatively temperate climates (particularly in Vancouver and Halifax). This finding holds true for single-detached houses, townhouses, and certain multi-unit residential building types, across building ages. In Toronto, standard heat pumps with gas backup are the lowest-cost option for nearly all households under mid-range assumptions, and still tend to be cost competitive even under high electricity and low gas price assumptions.

In Edmonton, heat pumps with gas backup are the lowest-cost option for single family homes and townhouses built in 1940 or 1980, and in other cases, gas and air conditioning is the most cost-competitive option, due to a combination of low gas prices and climate conditions. Edmonton's gas prices are substantially lower than in other cities modelled (including in the high gas cost assumption), while electricity rates are similar to other jurisdictions, which creates a significant cost differential between gas and electricity. Climate conditions play an important role: the cold climate drives up demand for electricity to meet heating needs (and amplifies the effect of the cost differential between gas and electricity in Alberta) at the same time as it makes heat pumps relatively less efficient and results in greater use of the backup heating system.

Apart from regional differences such as climate conditions and energy prices, the cost competitiveness of heat pumps is also sensitive to initial upfront cost assumptions for heat pump equipment, as well as the applicability of various rebates. The capital costs of heat pumps are expected to decline as they become more widespread and efficient, but current market constraints in some regions, such as a limited number of suppliers, can lead to high variability in initial equipment and installation costs. In addition, much of the cost variation for heat pumps is brand related, whereas gas heating systems tend to have less variability.[15]

15. The research underpinning this report included contacting manufacturers for price feedback.

### Table 2. Capital cost assumptions for different heating and cooling technologies for a single-detached home (mid-capital cost sensitivity)[16]

| Single detached - 1,770 sq ft | | | |
|---|---|---|---|
| **Building vintage** | **1940** | **1980** | **2023** |
| Gas-fired furnace[17]* | $4,500 - $6,030 | $4,080 - $4,850 | $3,750 - $4,170 |
| Central ducted air-conditioner* | $4,990 | $4,990 | $4,760 |
| Standard central ducted air-source heat pump (sized at -5°C) | $7,570 - $8,180 | $6,200 | $5,760 |
| Cold climate central ducted air-source heat pump (sized at -8.3°C) | $14,840 - $19,880 | $12,870 - $13,260 | $11,890 |
| Electric duct-heater element (secondary heating system) | $880 - $1,810 | $620 - $1,090 | $420 - $680 |
| Electric panel upgrade | $3,400 | | |

## 3.3 Policy and programming support the cost competitiveness of heat pumps

Existing policy and programing, in particular the carbon price and federal and provincial rebate programs, support the cost competitiveness of heat pumps, but the extent of the impact on costs varies across the country. In some regions, we find that heat pumps are often the lowest-cost option even absent existing programming, while in others, the current policy mix is necessary to support their cost competitiveness, particularly under high upfront cost and electricity price assumptions. Regardless of their impact on cost competitiveness, rebate programs are essential to addressing access barriers by reducing upfront costs and incentivizing higher rates of uptake (see Section 4).

Under some upfront cost and energy price assumptions — including low- and mid-range equipment and electricity prices — heat pumps are cost competitive in nearly all single-detached houses and townhouses in Montreal and Halifax *even absent* existing carbon pricing and rebates. In Edmonton, however, policy and programming could be expanded to draw down upfront costs and improve the cost competitiveness of heat pumps. Under mid-range assumptions for heat pump capital costs, electricity prices, and gas

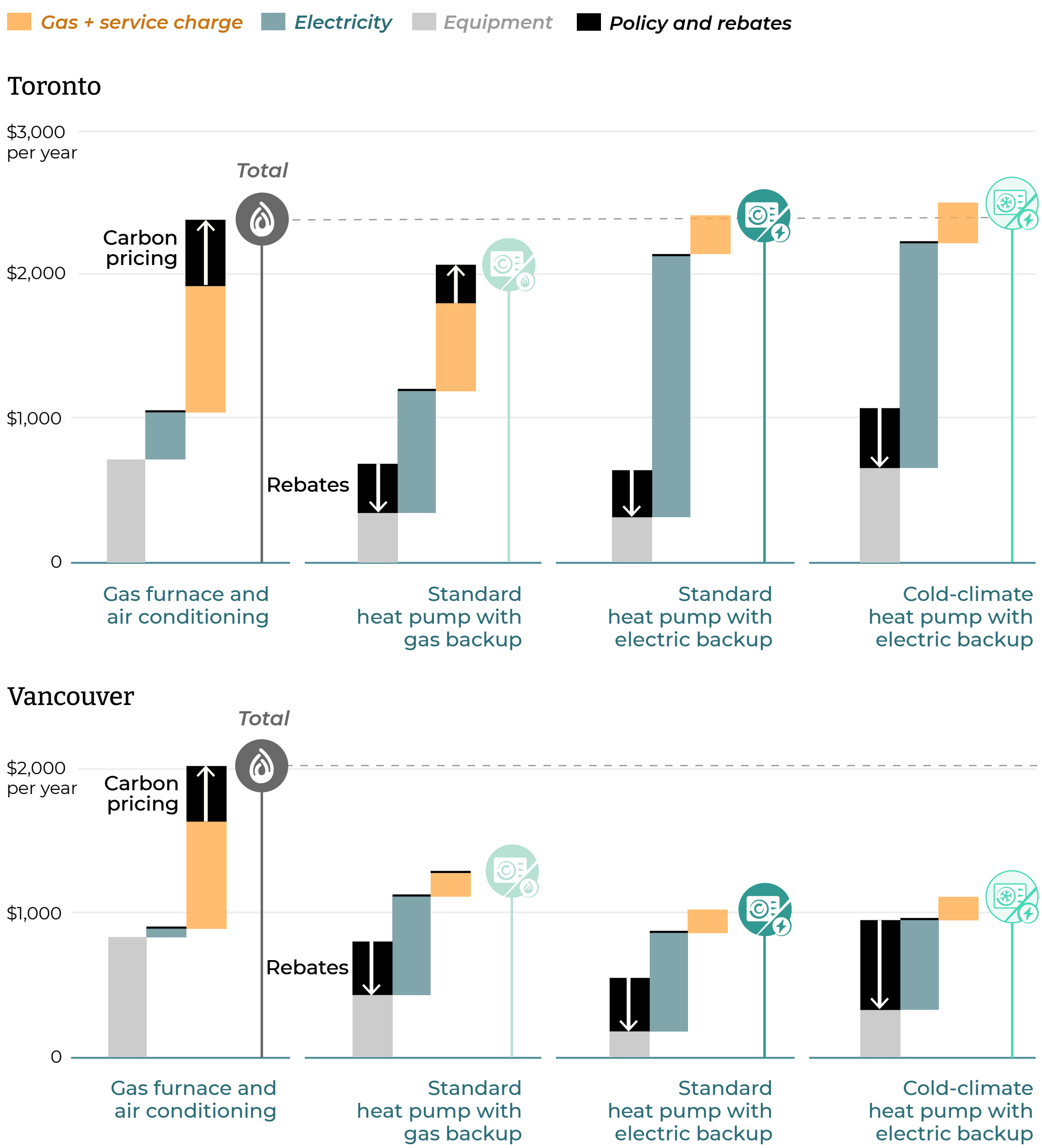
16. Refer to the technical report for capital cost assumptions in all building types. The range in the cost represents cost differences across the five cities modelled. In general, these technologies have the highest cost in Edmonton or Toronto and lowest cost in Vancouver. The low and high-equipment cost assumption modelled represents 75 per cent and 125 per cent of the mid-equipment cost assumption, respectively, and include installation and equipment costs.

17. *Low or high capital cost sensitivities were not applied to gas furnaces and air-conditioners, as the cost for these technologies tends to be more stable than the cost related to heat pumps.

prices, heat pumps are the lowest-cost option even without rebates in single-detached houses and townhouses in Vancouver.

## Figure 5. Policy and rebates support the cost competitiveness of heat pumps

Annualized cost of space heating and cooling by technology in single-detached homes built in 1980




*This figure is based on the mid-range assumptions for energy prices and equipment and installation costs, as well as our default assumptions regarding panel upgrades, financing, gas service fees, and existing programming (see box 4).*

## 3.4 In most cases, the cheapest backup for heat pump heating is electric, not gas

In all scenarios that model heat pumps meeting a household's heating and cooling needs, we assume additional costs to install and operate a backup heating system. The secondary system acts as a backup to the heat pump when outdoor temperatures fall below optimal levels for heat pumps to work efficiently—this temperature is known as the switchover temperature.[18] Above the switchover temperature, the heat pump provides all of the heating, while under the switchover temperature, the secondary system is engaged to meet heating needs. While our model includes secondary heating systems in all heat pump scenarios, some buildings may not in fact require backup heating, depending on climatic conditions, building envelope and design, and the specific heat pump technology.

We model two different types of backup systems to kick in when switchover temperatures are reached: electric resistance backup or gas-fired backup. In systems that use electric resistance backup, the household's heating and cooling needs are fully dependent on electricity at all times—otherwise known as all-electric systems.[19] For gas-fired backup, when switchover temperatures are reached, the heating system would switch from a heat pump to gas.

We find that for single-detached homes and townhouses in Vancouver, Montreal, and Halifax, electric backup for heat pumps is significantly cheaper than gas backup. For example, under mid-range equipment cost and energy pricing assumptions in a 1980s single-detached home in Vancouver, a standard heat pump with electric backup is $400 cheaper on average annually in comparison to a standard heat pump with gas backup. This does not consider the additional savings for a household if the owners decided to fully disconnect from gas and capture more cost savings from avoided fixed gas service fees. In general, in Toronto and Edmonton, heat pumps with gas backup are currently cheaper than heat pumps with electric backup.

All-electric heating and cooling are generally lowest-cost in multi-unit residential buildings with central make-up-air unit and in-unit HVAC systems, particularly in Halifax, Montreal, and Vancouver. However, in multi-unit residential buildings with central heating systems, standard heat pumps with gas backup tend to be lower-cost than the all-electric scenario, because centrally heated multi-unit residential buildings are on a commercial electricity rate and have peak charging rates.[20]

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18. See technical report for assumptions on switchover temperature.

19. In all-electric systems where heat pumps are paired with electric backup, peak usage and grid capacity are important considerations in planning. While these system-related issues are outside of the scope of this consumer-focused report, our forthcoming report on the building heat network will tackle these issues directly and will provide policy recommendations to address them.

20. The exception is Montreal, where all-electric systems and heat pumps with gas backup in multi-unit residential buildings are very similar in cost.

It’s important to note that if a household chooses to go all electric and removes all gas equipment from their home, including water heating and cooking, the savings would be even greater than what is reflected in our results. For example, a customer in Montreal that disconnects from the gas system would save over $4,000 over the lifetime of their system in avoided fixed gas system fees.[21] These savings are not included in our analysis and are an additional customer benefit to using all-electric systems. This may also be an important consideration for customers deciding between systems with gas backup and all-electric systems.

Despite the fact that gas backup tends to be less cost competitive than going all electric, it may be the most attractive option for those that already have a gas furnace that does not yet need to be replaced. This approach may also be relevant for households that need to install or replace only their cooling systems (Gard-Murray et al. 2023). In parts of the country with more nascent heat pump markets, suppliers may also be less ready to offer all-electric systems or may charge a premium. This situation is expected to improve as the market matures.

21. This calculation is based on an annual gas service fee of $228 in Montreal over 18 years.

# 4. Barriers to heat pump adoption

**Heat pumps tend to be the lowest-cost heating and cooling option for households across the country and across different types and ages of housing, our modelling results show. Yet despite their lifetime cost advantage, the relatively low uptake of heat pumps in much of the country thus far suggests that there are other barriers holding households back from choosing a heat pump when they replace their heating or cooling system. While the research into consumer motivations for heat pump adoption in the Canadian context is limited, emerging studies, lessons from other jurisdictions, and successful examples of pockets of high uptake in Canada highlight a range of barriers hampering adoption and point to policies that could help overcome them.[22]**

The factors holding back adoption include economic, behavioral, and structural barriers: upfront costs remain a substantial barrier, as do people's ability and willingness to adopt a new technology and navigate a complex system of government programs in what is often an uncertain and time-constrained context. There are also some structural challenges that limit access by parts of the population, in particular renter households.

Many of the challenges described below relate to the relatively early stage of the heat pump market and may resolve over time as the market matures and installations become more common. However, governments in Canada and around the world do not have the luxury of waiting for the market to mature. Because Canada needs to upgrade a significant proportion of existing homes and buildings each year in order to decarbonize the building stock, the next few years represent a key window of opportunity (Kennedy and Frappé-Sénéclauze 2021). If homeowners lock in another generation of fossil fuel heating equipment in the coming years, it would be a significant

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22. See, for example, Corbett and Rhodes 2022, Glave and Woollard 2022, Kaufman et al. 2019, Lades et al. 2021, Hesselink and Chappin 2019, and Michelsen and Madlener 2015.

*Locking in another generation of fossil fuel heating equipment would be a significant blow to Canada's ability to meet its emissions-reduction targets.*

blow to Canada's ability to meet its emissions-reduction targets. This window of opportunity highlights the urgency of accelerating household uptake in the near-term and avoiding further lock-in of fossil systems.

## 4.1 Consumer confidence is undermined by a lack of familiarity and unclear information

Though heat pumps are becoming more common across Canada, information gaps persist regarding their performance and cost, undermining consumer confidence and slowing uptake. A number of interrelated factors may be contributing to this gap. First and foremost, there is the fact that despite a recent uptick in deployment, heat pump technology remains relatively uncommon compared to alternatives (Natural Resources Canada 2020). Status quo bias and concerns about being an early adopter may remain barriers until heat pumps are more widely adopted across the country, as there may be uncertainty about performance in a specific home or location, and households may prefer to wait until they can rely on direct accounts of friends, neighbours, and family members who have installed one for themselves (Kaufman et al. 2019; Hesselink and Chappin 2019). In addition, while there have been significant improvements in the technology in recent years, including in noise levels and performance in colder climates and in larger, older homes, concerns may still persist based on past examples of poor performance, and perceptions of performance are a driver of people's willingness to adopt (Corbett and Rhodes 2022; Gaur et al. 2021). Moreover, the cooling benefits of heat pumps may be ignored or unrecognized when households replace failing heating or cooling systems, due to limited awareness regarding the value of heat pumps as space-cooling equipment (Gard-Murray et al. 2023).

A lack of supplier readiness and contractor expertise also contributes to information and access barriers and can undermine consumer confidence. Knowledge about the technology among contractors — including about performance in different climates and in different types of homes, as well as proper installation techniques — can be lacking (Owen et al. 2013). Consumers considering getting a heat pump may receive contradictory and confusing information from different sources on their costs and performance, including from different HVAC installers.[23] Moreover, anecdotal accounts of improper installation that undermines performance can have major impacts on consumer trust and confidence. Contractor capacity is growing with heat pumps in general as well as with hybrid systems, but knowledge of and experience with all-electric systems is still less advanced. Other jurisdictions

23. We included high upfront cost sensitivities in our modelling to account for the wide variety of quotes that consumers may receive from contractors. See Table 2 for more details.

such as the United Kingdom are addressing these issues through dedicated training programs and grants that enable heating engineers to upskill and become qualified heat pump installers at a low cost (Government of the United Kingdom 2023a).

Exacerbating these informational barriers to heat pump adoption is the fact that many replacement decisions are made with a high degree of urgency when existing equipment fails, with households needing to quickly procure a replacement to provide heating or cooling. One recent consumer study in B.C. found that heating system breakdown is the trigger for replacement decisions in over one third of cases, with fear of imminent breakdown comprising an additional 20 per cent (Glave and Woollard 2022). Together, this means that households may be operating in a highly time-constrained environment in over half of cases. Status quo bias is reinforced by this time element, as consumers have little time to increase their familiarity and comfort level with new technology, or find an installer who works with heat pumps, as part of the decision-making process. There is also an added time burden of navigating a relatively complex system of rebate programs under these time constraints, and program requirements for energy audits that precede installation may preclude the ability of households to make these replacement choices when existing equipment fails (Glave and Woollard 2022).

## 4.2 High upfront costs remain a major barrier

Though the cost of heat pumps is expected to continue to decline, and our results show that lifetime costs for heat pumps are lower than the alternatives in most cases, the higher upfront cost of heat pumps remains a barrier for households, despite rebates intended to bring down capital costs (see Table 2). When making purchase decisions, households tend to heavily weigh up-front costs and discount future benefits — a substantial barrier to heat pump uptake because the key cost advantage of heat pumps is their lower operating costs, which offset their higher capital costs over the course of a few years (Kaufman et al. 2019; Goody 2014).

Moreover, households have little basis to anticipate changes over time in fossil fuel and electricity prices, hindering their ability to make informed decisions based on lifetime costs and reinforcing the tendency to emphasize upfront costs, which are easily measured and understood (Howarth and Andersson 1993; Hesselink and Chappin 2019). Households also often assess costs over a shorter time horizon than the equipment lifetime, not least as such assets are non-portable and homeowners and renters may move within this period. In addition, awareness of rebate programs to support heat pump adoption is relatively low across Canada, though research suggests that simply improving awareness of existing rebate programs may not be an effective way to significantly increase adoption (Corbett and Rhodes 2022).

The relatively high upfront costs pose a particular barrier for lower-income households, meaning that these households may be locked out of seeing the lifetime savings that a heat pump can deliver, as well as the potentially life-saving benefits of having access to space cooling. Forthcoming research from the B.C. Centre for Disease Control indicates that receiving income assistance (which places households below the poverty line) was strongly associated with increased mortality during the 2021 B.C. heat wave, underscoring the importance of ensuring that lower-income households are able to access space cooling (Lindsay 2023). Since most existing rebate programs confirm eligibility and disburse payment only after the installation process is complete — including, notably, the federal Greener Homes Program — households have to carry significant upfront costs for installation before they are reimbursed, a cost that lower-income households in particular may be unable to carry. Moreover, not knowing in advance whether one ultimately qualifies for the rebates can be a major psychological barrier, made worse by anecdotal stories of households that failed to receive anticipated rebates because of administrative errors by them or their contractors (Dunn 2023).

## 4.3 Complex and cumbersome programming impedes uptake

While there are many programs in place across Canada to reduce the upfront cost of heat pumps, the complexity of these programs and shortcomings in their design limit their effectiveness and create a substantial administrative burden for households. Multiple support programs are offered by different levels of government, depending on the jurisdiction, with different qualifying criteria (including different equipment eligibility), different approval times, and different applications (see Appendix).[24] In some cases, notably for the Greener Homes grant and loan programs, home energy audits are required that households must pay for out-of-pocket before knowing whether they will ultimately qualify for the program. The administrative burden created by this type of complex programming has been shown to be a key barrier that holds households back from following through on initial intentions to install a heat pump (Lades et al. 2021).[25] Lagging applications to the Greener Homes Grant over the first two years suggest challenges accessing the program: application rates are currently behind government targets, with only 30,000 payments issued in each of the first two years of the program, less than one third of the annual uptake needed for the program to meet its target (Natural Resources Canada 2023b).[26] As well as presenting a barrier to the general population, the complexity of end-user programming may be a particular barrier for the elderly, who are more vulnerable to extreme heat, and for recent immigrants.

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24. In addition to complex programming, households in some regions may encounter restrictive bylaws regarding heat pump placement, noise restrictions, and visibility. Condo owners, in addition, must seek approval for retrofits like heat pump installations, and such approval may be denied by their condo association.

25. This finding is in line with findings on the effects of administrative cost on other energy efficiency investments and is hypothesized to be largely due to present bias (i.e. delaying more challenging tasks despite long-term benefits). Some research suggests that addressing behavioral barriers through reducing the administrative burden may be even more important in improving uptake than further financial incentives (Lades et al. 2021).

26. The Greener Homes grant program began accepting applications in 2021 and has a target of supporting 700,000 homeowners over seven years, by 2028.

There are, however, newer examples of programming that is simpler and easier to access: select provincial programs (in New Brunswick, Prince Edward Island, and Nova Scotia) provide heat pumps for free for qualifying low-income households, and the recent federal Oil to Heat Pump Affordability Program does not require an audit. These direct incentive programs, offered specifically for heat pumps, provide greater clarity and ease of access for consumers (Turner 2023).

One potential pathway to reduce the administrative burden and improve the accessibility of existing rebate programs is the enhanced deployment of point-of-sale rebates, which provide instant discounts to consumers upon purchase. Point-of-sale rebates have been shown to be effective with consumers and have been widely deployed to support electric vehicle adoption, but their use for heat pumps is limited to date (Roberson and Helveston 2022).[27] Intermediaries such as retailers and contractors play an influential role in shaping consumer choice when point-of-sale rebates are used, ensuring that these actors are aware of the benefits of heat pumps will be critical to program success (Matthews et al. 2016).

Another option for improving access to heat pump installations is on-bill financing, where utility companies finance the upgrades and recover the costs through repayment on the billing system. In turn, people pay back their retrofit loans through their electricity bills. Since energy bills will tend to be lower in homes with heat pumps (see Section 3), amortizing the upfront costs with on-bill financing can allow for lower monthly spending on heating and cooling—even including including the cost of monthly loan payments.

There are many other potential benefits of on-bill financing, including the fact that utilities already have established billing relationships with their customers, as well as access to information about their energy use and payment history, and that on-bill financing can allow for occupants to transfer the loan to new occupants if they move before maturity. For some programs, such as the U.K.'s Green Deal program, on-bill retrofits are designed for the property, not the homeowner. This is beneficial because if the loan applicant moves, they can stop paying for the loan and easily transfer it to the next owner through the utility bill (Government of the United Kingdom 2023b). Tenants can also ask their landlords to upgrade the efficiency of their homes and have the loan included on the tenant's utility bill (Natural Resources Canada 2016).

27. Prince Edward Island provides one recent example of the deployment of point-of-sale rebates, albeit with substantial eligibility restrictions (Government of Prince Edward Island 2022).

## 4.4 Structural barriers limit access for many households

In addition to the challenges discussed above, which undermine the ability or willingness of households to choose a heat pump when making heating system replacement decisions, structural barriers also exist that limit access of parts of the population to these technologies in a more systemic way. Most rebate and loan programs across Canada, for example, target owner-occupied households in single-detached homes: owners of condos are often ineligible for rebates, as are landlords and renters (see the Appendix for eligibility criteria of different programs) (Wyton 2023).

Renters in particular face unique barriers in being able to access heat pump technologies, many of which are more challenging to address than barriers faced by homeowners. Many of these barriers stem from the fact that while renters typically pay energy bills, landlords pay for the installation of heating and (in many cases) cooling systems.[28] There is limited incentive for landlords to invest additional capital to install a heat pump when the benefits — lower bills, a more comfortable home environment, and resilience to extreme heat — accrue to occupants rather than owners. Since owners, in most cases, do not benefit directly from lower energy bills, some may seek higher rents to amortize their upgrading costs.[29] In addition, the asymmetry of information between owners and prospective tenants around the conditions of the unit — including indoor air temperature and the cost of utility bills, for example — limits the incentives for landlords to upgrade the system.

Furthermore, there is no "right to cooling" in Canada, and most jurisdictions lack legislated or regulated upper temperature limits that would trigger obligations to provide cooling in the absence of a financial incentive (Griffin 2023). Some jurisdictions are, however, beginning to move in this direction. British Columbia has proposed changes to the B.C. Building Code that would establish a maximum indoor temperature limit of 26 degrees celsius in one living area, through either passive or active cooling, and the City of Vancouver will require space cooling in all new multi-family homes as of 2025 (B.C. Ministry of Housing 2023; City of Vancouver 2022).

While these measures apply to new builds, addressing the challenges of retrofitting existing housing stock and improving access to space cooling for renters in these buildings is essential for creating equitable access to these lifesaving technologies in an era of increasing extreme heat.[30] The City of Hamilton is attempting to address this challenge by developing a bylaw to require landlords to ensure safe temperature limits in both new and existing

28. Even if renters had the ability to install a heat pump themselves, incentives are weaker to do so because renters tend to move more frequently than homeowners and the payback accrues over time.

29. However, in jurisdictions where rent increases are regulated, they may be unable to do so.

30. There are numerous documented instances of landlords restricting the ability of tenants to install air conditioning themselves, and there are additional complexities in upgrading electrical systems in older, multi-unit buildings, which are often the most affordable for renters (Uguen-Csenge 2023).

rentals (City of Hamilton 2023), while Efficiency Nova Scotia has a dedicated rebate program for efficiency upgrades (including heat pumps) for multi-unit rental buildings, with specific affordability criteria (Efficiency Nova Scotia 2023).

Energy poverty is a real problem in Canada, and addressing the barriers that keep renters from benefiting from the energy and cost savings of heat pumps is a crucial step in addressing it, as people living in poverty are more than twice as likely to rent their homes than the general population (Randle et al. 2022). In addition, improving access to clean technologies for renters is critical to reaching national emissions reduction and resilience targets, given that one third of Canadians rent their homes (Statistics Canada 2022b).[31]

31. Canada's National Adaptation Strategy sets a number of relevant targets, including: "By 2025, 50% of Canadians have taken concrete actions to better prepare for and respond to climate change risks facing their household; by 2026, 80% of health regions will have implemented evidence-based adaptation measures to protect health from extreme heat; and by 2040, deaths due to extreme heatwaves have been eliminated." If these targets are to be achieved, proactive efforts in policy design to address inequities in access to space cooling are required.

# 5. Policy implications and recommendations

**From a lifetime costs perspective, heat pumps tend to be the lowest-cost choice for consumers, especially given current policy and programming. However, upfront cost remains a significant barrier in heat pump adoption. Further barriers discouraging uptake include a lack of consumer confidence, unclear information, the time-constrained nature of most heating replacement decisions, and the burden of navigating complex and cumbersome government programming. There are also inequities in access that effectively lock many Canadians out of being able to see the benefits of installing a heat pump, meaning that those who are most vulnerable to extreme heat and rising energy bills are currently the least able to reap the benefits of these technologies.**

***Those who are most vulnerable to extreme heat and rising energy bills are currently the least able to reap the benefits of these technologies.***

All of these barriers can and should be addressed to improve uptake across the country.[32] Supporting the deployment of heat pumps is good policy on all fronts: it lowers bills for households and helps governments meet their emissions and resilience goals. All orders of government have an important role to play, particularly in this relatively early stage of the heat pump's adoption curve. In some cases, we recommend policies to address existing market barriers and streamline the installation process for households; in other cases, we recommend a regulatory approach to overcome structural hurdles. Our recommendations are as follows.

32. Evidence from jurisdictions with very high heat pump uptake, such as Sweden, illustrate that a policy mix to address these barriers can help accelerate uptake by shifting consumers' perception of heat pumps from "an unfamiliar and potentially risky technology to a mainstream heating system option." (Rosenow et al. 2022).

1. **All orders of government should maintain current policies and rebates that support heat pump adoption, even as uptake accelerates.** The existing policy mix results in heat pumps being the lowest-cost heating and cooling option for most households in the cities we modelled across Canada. Broad pricing signals—particularly the carbon price—are key factors in making the case for heat pumps over gas. The federal government should maintain the schedule of planned carbon price increases, as it is the most cost-effective way of providing broad incentives across the economy for low-cost emissions reductions, including for home heating. Maintaining the current scale of existing financial supports as heat pump adoption accelerates in the near term is important during this relatively early market stage. There may eventually be a case for sunsetting some programming as the market matures and costs fall further in the future, but supports that are targeted to lower-income households in particular will likely need to be maintained over the long term.

2. **All orders of government should streamline existing programming and improve equity of access.** While existing rebates generally support the cost competitiveness of heat pumps, major issues face consumers in accessing and navigating these rebates, and consumers are often required to carry substantial upfront costs while waiting for their reimbursement. Improvements to the design and coordination of existing programs could include loosening requirements for home energy audits as a condition of eligibility, harmonizing equipment eligibility and other eligibility criteria across jurisdictions, and improving access for renters, including through broadening eligibility for landlords to access rebates for rental properties (see current eligibility restrictions in Appendix). In addition, governments should consider expanding and streamlining programs to reduce or eliminate up-front carrying costs for consumers—for example, through point-of-sale rebates and on-bill financing (as discussed in Section 4).

3. **Provincial governments should support the establishment of one-stop shop energy and efficiency services** to build consumer confidence and support households through the program application and installation processes. A one-stop shop approach involves having one centralized organization serving as the single point of entry for consumers seeking information, support, funding, and program services for home heating and cooling, including heat pump installation, efficiency retrofits, and access to funding and/or financing.

   One-stop shop models have been proven to increase heat pump adoption in other countries. This is partly because a one-stop shop approach reduces the time and resources households need to commit to the retrofit process, and makes it easier for applicants to receive support from multiple funding sources (International Energy Agency 2023; European Commission 2023).[33]

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33. One-stop shops can be public or private. For example, Ireland's approach offers households all the services and support required for a complete home energy upgrade, which involves managing the entire process for applicants from the initial home energy assessment, grant application, project management, contractor works, and the final building energy rating certification (International Energy Agency 2022; Pardalis et al. 2022; Sustainable Energy Authority of Ireland 2023). Another public example is Germany's KFW Effizienzhaus national retrofit program, which leans

A one-stop shop approach also facilitates the provision of tailored information and advice from a single trusted source, which can help overcome consumer trust and informational barriers (International Energy Agency 2023; European Commission 2023). This approach would address many of the barriers to heat pump uptake at once.

This one-stop shop service should also be made available to housing associations, condo associations, and other housing governance structures. It would provide training to building managers and others to ensure that equipment functions as intended and that the needs of tenants are being met. In addition to advising households on energy and efficiency technologies and programs, governments should still expand and streamline existing programs to further simplify the experience and improve equity of access (see recommendation 2).

4. **To protect Canadians from increasingly frequent extreme heat and improve equity of access to life-saving space cooling, governments should establish maximum indoor temperature limits and active and passive cooling requirements.** Provinces should update their building codes to require that safe maximum temperature limits be maintained through a combination of active and passive cooling, and the federal government should ensure that the forthcoming resiliency considerations in the national building code also include cooling requirements and safe maximum indoor temperature limits.[34] In addition to these measures to improve resilience in new buildings, governments should develop dedicated strategies to improve renters' access to space cooling in existing buildings, including considering dedicated incentive programs and regulations that require clean heating and cooling when heating systems are replaced.

All orders of government should ensure that policies that seek to improve resilience, and policies that seek to reduce emissions from homes and buildings, are in sync and working synergistically. Otherwise, there is a risk that policies and regulations to increase heat resilience — such as requiring active cooling in building codes or expanding access to cooling technologies through programming — will lead to decisions and investments that are at odds with climate change mitigation goals. This could happen, for example, if central air conditioning uptake accelerates, when a heat pump could more elegantly have met that cooling need

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on licensed Energy Advisors who provide support to apply for retrofit loans or grants, devise remodelling plans, direct the actual retrofits and all contractors (including the evaluation of quotes), measure results, and help fill out relevant application forms (KfW 2023; Pardalis et al. 2022). Sweden's Klimatfastigheter Småland AB is an example of a private one-stop shop that coordinates all aspects of retrofits for households, such as negotiating the price for all the different renovation works on behalf of its clients (Pardalis et al. 2022).

34. Twenty-six degrees Celsius is often stated as the temperature above which indoor building temperatures become dangerous and associated with higher mortality (BC HEAT Committee 2022). One of the targets in Canada's National Adaptation Strategy is: "By 2026, additional climate change resiliency considerations are incorporated into 3 Canadian Codes (National Building Code, Canadian Highway Bridge Design Code, and Canadian Electrical Code)" (Environment and Climate Change Canada 2023).

instead.[35] Pairing a building code requirement for active cooling with a requirement that heating and cooling equipment be non-polluting and 100 per cent energy efficient would protect against this risk (see recommendation 5).

5. **Provincial and municipal governments should require non-polluting and high-efficiency heating and cooling in new buildings, in regions where the all-electric heating scenario is the lowest-cost option.** Doing so would avoid locking in fossil infrastructure and equipment. Our results show that, of the five cities we modelled, heat pumps with electric backup are already the lowest-cost option in all new builds in Vancouver, Montreal, and Halifax. Heat pumps with electric backup are also the cheapest options for newly built single-detached homes and townhouses in Toronto (see Section 3). Requiring clean and high-efficiency heating and cooling (as well as water heating and cooking) in new builds in regions where it is cost competitive avoids extending gas infrastructure to new housing developments — infrastructure that may end up stranded or contribute to elevated energy bills as the country decarbonizes.[36] It also corrects against misaligned incentives, as developers may have fewer incentives than owners to choose a system that delivers low operating costs (as opposed to a system that is currently desirable based on past performance). In regulating new builds, governments should avoid being overly prescriptive and should allow for flexibility of different non-emitting heating and cooling systems that may be particularly effective in different circumstances.

35. See Gard-Murray et al. (2023) for further discussion of the benefits of replacing new central air conditioners with heat pumps, and policy options to do so.

36. Implications of different electrification pathways for the building heat network and strategies for managing peak demand will be explored in the Canadian Climate Institute's forthcoming research on decarbonizing building heat.

# Appendix

## Select programs across Canada that support heat pump adoption

***This is not an exhaustive list of programs available to incent heat pump adoption, and not all of these rebate programs were included in our modelling. For more details on the assumptions underpinning the modelling, see the accompanying technical report.***

### PROGRAMS INCLUDED IN OUR MODEL

**CANADA GREENER HOMES GRANT,** ***CANADA***
Funder: Government of Canada

Grants up to $5,000 towards the cost of eligible home retrofits, including heat pumps.

**Eligibility constraints**
- Pre- and post-retrofit EnerGuide evaluations needed.
- Landlords renting their properties and renters are ineligible.
- Co-ops and all homes that are six months or newer ineligible.

**CLEANBC BETTER HOMES AND HOME RENOVATION REBATE PROGRAM,** ***B.C.***
Funder: Government of B.C.

Up to $6,000 in rebates for heat pumps.
Up to $500 for electric service upgrades.

**Eligibility constraints**
- Landlords renting their properties and renters are ineligible.
- Multi-unit residential buildings ineligible.
- Proof of fossil fuel system removal needed.

**NOVA SCOTIA'S HEATING SYSTEM REBATES,** ***NOVA SCOTIA***
Funder: Efficiency Nova Scotia

Up to $1,600 in rebates for heat pumps.

**Eligibility constraints**
- Renters ineligible.
- Homes that are six months or newer ineligible.

**NOVA SCOTIA'S AFFORDABLE HOUSING PROGRAM,** ***NOVA SCOTIA***
Funder: Efficiency Nova Scotia

Up to 300,000 per project or 80% of the project cost, whichever is lower. Rebates for energy efficient upgrades.

**Eligibility constraints**
- Multi-unit residential rental properties.
- Must meet the maximum rental rate criteria according to a housing type.

**NOVA SCOTIA'S COMMERCIAL NEW CONSTRUCTION PROGRAM,** ***NOVA SCOTIA***
Funder: Efficiency Nova Scotia

Up to a maximum of $750,000 for meeting various energy efficiency standards and requirements, including heating and cooling equipment.

**Eligibility constraints**
- A new structure.
- Project must implement at least two energy efficient measures.
- Project must achieve a reduction in total building energy consumption of at least 25% and at least 100,000 kWh of electricity savings.

**AFFORDABLE MULTI-FAMILY RESIDENTIAL PROGRAM,** ***ONTARIO***
Funder: Enbridge Gas

Up to $200,000 for energy-efficient retrofits or new constructions.

**Eligibility constraints**
- In addition to social and municipal housing providers, shelters, and co-ops, market-rate multi-family buildings are eligible if at least 30 per cent of units are rented at less than 80 per cent of the median market rent.

**TORONTO HOME ENERGY AND LOAN PROGRAM,** ***ONTARIO***
Funder: City of Toronto

$2,000 rebate for a standard air-source heat pump.
$2,500 rebate for a cold climate heat pump.

**Eligibility constraints**

- Single-detached, semi-detached, or row house in the City of Toronto.
- Renters ineligible.

**LOGISVERT EFFICIENT HOMES PROGRAM,** ***QUEBEC***
Funder: Hydro-Québec

Receive $140 per 1,000 BTU/h at -8°C for a high-efficiency heat pump.

**Eligibility constraints**

- Single-family, semi-detached, row house, mobile home, four-season cottage) located in Québec.

**EFFICIENT SOLUTIONS PROGRAM,** ***QUEBEC***
Funder: Hydro-Québec

Up to 75% of eligible purchase and installation costs.

**Eligibility constraints**

- Commercial, industrial, and institutional customers.
- New and older buildings are eligible.

## PROGRAMS NOT INCLUDED IN OUR MODEL

**CANADA GREENER HOMES INITIATIVE'S OIL TO HEAT PUMP AFFORDABILITY PROGRAM,** ***CANADA***
Funder: Government of Canada

Upfront payment of up to $10,000 for cold climate air-source heat pump systems.

**Eligibility constraints**
- Landlords renting their properties and renters are ineligible.
- While the program does not require the removal of the existing heating source, many provinces and municipalities require the removal of an oil tank that is no longer in use.
- Homes that are six months or newer ineligible.
- Program is for cold climate heat pumps only.

**CANADA GREENER HOMES LOAN,** ***CANADA***[37]
Funder: Government of Canada

10-year, interest-free loans between $5,000 and $40,000 for eligible retrofits.

**Eligibility constraints**
- Applicants must be eligible for and apply for the Canada Greener Homes Grant.
- Adequate credit history needed.
- Loan must be approved before retrofits can start.

**HOMEWARMING PROGRAM,** ***NOVA SCOTIA***
Funder: Government of Nova Scotia

Full cost of heat pump and installation covered for low-income households.

**Eligibility constraints**
- Households are only eligible if their household income is less than $27,250 -$72,113, depending on the household size.
- Landlords renting their properties and renters are ineligible.
- Applicants should not plan to sell their properties in the near future.

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37. While we assume financing beginning at 7 per cent interest in this report, we have included the impact of interest-free financing, such as that provided by the Canada Greener Homes Loan, in our online heat pump cost calculator.

**CLEAN HOME HEATING INITIATIVE,** ***ONTARIO***
Funder: Enbridge Gas and the Government of Ontario

Up to $4,500 in support for installing an electric heat pump.

**Eligibility constraints**

- Only people who reside in Ajax, Barrie, Pickering, Whitby, Sault Ste. Marie, St. Catharines, Peterborough, and London are eligible.[38]
- Renters ineligible.
- Program is on a first-come, first-served basis and subject to the availability of program funding.

**FREE HEAT PUMP PROGRAM,** ***P.E.I.***
Funder: Government of P.E.I.

Full cost of heat pump and installation covered for low-income households.

**Eligibility constraints**

- Landlords renting their properties and renters are ineligible.
- Households are only eligible if their household income is up to $75,000.
- Properties valued at $300,000 or more ineligible.

**ENHANCED ENERGY SAVINGS PROGRAM,** ***NEW BRUNSWICK***
Funder: Government of NB

Full cost of heat pump and installation covered for low-income households.

**Eligibility constraints**

- Landlords renting their properties and renters are ineligible.
- Households are only eligible if their household income is up to $70,000.
- Program is on a first-come, first-served basis and subject to the availability of program funding.

38. The Clean Home Heating Initiative is only offered in select northern and southern communities that represent a diverse geographic spread that will provide the opportunity to test the hybrid heating system in a range of climates.

# References

Ballester, Joan, Marcos Quijal-Zamorano, Raúl Fernando Méndez Turrubiates, Ferran Pegenaute, François R. Herrmann, Jean Marie Robine, Xavier Basagaña, Cathryn Tonne, Josep M. Antó, and Hicham Achebak. 2023. "Heat-Related Mortality in Europe During the Summer of 2022." *Nature Medicine*, 1-10. https://www.nature.com/articles/s41591-023-02419-z

B.C. HEAT Committee (B.C. Health Effects of Anomalous Temperatures Coordinating Committee). 2022. *B.C. Provincial Heat Alert and Response System*. Victoria, B.C. http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/Provincial-Heat-Alerting-Response-System.pdf

BC Hydro. 2020. *Not-So Well-Conditioned: How Inefficient A/C Use is Leaving British Columbians Out of Pocket in the Cold*. Vancouver, B.C. https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/news-and-features/bch-ac-report-aug-2020.pdf

BC Hydro. 2022. *AC Dependency: Summer Demand for Electricity Increasing with AC Use*. Vancouver, B.C. https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/news-and-features/ac-dependency-report-bchydro.pdf

B.C. Ministry of Housing. *Public Review BC Building Code 2023: Proposed Change to Reduce Risk of Overheating in Dwelling Units*. Victoria, B.C. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/bc-codes-2023-public-review-pcf/overheating.pdf

Beugin, Dale, Dylan Clark, Sarah Miller, Ryan Ness, Ricardo Pelai, and Janna Wale. 2023. *The Case for Adapting to Extreme Heat: Costs of the 2021 B.C. Heat Wave.* Canadian Climate Institute. https://climateinstitute.ca/reports/extreme-heat-in-canada/

Billimoria, Sherri, Mike Henchen, Leia Guccione, and Leah Louis-Prescott. 2018. *The Economics of Electrifying Buildings: How Electric Space and Water Heating Supports Decarbon-*

*ization of Residential Buildings*. Rocky Mountain Institute. https://rmi.org/insight/the-economics-of-electrifying-buildings/

British Columbia Coroners Service. 2022. *Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021.* Victoria, B.C. https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf

Canadian Climate Institute. 2023a. *Early Estimate of National Emissions: Independent advance data for Canada's National Inventory Report.* https://440megatonnes.ca/early-estimate-of-national-emissions/

Canadian Climate Institute. 2023b. "The First Step To Reach Canada's Net Zero Goal is to Reduce Annual Greenhouse Gas Emissions to 440 Megatonnes or Lower by 2030: Is Canada on Track?" Retrieved July 30, 2023, from https://dashboard.440megatonnes.ca

Carrier. 2023. "How Are Heat Pumps and Air Conditioners Similar?" Retrieved July 30, 2023, from https://www.carrier.com/residential/en/ca/products/heat-pumps/heat-pumps-vs-air-conditioners/

CBC News. 2022. "For this Remote First Nation, Installing Heat Pumps is Worth the Effort." Retrieved August 24, 2023, from https://www.cbc.ca/news/science/what-on-earth-heat-pumps-heiltsuk-nation-1.6475202

City of Hamilton. 2023. *Special Public Health Committee: Report 23-006.* Hamilton, Ontario. https://pub-hamilton.escribemeetings.com/FileStream.ashx?DocumentId=365259

City of Vancouver. 2022. *Climate Emergency—Bylaw and Policy Updates Applicable to New Buildings*. Vancouver, BC. https://council.vancouver.ca/20220517/documents/R1a.pdf

Corbett, Meghan, Ekaterina Rhodes, Aaron Pardy, and Zoe Long. 2023. "Pumping up Adoption: The Role of Policy Awareness in Explaining Willingness to Adopt Heat Pumps in Canada." *Energy Research and Social Science, 96*. https://www.sciencedirect.com/science/article/abs/pii/S2214629622004297

Delta-EE. "Heat Pump Costs Projected to Fall by 40%." Retrieved August 17, 2023, from https://delta.lcp.com/press-release/heat-pump-costs-projected-to-fall-by-40/

Dion, Jason, Caroline Lee, Anna Kanduth, Christiana Guertin, and Dale Beugin. 2022. *The Big Switch: Powering Canada's Net Zero Future*. Canadian Climate Institute. https://climateinstitute.ca/reports/big-switch/

Dunn, Thom. 2023. "A Heat Pump Might Be Right for Your Home: Here's Everything to Know." The New York Times. Retrieved August 22, 2023, from https://www.nytimes.com/wirecutter/guides/heat-pump-buying-guide/

Ecotrust Canada. 2019. *Project Review: Report on Bella Bella Heat Pump Project*. Vancouver, B.C. https://ecotrust.ca/wp-content/uploads/2020/03/Heiltsuk-First-Nation-2019-Heat-Pump-Review.pdf

Efficiency Nova Scotia. 2023. "Affordable Multifamily Housing Program." Retrieved August 24, 2023, from https://www.efficiencyns.ca/business/business-types/affordable-housing/

EnergieSchweiz. 2021. *Feldmessungen von Wärmepumpen-Anlagen Heizsaison 2020/21* [Field Measurements of Heat Pump Systems in the 2020/21 Heating Season]. Ittigen, Switzerland. https://www.ost.ch/fileadmin/dateiliste/3_forschung_dienstleistung/institute/ies/wpz/sonstige_wichtige_dokumente/2021_bericht_feldmessungen.pdf

Energy Systems Catapult. 2023. *Electrification of Heat Demonstration Project: Interim Heat Pump Performance Data Analysis Report*. Birmingham, United Kingdom. https://es.catapult.org.uk/report/electrification-of-heat-interim-heat-pump-performance-data-analysis-report/

Environment and Climate Change Canada. 2020. *A Healthy Environment and a Healthy Economy: Canada's Strengthened Climate Plan to Create Jobs and Support People, Communities and the Planet*. Government of Canada. Gatineau, Quebec. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy.html

Environment and Climate Change Canada. 2023. *Canada's National Adaptation Strategy: Building Resilient Communities and a Strong Economy*. Government of Canada. Gatineau, Quebec. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/national-adaptation-strategy/full-strategy.html

European Commission. 2023. *Committee on Industry, Research and Energy's Report on the Proposal for a Directive of the European Parliament and of the Council on the Energy Performance of Buildings*. Brussels, Belgium. https://www.europarl.europa.eu/doceo/document/A-9-2023-0033_EN.html

Ferguson, Alex and Jeremy Sager. 2022. *Cold-Climate Air Source Heat Pumps: Assessing Cost Effectiveness, Energy Savings and Greenhouse Gas Emission Reductions in Canadian Homes*. Natural Resources Canada. Ottawa, Ontario. https://ftp.maps.canada.ca/pub/nrcan_rncan/publications/STPublications_PublicationsST/329/329701/gid_329701.pdf

Fortis BC. 2023. "Home Energy Calculator." Retrieved July 30, 2023, from https://www.fortisbc.com/rebates-and-energy-savings/saving-energy-in-your-home/home-energy-calculator

Fraunhofer Institute for Solar Energy Systems ISE. 2020. *Wärmepumpen in Bestandsgebäuden: Ergebnisse aus dem Forschungsprojekt «WPsmart im Bestand»* ["WPsmart im Bestand": Heat Pump Field Trial—Focus on Existing Buildings and Smart Control]. Freiburg, Germany. https://www.ise.fraunhofer.de/content/dam/ise/de/downloads/pdf/Forschungsprojekte/BMWi-03ET1272A-WPsmart_im_Bestand-Schlussbericht.pdf

Gard-Murray, Alexander, Brendan Haley, Sarah Miller, Mathieu Poirier. 2023. *The Cool Way to Heat Homes: Installing Heat Pumps Instead of Central Air Conditioners in Canada*. Building Decarbonization Alliance, Canadian Climate Institute, Efficiency Canada, Greenhouse. https://climateinstitute.ca/reports/cool-way-heat-homes/

Gaur, Ankita Singh, Desta Z. Fitiwi, and John Curtis. 2021. "Heat Pumps and Our Low-Carbon Future: A Comprehensive Review". *Energy Research & Social Science*, 71, 101764. https://doi.org/10.1016/j.erss.2020.101764

Gilpin, Emilee. 2018. "Skidegate on the Way to Becoming a 'City of the Future.'" Canada's National Observer. Retrieved August 24, 2023, from https://www.nationalobserver.com/2018/04/09/brighter-news-clean-energy-success-story

Glave, James, and Donovan Woollard. 2022. *Stuck: Why Home Electrification is Lagging in British Columbia and What Must be Done to Break the Deadlock on Residential Carbon Retrofits*. Open Technologies. https://opentech.eco/products/stuck/

Government of B.C. n.d. "Do Heat Pumps Work Well in Cold Weather?" Retrieved July 30, 2023, from https://www.betterhomesbc.ca/products/do-heat-pumps-work-well-in-cold-weather/

Government of Prince Edward Island. 2022. "Point of Sale Heat Pump Rebates." Retrieved July 30, 2023, from https://www.princeedwardisland.ca/en/information/environment-energy-and-climate-action/point-of-sale-heat-pump-rebates

Government of the United Kingdom. 2023a. "Thousands of Heat Pump Installers to be Trained for Fraction of the Price". Retrieved August 23, 2023 from https://www.gov.uk/government/news/thousands-of-heat-pump-installers-to-be-trained-for-fraction-of-the-price

Government of the United Kingdom. 2023b. "Green Deal: Energy Saving for Your Home." Retrieved July 30, 2023, from https://www.gov.uk/green-deal-energy-saving-measures

Goody, Mark Christopher. 2014. *Household Decision-Making Dynamics Associated with the Adoption of High-Involvement Renewable Energy Technologies: A Case Study of Consumer Experiences in the Adoption of Residential Ground Source Heat Pump Systems in Rural Southwestern Ontario (Canada.)* Master's thesis submitted to the University of Waterloo. Waterloo, Ontario. https://uwspace.uwaterloo.ca/bitstream/handle/10012/8836/Goody_Mark.pdf?sequence=1&isAllowed=y

Griffin, Tyler. 2023. "As Extreme Heat Gets Worse, Expert Calls for Access to Cooling as a Human Right." CBC News. Retrieved August 23, 2023, from https://www.cbc.ca/news/canada/toronto/heat-experts-cooling-centres-1.6899857

Hesselink, Laurens X.W., and Emile J.L. Chappin. 2019. "Adoption of Energy Efficient Technologies by Households—Barriers, Policies and Agent-Based Modelling Studies". *Renewable and Sustainable Energy Reviews*, 99, 29-41. https://doi.org/10.1016/j.rser.2018.09.031

Howarth, Richard B., and Bo Andersson. 1993. "Market Barriers to Energy Efficiency". *Energy Economics*, 15(4), 262-272. https://doi.org/10.1016/0140-9883(93)90016-K

HRAI (Heating Refrigeration and Air Conditioning Institute of Canada). 2023. "How Does a Heat Pump Work?" Retrieved July 30, 2023, from https://www.hrai.ca/consumer-tip/how-does-a-heat-pump-work

Hydro Quebec. 2023. "Tips on Air-Conditioning." Retrieved July 30, 2023, from https://www.hydroquebec.com/residential/energy-wise/windows-heating-air-conditioning/air-conditioning-tips.html

INSPQ (Institut national de santé publique du Québec). 2019. *Surveillance des impacts des vagues de chaleur extrême sur la santé au Québec à l'été 2018*. Quebec City, Quebec. https://www.hydroquebec.com/residential/energy-wise/windows-heating-air-conditioning/air-conditioning-tips.html

International Energy Agency. 2022. *The Future of Heat Pumps*. Paris, France. https://www.iea.org/reports/the-future-of-heat-pumps

International Energy Agency. 2023. "Heat Pumps: Latest Findings." Retrieved July 30, 2023, from https://www.iea.org/energy-system/buildings/heat-pumps

Kanduth, Anna. 2022. "Heat Pumps Can Power Major Emissions Reductions from Buildings." 440 Megatonnes. Retrieved July 30, 2023, from https://440megatonnes.ca/insight/heat-pumps-can-power-major-emissions-reductions-from-buildings/

Kaufman, Noah, David Sandalow, Clotilde Rossi Di Schio, and Jake Higdon. 2019. *Decarbonizing Space Heating with Air Source Heat Pumps*. Columbia's Center on Global Energy Policy. New York, NY. https://www.energypolicy.columbia.edu/publications/decarbonizing-space-heating-air-source-heat-pumps/

Kennedy, Madi, and Tom-Pierre Frappé-Sénéclauze. 2021. *Canada's Renovation Wave: A Plan for Jobs and Climate*. The Pembina Institute. Calgary, Alberta. https://www.pembina.org/reports/canadas-renovation-wave.pdf

Kevin Dorma Consulting. 2021. "Evaluation of an Air Source Heat Pump in Calgary." Retrieved July 30, 2023, from https://kevindorma.ca/2021/10/09/evaluation-of-an-air-source-heat-pump-in-calgary/

KfW. 2023. "This Is How the State Promotes Your Energy-Efficient, Sustainable Home." Retrieved July 30, 2023, from https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bauen-und-Sanieren/

Lades, Leonhard K., J. Peter Clinch, and J. Andrew Kelly. 2021. "Maybe Tomorrow: How Burdens and Biases Impede Energy-Efficiency Investments." *Energy Research & Social Science*, 78, 102154. https://doi.org/10.1016/j.erss.2021.102154

Lee, Michael Joseph, Kathleen E. McLean, Michael Kuo, Gregory RA Richardson, and Sarah B. Henderson. 2023. "Chronic Diseases Associated With Mortality in British Columbia, Canada During the 2021 Western North America Extreme Heat Event." *GeoHealth*, 7(3). https://doi.org/10.1029/2022GH000729

Lindsay, Bethany. 2023. "Summer Now Means Fear for Some, as Study Shows Poverty Brought Biggest Risk of Death in B.C. Heat Dome." CBC News. Retrieved August 18, 2023, from https://www.cbc.ca/news/health/bc-heat-dome-poverty-connection-1.6891461

Manitoba Hydro. 2023. "Cold Climate Air Source Heat Pumps." Retrieved July 30, 2023, from https://www.hydro.mb.ca/your_home/heating_and_cooling/cold_climate_air_source_heat_pumps/

Matthews, Lindsay, Jennifer Lynes, Manuel Riemer, Tania Del Matto, and Nicholas Cloet. 2017. "Do We Have a Car for You? Encouraging the Uptake of Electric Vehicles at Point of Sale." *Energy Policy*, 100, 79-88. https://doi.org/10.1016/j.enpol.2016.10.001

Matson, John, and Chris Potter. 2022. Clean Energy 101: Heat Pumps. Rocky Mountain Institute. Basalt, Colorado. https://rmi.org/clean-energy-101-heat-pumps/

McKenna, Claire, Amar Shah, and Silberg Mark. 2020. *It's Time to Incentivize Residential Heat Pumps*. Rocky Mountain Institute. Basalt, Colorado. https://rmi.org/its-time-to-incentivize-residential-heat-pumps/

Michelsen, Carl C., and Reinhard Madlener. 2016. "Switching from Fossil Fuel to Renewables in Residential Heating Systems: An Empirical Study of Homeowners' Decisions in Germany." *Energy Policy*, 89, 95-105. https://doi.org/10.1016/j.enpol.2015.11.018

Moliere, Ashley. 2022. "Trying to Chill: The Pros and Cons of Portable and Window Air Conditioning Units." CBC News. Retrieved July 30, 2023, from https://www.cbc.ca/news/canada/british-columbia/portable-window-air-conditioning-units-1.6483615

Natural Resources Canada. 2016. *Financing Energy Efficiency Retrofits in the Built Environment: Study for the Energy and Mines Ministers' Conference*. Government of Canada. Winnipeg, Manitoba. https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/Financing%20Report-acc_en.pdf

Natural Resources Canada. 2020. "Residential Sector Canada Table 27: Heating System Stock by Building Type and Heating System Type." Retrieved July 30, 2023, from https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ca&year=2020&rn=27&page=0

Natural Resources Canada. 2022. "Heating and Cooling With a Heat Pump." Retrieved July 30, 2023, from https://natural-resources.canada.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817#d2

Natural Resources Canada. 2023a. "Green Buildings." Retrieved July 30, 2023, from https://natural-resources.canada.ca/energy-efficiency/green-buildings/24572

Natural Resources Canada. 2023b. *Inquiry of Ministry Q-1368*. Government of Canada. Ottawa, Ontario.

Owen, Alice, Gordon Mitchell, and Rachael Unsworth. 2013. "Reducing Carbon, Tackling Fuel Poverty: Adoption and Performance of Air-Source Heat Pumps in East Yorkshire, UK." *Local Environment*, 18(7), 817-833. https://doi.org/10.1080/13549839.2012.732050

Pardalis, Georgios, Krushna Mahapatra, and Brijesh Mainali. 2022. "Comparing Public- and Private-Driven One-Stop-Shops for Energy Renovations of Residential

Buildings in Europe." *Journal of Cleaner Production, 365*, 132683. https://doi.org/10.1016/j.jclepro.2022.132683

Poirier, Mathieu, and Claire Cameron. 2023. *The Case for Building Electrification in Canada*. The Transition Accelerator. https://transitionaccelerator.ca/wp-content/uploads/2023/06/BDA-The-Case-for-Building-Electrification-in-Canada.pdf

Quick, Matthew, and Michael Tjepkema. 2023. *The Prevalence of Household Air Conditioning in Canada*. Statistics Canada. Ottawa, Ontario. https://www150.statcan.gc.ca/n1/pub/82-003-x/2023007/article/00002-eng.htm

Randle, Jeff, Zachary Thurston, and Thierry Kubwimana. 2022. *Housing Experiences in Canada: People in Poverty*. Statistics Canada. Ottawa, Ontario. https://www150.statcan.gc.ca/n1/pub/46-28-0001/2021001/article/00017-eng.htm

Roberson, Laura, and John Paul Helveston. 2022. "Not All Subsidies Are Equal: Measuring Preferences for Electric Vehicle Financial Incentives." *Environmental Research Letters,* 17(8), 084003. https://iopscience.iop.org/article/10.1088/1748-9326/ac7df3

Rosenow, Jan, Duncan Gibb, Thomas Nowak, and Richard Lowes. 2022. "Heating up the Global Heat Pump Market." *Nature Energy*, Vol. 7, Issue 10, pp. 901–904. https://doi.org/10.1038/s41560-022-01104-8

Statistics Canada. 2022a. "Households and the Environment Survey: Energy Use, 2019." Retrieved July 30, 2023, from https://www150.statcan.gc.ca/n1/daily-quotidien/220502/dq220502b-eng.htm

Statistics Canada. 2022b. "To Buy or to Rent: The Housing Market Continues to be Reshaped by Several Factors as Canadians Search for an Affordable Place to Call Home." Retrieved July 30, 2023, from https://www150.statcan.gc.ca/n1/daily-quotidien/220921/dq220921b-eng.htm

Statistics Canada. 2023a. "Primary Heating Systems and Type of Energy." Retrieved July 30, 2023, from https://doi.org/10.25318/3810028601-eng

Statistics Canada. 2023b. "Air Conditioners." Retrieved July 30, 2023, from https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810001901

Statistics Canada. 2023c. Census Profile. 2021 Census of Population. Statistics Canada Catalogue no. 98-316-X2021001. Ottawa, Ontario. Retrieved August 7, 2023, from https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E

Sustainable Energy Authority of Ireland. 2023. "One Stop Shop Services." Retrieved July 30, 2023, from https://www.seai.ie/grants/home-energy-grants/one-stop-shop/

Sustainable Gabriola. 2022. "Sustainable Gabriola Initiatives." Retrieved July 30, 2023, from https://sustainablegabriola.ca/initiatives/

Tan, Lacey, and Mohammad Hassan Fathollahzadeh. 2021. "Why Heat Pumps Are the Answer to Heat Waves." Rocky Mountain Institute. Basalt, Colorado. Retrieved August 7, 2023, from https://rmi.org/why-heat-pumps-are-the-answer-to-heat-waves/

Turner, Chris. 2023. *Heat Pumps Are Hot in the Maritimes*. Canadian Climate Institute. https://climateinstitute.ca/publications/heat-pumps-are-hot-in-the-maritimes/

Uguen-Csenge, Eva. 2023. "Landlords in B.C. Warning Renters against Installing AC Units Despite Rising Heat." CBC News. Retrieved July 30, 2023, from https://www.cbc.ca/news/canada/british-columbia/bc-air-conditioner-renters-1.6906665

Wyton, Moira. 2023. "Growing Calls to Extend B.C.'s Heat-Pump Rebates to Condos to Keep Vulnerable Residents Cool." CBC News. Retrieved August 24, 2023, from https://www.cbc.ca/news/canada/british-columbia/condo-owners-heat-pumps-extreme-heat-1.6888316

Zhang, Arthur. 2023. "What's Needed to Further Amp up Heat Pumps in the Maritimes." Canadian Climate Institute. Retrieved August 7, 2023, from https://440megatonnes.ca/insight/whats-needed-to-further-amp-up-heat-pumps-in-the-maritimes/

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