The Cool Way to Heat Homes

Installing Heat Pumps Instead of Central Air Conditioners in Canada

Authors: Alexander Gard-Murray, Brendan Haley, Sarah Miller, Mathieu Poirier

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Efficiency Canada

Greenhouse

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Authors:

Alexander Gard-Murray
Director
Greenhouse Institute

Brendan Haley
Director of Policy Research
Efficiency Canada

Sarah Miller
Research Lead, Adaptation
Canadian Climate Institute

Mathieu Poirier
Director of Policy
Building Decarbonization Alliance

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About the Building Decarbonization Alliance:

An initiative of the Transition Accelerator, the **Building Decarbonization Alliance** is a cross-sector coalition that works to inspire and inform industry and government leadership, accelerate market transformation, and get the building sector on track to meet its emissions reduction goals. We convene conversations, conduct original research, and identify structural barriers to electrification—and work with our partners to overcome them.

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The Opportunity

The heating and cooling equipment that Canadians rely on has big consequences for their finances and their environment. To meet the growing need for cooling, many people are buying central air conditioners and pairing them with their existing heating source. But in doing so, **they inadvertently miss an opportunity to get high-efficiency, low-emissions heating and cooling from a single piece of equipment: a heat pump.**

Cold winters have always been with us, making space heating "literally a matter of life and death."[1] But as climate change leads to more frequent and more extreme heat waves, space cooling is increasingly a matter of life and death as well. More than 600 people died under the 2021 heat dome in British Columbia, making it the deadliest weather event in Canadian history. Worsening climate change will only make similar events more likely in the future.[2] Understandably, demand for central air conditioners has been growing across the country.

On a mechanical level, central air conditioners and ducted air-source heat pumps are essentially the same machines.[3] In their simplest form, they both work by gathering heat in one space and pushing it somewhere else. The difference is that while air conditioners can only move heat in one direction—from inside the home to outside—heat pumps are designed

Installing a heat pump instead of a central air conditioner is a great way to get high-efficiency, low-emissions heating and cooling from one piece of equipment.

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1 Tardy and Lee (2019).

2 Government of Canada (2022a).

3 This report is focused on ducted air conditioners and air-source heat pumps: those that distribute air through existing ductwork in a home. When we use the terms "heat pump" and "air conditioner" without other qualifiers, we are referring to the ducted versions of these technologies, and not to alternatives like mini-split heat pumps or window air conditioners.

to switch directions so they can also bring heat in from outside. This means they can both heat and cool as needed. In a common single-speed model, these extra parts only add a few hundred dollars to the manufacturing cost of a two-way heat pump over a one-way central air conditioner.[4] But that small extra cost brings big benefits.

What makes a heat pump really special is not just that it can heat, but that it heats *much more efficiently* than any other heating method. **While gas, propane, oil, wood, and electric resistance all need to create new heat, heat pumps simply *move* existing heat, requiring much less energy.** Using less energy can lower heating bills, especially when switching from oil, propane, or electric resistance heating.[5] And because heat pumps are powered by electricity, they don't require burning fossil fuels, meaning they can substantially reduce greenhouse gas emissions from building heat.[6]

Yet despite all these advantages, **nearly 7,000 Canadian households install a central air conditioner every week, when they could have installed a heat pump instead**.[7] For many people this isn't a conscious choice: many don't realize there's an alternative, and a "heat pump" doesn't sound like something you'd buy to cool your home. That's a problem, because heating and cooling equipment can last for decades, and people rarely replace it before it fails. That means seven thousand times a week, another Canadian home gets locked out of the benefits of high-efficiency heating for decades to come.

In this report, we show how Canadian policymakers can seize this opportunity and make every new central air conditioner a heat pump instead. Because the machines are so similar, this can be done with minimal disruption to manufacturers, distributors, installers, and consumers. Families will still get the cooling that they want—and that they increasingly need—while also getting access to much more efficient heating. We project that this one change would save Canadians C$10.4 billion in energy bills and cut the country's emissions by 19.6 million tonnes of CO_2 equivalents, producing C$12.6 billion in net benefits.[8] We lay out multiple potential routes for implementation, showing that **installing heat pumps instead of central air conditioners is a feasible and cost-effective strategy for meeting Canadians' heating and cooling needs**.[9]

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4 As of 2015, the manufacturing cost difference between a common 15 SEER, 3-tonne heat pump and a comparable central air conditioner was US$144. Accounting for inflation (at a rate of 1.25) and currency conversion (at US$1 = C$1.33), the cost difference today would be about C$239. See U.S. Department of Energy (2016). "Technical Support Document: Energy Efficiency Program for Consumer Products: Residential Central Air Conditioners and Heat Pumps."

5 Poirier and Cameron (2023).

6 Tan and Teener (2023), for example, find that replacing a gas furnace with a heat pump could reduce emissions in the United States by up to 93%.

7 Data for split-system packaged units below 5 tonnes, obtained from the Heating, Refrigeration, and Air Conditioning Institute of Canada.

8 Tonnes of CO_2 equivalents (tCO_2e) is a measure that combines multiple kinds of greenhouse gases like methane and nitrous oxide by converting them into a common unit based on the warming potential of carbon dioxide. The average Canadian's carbon footprint is around 15.5 tCO_2e annually. See https://www.bchydro.com/news/conservation/2022/carbon-emissions-profile.html.

9 We build on a growing chorus of studies emphasizing the benefits of installing heat pumps instead of air conditioners. See Pantano et al. (2021) for the original "Hybrid Heat Homes" concept, as well as Malinowski et al. (2022), and Building Decarbonization Coalition (2023).

Why Canada Needs More Heat Pumps

Achieving Our Decarbonization Goals

The Federal Government is committed to reducing emissions 40–45% below 2005 levels by 2030 and reaching net-zero emissions by 2050. The building sector is crucial to meeting these goals: buildings are Canada's third-largest source of emissions, behind only transportation and the oil and gas sectors. Including fuels burnt to generate their electricity, buildings account for 18% of Canada's greenhouse gasses.[10] Space heating and cooling represent more than 67% of building energy use, making them indispensable to any effort to reduce building emissions.[11] Without decarbonizing heating and cooling, Canada's climate commitments will be out of reach. At the current pace of retrofits, it will be more than 140 years before Canada's building sector is decarbonized.[12]

Hitting our 2030 and 2050 goals requires strong and swift action to reduce fossil fuel consumption in homes and buildings. Delay makes the problem much harder: because HVAC (heating, ventilation, and air conditioning) equipment lasts for 15 years or more, replacement decisions made today have emissions implications for decades to come.

Fortunately, technological improvements in heat pump efficiency mean we have the opportunity to cost-effectively reduce our building emissions. Heat pump performance has significantly improved across the product range. Single-speed heat pumps are now only marginally more costly to manufacture than comparable central air conditioners. And more efficient variable-speed and cold-climate units are becoming increasingly affordable, making the transition to clean heating more feasible than ever. *See "Different Heat Pump Designs"*.

Accounting for 18% of Canada's greenhouse gasses, buildings are Canada's third-largest source of emissions, behind only transportation and the oil and gas sectors.

JT8/Shutterstock.com

10 https://natural-resources.canada.ca/energy-efficiency/green-buildings/24572.

11 Natural Resources Canada (2020a, 2020b).

12 Haley and Torrie (2021).

Different Heat Pump Designs

The most common heat pumps on the market today are “single-speed”, “single-stage”, or “fixed output” models. Like most air conditioners or furnaces, they only have two settings—on or off—and they hit a given temperature by cycling between them. This gets the job done, but usually uses more energy than running at a lower level for a longer period would.

Newer “variable-speed”, “multi-speed”, or “inverter” units offer even more flexibility, because they can adjust their output dynamically to match a home’s needs. Changing speed lets them operate more efficiently, and they tend to be more comfortable than single-speed heat pumps—as well as single-stage furnaces—because they don’t need to “dump” large amounts of warm air when running.

Traditionally heat pump performance declined when temperatures got really cold. But now there are specialized “cold-climate” models that can maintain their full heating capacity down to -15C, and can still operate effectively down to -25C.[13] Cold-climate performance is no longer confined to expensive high-end units either. There are increasing numbers of “mid-range” cold-climate models available whose costs are not far above that of non-cold climate units.[14] When combined with existing rebates, these units can even be cheaper than single-speed alternatives.

For a more in-depth guide to heat pump operation and terminology, ENERGY STAR Canada has a helpful guide to heating and cooling with heat pumps.[15]

Cooling Homes in a Warming Climate

Avoiding further emissions is especially crucial because historical emissions have already locked Canada into substantial warming, exacerbating extreme heat risks. Even if future emissions growth is low, we are already likely to see heat-related hospitalizations increase 21% by 2050 and more than double by 2100.[16] Warming will also drive increased risk of wildfires, especially in the Prairies.[17] This year Canada is already experiencing its worst wildfire season in recorded history.[18]

The natural response to a warming climate is to invest in space cooling, and Canadians are buying more central air conditioners every year. But these don’t do anything to reduce emissions, since they only increase energy consumption.

13 https://carbonswitch.com/best-cold-climate-heat-pump/.

14 See these testimonials from customers of the Toronto and Region Conservation Authority, who installed mid-range cold climate units for less than C$5,000: https://www.youtube.com/watch?v=MMO0WvBz7aI and https://www.youtube.com/watch?v=v8_mQo8N1q8. See also https://taf.ca/hybrid-heat-pumps-can-be-a-stopgap-to-an-electric-future/.

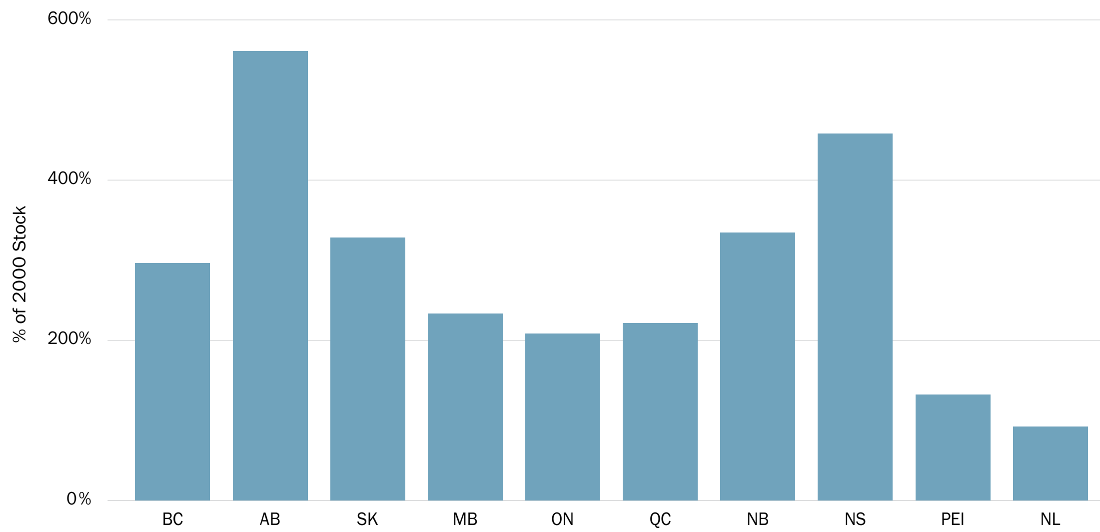
15 https://natural-resources.canada.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817.

16 Canadian Institute for Climate Choices (2021).

17 Wang et al. (2015).

18 https://www.theglobeandmail.com/canada/article-quebec-wildfire-smoke-causes-widespread-smog-warnings-grounds-some/.

***Figure 1:** Central Air Conditioner Stock in 2020, Relative to 2000 (%)*[19]



Using heat pumps instead of air conditioners, however, would make the net effect on climate change strongly positive. This is because, while heat pumps have the same ability to cool as air conditioners, they also significantly reduce energy and emissions from heating.[20] Canada gets more than two-thirds of its electricity from emissions-free sources: heat pumps allow that electricity to power home heat as well.[21] Of course, not all power in Canada is emissions-free. But heat pumps' efficiency can still cut emissions even when powered by electricity derived from fossil fuels.[22] And as the emissions intensity of the grid continues to improve, heat pumps will make the most of the resulting clean energy.

Over the course of a year, a single-stage heat pump that meets the current minimum efficiency standards will, on average, produce 220% more heat energy than it consumes in electricity.[23] A variable-speed cold-climate unit can run at 400% efficiency or more.[24] The maximum efficiency of electric resistance, the next-most-efficient heating source, is 100%. Fossil fuel furnaces, on the other hand, can never generate more heat energy than they consume in fuel energy: existing methane gas, oil, and propane furnaces are generally between 80–90% efficient; new gas and propane furnaces are 95% efficient.[25] Because heat pumps leverage the energy that goes into them so effectively, generating electricity with methane gas (for example) and then powering a heat pump can be more efficient than burning that gas for heat would be.[26]

19 NRCan (2022).

20 The energy consumption needed for a given level of cooling will be the same for a heat pump and a comparable air conditioner. The primary reason a heat pump is still a net positive for the climate is its super-efficient heating ability.

21 CER (2022).

22 See our modelling results on p. 17 for projected emissions savings.

23 HSPF2 of 7.5 means 220% efficiency, or a "coefficient of performance" of 2.2. See Malinowski et al. 2022.

24 It seems impossible that heat pumps could create heat from cold air. Though this effect is counterintuitive, anyone can experience it themselves by putting their hands behind a freestanding refrigerator, which works on a similar principle. The air at the back of a fridge is warm because the fridge is gathering the heat energy from the air inside and transferring it to the air outside the fridge. A heat pump is just doing the same thing, except drawing heat from outside the home instead of inside the fridge.

25 NRCan housing archetype data suggest an average efficiency of 84% for methane gas, 82% for oil, and 87% for propane. See also Malinowski et al. 2022.

26 Knobloch et al. (2020) analyze lifecycle emissions of heat pump and fossil boilers, and found that heat pumps had lower emissions as long as the grid's intensity is below 1,000 g of CO_2 equivalent per kWh, which "roughly corresponds to the emissions intensity of older coal power plants". In Canada, even provinces that continue to rely on coal power already have electricity generation intensities below this level (540 in Alberta, 730 in Saskatchewan, and 690 in Nova Scotia); see ECCC (2023a).

Pairing a heat pump with an existing system in a hybrid configuration can help build a foundation for long-term electrification by increasing familiarity with heat pumps among both consumers and contractors.

Depending on the local climate, the quality of the building insulation and air sealing, and the capabilities of the unit, a heat pump may meet all of a home's heating load. Some Canadians will be able to meet all their heating needs with a heat pump, especially in warmer areas.[27] In other areas, households can combine a heat pump with an existing heat source in a "hybrid" configuration. Heat pump efficiency declines as temperatures drop, so as it gets colder systems can shift to using another heat source as backup. This could be electric or a fossil fuel backup like methane gas or propane.

In the long run, Canada must fully decarbonize home heating to achieve net zero emissions. But the emissions reduction benefits of installing heat pumps instead of air conditioners are not dependent on every Canadian home choosing to go electric all at once. In addition to immediate emissions benefits from reducing reliance on fossil fuels, pairing a heat pump with an existing system in a hybrid configuration can help build a foundation for long-term electrification by increasing familiarity with heat pumps among both consumers and contractors. Even if a household gets a hybrid system today, a good experience with heat pumps will make it easier to fully electrify at the time of next replacement.[28]

27 Though some insurers may require a backup heat source even if a heat pump is capable of meeting a home's whole heating load.
28 Pantano et al. (2021).

Understanding Barriers to Heat Pump Deployment

Six million Canadian homes have a central air conditioner, but only 800,000 homes have a ducted heat pump.[29] **Canadians bought 36,000 new ducted heat pumps in 2022, but they also bought 10 times as many central air conditioners**.[30] Given all the benefits of heat pumps, why are central air conditioners outselling them? Heat pumps have faced at least five major barriers to adoption:

1. lower familiarity,
2. infrequent purchasing,
3. short replacement timeframes,
4. limited stock availability, and
5. higher upfront cost.

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The first problem is **low familiarity among consumers and contractors**. The term "heat pumps" suggests devices that can only heat, so consumers looking for cooling can easily overlook them. Past experience can also be a barrier: a few decades ago, heat pumps did not perform as well in cold temperatures. Performance has improved dramatically, and in the last decade both regular and cold-climate models have become well-suited for climates across Canada. But consumers and contractors who first used heat pumps decades ago sometimes retain the idea that they don't perform well in cold climates. Consumers may also not realize that a heat pump can use an existing heat source as backup.

Second, opportunities for consumers to learn about heat pumps are further constrained by the fact that **for individual households, HVAC replacement is an infrequent event**. Central air conditioners have an average lifespan of 12–17 years, and NRCan recommends that households start looking into replacements after 10 years.[31] Barring early failure, this is not a decision most families need to make very often. And compared with buying a car, where advertising for new models is omnipresent, HVAC tends not to be "top-of-mind". That makes consumers even more dependent on their contractors to guide them. A household that misses out on getting a heat pump today is unlikely to get another chance to buy for at least 12–17 years.

Unfamiliarity and lock-in are exacerbated by a third problem: **consumers often have very little time to make HVAC purchasing decisions**. Many HVAC purchases happen when the old units fail. Because failure is more common when temperatures are extreme, replacement often means emergency replacement. A family whose air conditioner has broken down in the middle of a heat wave is unlikely to have the luxury of extensively researching new cooling options, and is more likely to accept whatever their contractor recommends. Contractors facing a surge of failures during the same weather event have limited time to educate each consumer about new technology options or government incentive programs.

29 NRCan (2022), Canada, Tables 27 and 33.

30 Data from HRAI.

31 Schwartz (2020) and NRCan (2023d).

Fourth, **consumers may not always be able to find the right heat pump in stock**. HVAC units are not one-size-fits-all. Size and specifications need to be calibrated to each home's needs. Because central air conditioners currently outsell heat pumps, distributors are less likely to have the exact model of heat pump required in stock. Even a consumer who knows they want a heat pump, and who has a contractor happy to install one, may not be able to find the unit they need in stock with the local distributor. And because of the emergency replacement issue, consumers often do not have time to wait for the right heat pump to arrive.[32]

Finally, **heat pumps tend to be more expensive to have installed**. For a regular model, the cost difference for a manufacturer is only a few hundred dollars in parts, like the reversing valve that lets the machine change the direction of flow for the heat it pumps. But at each stage in the supply chain, this small initial cost difference gets magnified. So a few hundred dollars in manufacturing costs can become a C$1,000–C$2,000 difference for a consumer buying a regular heat pump. The cost difference can be C$5,000 or more for a top-of-the-line cold-climate model.[33]

Of course, for that initial difference in cost, consumers get a "2-in-1" machine that both heats and cools. Because of heat pumps' efficiency, the lifetime cost of owning a heat pump for many households is the same or even lower than alternative heating methods.[34] But not all households are able to wait for the lower bills to make up the difference. In some cases rebates and incentives can actually make heat pumps as cheap or even cheaper than a comparable central air conditioner. But navigating incentive programs takes time as well, which can be hard when making an emergency purchase.[35] And the upfront cost still creates sticker shock, placing heat pumps at a disadvantage.[36]

None of these barriers is insurmountable. Canadians' adoption of heat pumps is already growing. Between 2018 and 2022, ducted heat pump sales increased by 18%.[37] But even with increasing sales, Canadian households are not on track to electrify their space heating by 2100, let alone 2050.[38] Taken together, the barriers discussed here create friction that slows down home heating electrification just when it needs to be accelerating.

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32 Successful incentive programs can exacerbate this problem: Ontario's Home Efficiency Rebate Plus program caused a spike in demand for heat pumps, beyond what distributors had anticipated, leaving many people unable to find an eligible heat pump.

33 Replacing a basic, single-stage central air conditioner system currently costs between C$4,000 and C$7,500 on average. Replacing a central air conditioner with a comparable single-stage 3-tonne heat pump, large enough to heat a 1,500 square foot home, costs between C$5,500 and C$8,000. A cold-climate heat pump of the same size costs between C$11,500 and C$14,500 on the lower end, or potentially more than C$20,000 for higher-rated equipment. See https://www.furnaceprices.ca/air-conditioners/central-air-conditioner-prices-canada/ and https://www.furnaceprices.ca/heat-pumps/heat-pump-prices/. Note that these prices are just averages and particular models may be priced differently, and that these costs include installation as well as equipment.

34 Ferguson et al. (2022) find substantial annual savings in Halifax (C$195–229), Montreal (C$459-462), Quebec City (C$509–521), Fredericton (C$640–651) using a cold-climate air-source heat pump, paired either with electric resistance or a gas backup. Regina, London, Toronto, and Ottawa would all see savings around C$100 a year with a CCASHP and a gas backup.

35 Incentives that require a lengthy auditing process are difficult for households making emergency replacements. And incentives targeted towards only the most efficient units leave out the majority of the market.

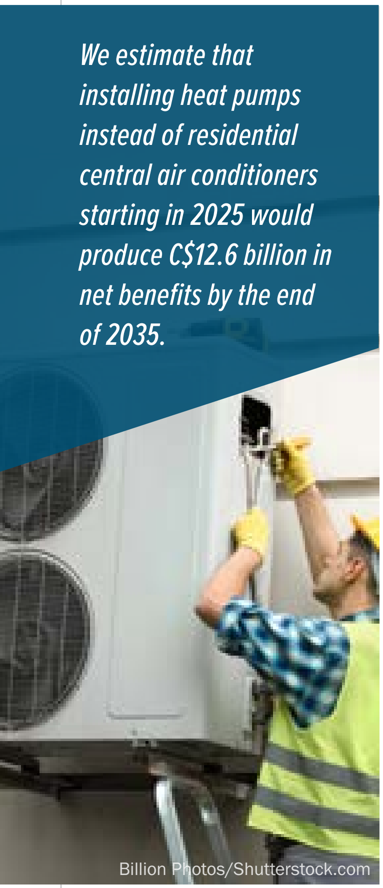
36 There are incentive programs that can bring the cost of a heat pump down substantially. Recognizing the benefits of heat pumps, the federal and provincial governments have recently instituted incentive programs that substantially reduce their cost. As part of the Canada Greener Homes Initiative, Canadians can get grants between C$2,500 and C$5,000 for heat pump installation (see NRCan 2023b) and up to C$10,000 for families below the median income who are switching from oil heating (see NRCan 2023c). New Brunswick, Nova Scotia, and Prince Edward Island all have no-cost heat pump installation programs for low-income households. Unfortunately these incentives are not always straightforward to secure, introducing new steps into the buying process. And "sticker shock" can still turn off consumers at an early stage, or result in purchase of a one-way AC during an emergency replacement situation.

37 Data from HRAI.

38 Haley and Torrie (2021).

What If Every New Central Air Conditioner Were a Heat Pump Instead?

We estimate that installing heat pumps instead of residential central air conditioners starting in 2025 would produce C$12.6 billion in net benefits by the end of 2035.



Billion Photos/Shutterstock.com

While these barriers have hindered deployment of heat pumps, central air conditioners continue to proliferate. Canadians install ten times more central air conditioners than heat pumps each year, and the gap is growing despite a range of heat pump promotion policies focused on incentivizing consumer adoption.[39] Because of heat pumps' advantages, Canadians would be better off if every one of those new central air conditioners had been a heat pump instead. So what if Canada adopted a *market transformation strategy* to accomplish just that?

As discussed in the introduction, ducted air conditioners and heat pumps are nearly identical machines. **Because of the technological similarity between heat pumps and central air conditioners, Canada could speed up deployment of the former by phasing out the latter**.

Transforming the market in this way would help address all five barriers to heat pump deployment. Making heat pumps the default option bypasses the first four barriers of low familiarity, infrequent purchasing, short replacement windows, and limited stock availability. And expanding the supply of heat pumps should bring down upfront prices, especially if government or utility incentives reduce the cost differential.[40]

Impact on Energy Bills and Emissions

We estimate that installing heat pumps instead of residential central air conditioners starting in 2025 would produce C$12.6 billion in net benefits by the end of 2035. This change would add 5.4 million new heat pumps to Canadian homes. Even accounting for the higher price of heat pumps, **the present value of the benefits would be more than four times larger than the costs.**[41]

Table 1: *Effects of Installing Heat Pumps Instead of Central Air Conditioners, 2025-2035*

Additional Heat Pumps Installed	5.4 million
Energy Bill Reductions	C$10.4 billion
Additional Capital Costs	–C$3.7 billion
Net Present Value of Energy Bill Benefits	**C$6.7 billion**
Greenhouse Gas Reductions	19.6 million tonnes CO_2e
Monetized Climate Benefits	C$5.9 billion
Net Present Value of Energy Bill + Emissions Benefits	**C$12.6 billion**

39 Central air conditioner sales grew by 32% between 2018 and 2022, while heat pump sales grew by 18% (data from HRAI).

40 Our modelling does not assume, however, that capital costs decrease in response to installing heat pumps instead of central air conditioners.

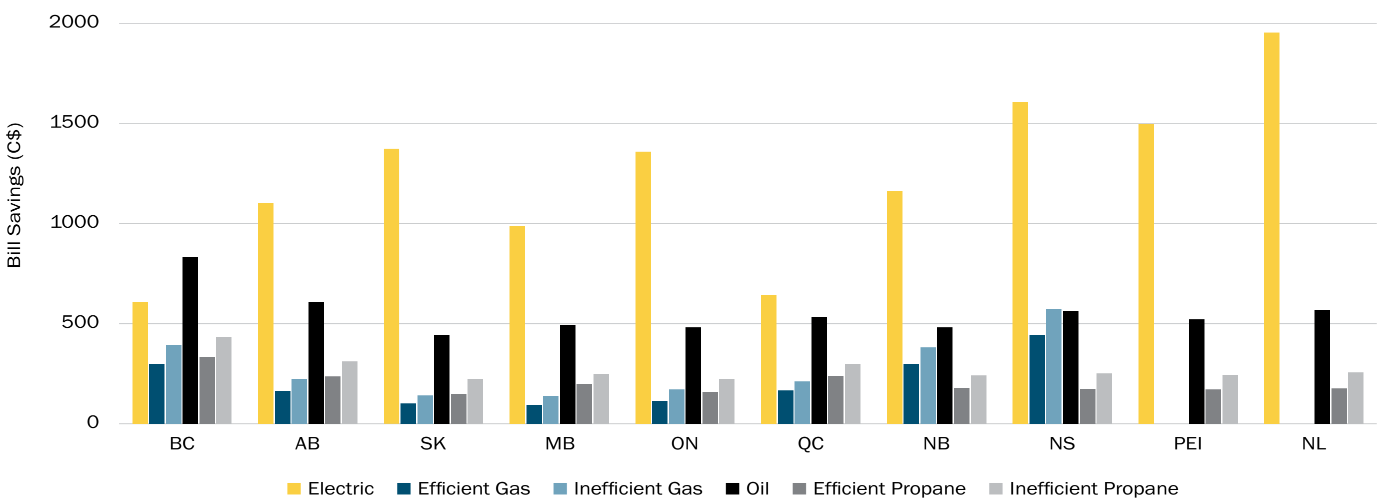
41 We focus on these medium-term benefits because after 2035 new technology and additional policies are likely to be in place, and it is more difficult to assess what "business-as-usual" deployment and energy prices would be. But if we extended our current modelling approach to 2050, the net present value of benefits would grow even faster, producing a benefit-cost ratio of more than 12x.

The estimates are derived from a province-level model that we built to understand the impact of installing heat pumps instead of central air conditioners.[42] The model combines historical data on central air conditioner stocks and sales with projections of future housing growth to estimate how many central air conditioners would be sold in each province in a business-as-usual scenario.[43] We assume that starting in 2025, every new residential unit that would have been a central air conditioner now becomes a heat pump instead. We model the performance of heat pumps in each province, making conservative assumptions about the kind of equipment households would install.[44] We assume that households would continue to use their existing primary heating system as a backup, and we calculate how much energy of different types (electricity, gas, oil, and propane) each home would use. We then use projections of provincial energy prices and grid emissions intensities to calculate how household energy bills and carbon emissions would change.

These benefits accrue to Canadians in every province.[45] Because provinces have different mixes of backup heating systems, energy prices, and electric generation emissions intensities, the precise bill and greenhouse gas reductions vary. **But our modelling suggests that the policy would have positive effects in all of them, regardless of whether households use electric resistance, gas, oil, or propane as their backup.**[46]

Because households can combine heat pumps with other backup energy sources, people would have a choice of heating sources instead of being stuck with one furnace. They can use the heat pump when it is most economical to do so. For some households, bills would remain similar; for others, bills would go down. **We estimate that replacing the entire supply of new central air conditioners with heat pumps will mean bill savings of C$10.4 billion across Canada, an average of C$349 per affected household in 2030**.

Figure 2: *Average Annual Bill Savings per Household in 2030 (C$)*



42 See the Appendix for more details on the modelling strategy.

43 We do not assume any increase in central air conditioner sales in response to increasing climate change. This is a conservative assumption: in reality air conditioner sales are likely to accelerate in a business-as-usual scenario, increasing the benefits of our suggested intervention.

44 We conservatively assume a single-stage heat pump with a 14.3 SEER2 and a HSPF2 of 7.5 that switches to an existing furnace at 5C when paired with fossil fuel backups, and maximizes heat pump use when paired with electric resistance backups.

45 We did not model heat pump deployment in Canada's territories, since central air conditioning is uncommon in far Northern regions.

46 See the Appendix for more detailed model results.

Phasing out central air conditioners and replacing the supply with heat pumps would produce significant emissions reductions because in addition to providing cooling, a heat pump will either replace or reduce the consumption of fossil fuels for home heating.

Richard Cavalleri/Shutterstock.com

The households that see the largest financial benefits are those using energy sources that are already comparatively expensive, especially electric resistance or oil. These households could earn back the added cost of buying a heat pump within 1–2 years, and see net savings after that. Households using propane as a backup could earn back the added cost of the heat pump within 2–6 years. Households that are using average-efficiency gas furnaces could earn back the cost of the heat pump within 3–9 years, and households using new high-efficiency gas furnaces could earn back the cost within 3–12 years. This assumes that governments do not offer any extra incentives to households to buy heat pumps, and that the increased scale of heat pump deployment doesn't bring down costs. If either of these things happens, we would expect households to break even earlier.

Phasing out central air conditioners and replacing the supply with heat pumps would also produce significant emissions reductions. That's because in addition to providing cooling, a heat pump will either replace or reduce the consumption of fossil fuels for home heating. The precise amount of emissions reductions per household depends on the efficiency of the individual heat pump and the building envelope, the carbon intensity of the backup heat source and the electrical grid, and the local climate. **We estimate that the shift from fossil fuels to an increasingly clean electricity grid would cut carbon emissions by 19.6 million tonnes of CO_2-equivalents from 2025–2035**.

In 2035, this program alone would result in a 9.1% reduction from current residential space heating emissions, or 2.7% of *all current building emissions*.[47] **Applying the social cost of carbon to these emissions reductions means C$5.9 billion in additional long-term benefits.**[48]

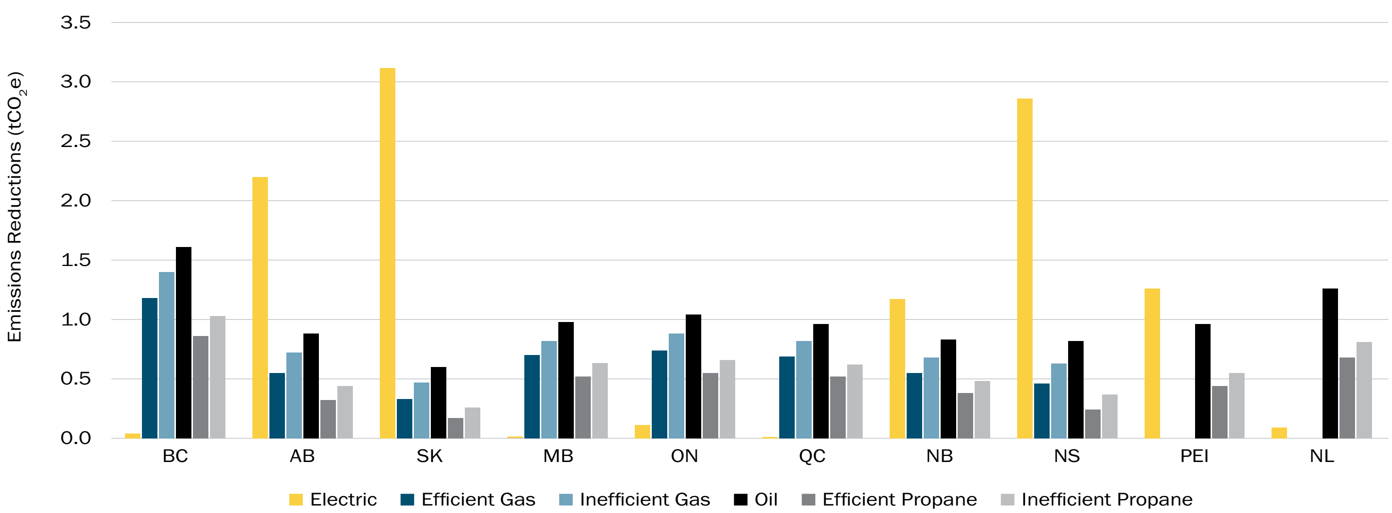
47 Our modelling projects total annual emissions reductions of 3.373 million tonnes CO_2e in 2035. In the most recent year available, the Comprehensive Energy Use Database reports space heating emissions of 36.8 million tonnes of CO_2e, including those associated with the production of electricity (NRCan 2022). Dividing 3.373 by 36.8 gives 9.1%. According to NRCan, total building emissions (with electricity included) are responsible for around 122 million tonnes of CO_2e: dividing by this figure gives 2.7%. See https://natural-resources.canada.ca/public-consultations-and-engagements/the-canada-green-buildings-strategy/25009.

48 ECCC (2023b).

Homes using electrical resistance will see the largest emissions reductions in provinces where the grid is emissions-intense, like Alberta, Saskatchewan, and Nova Scotia (2.2–3.1 tCO_2e/year by 2030). New Brunswick and Prince Edward Island will also see healthy emissions reductions for electric backup homes (1.2–1.3 tCO_2e/year by 2030). That's because even though electric resistance and heat pumps both use electricity, heat pumps do so much more efficiently.[49] For homes using fossil fuel backup, savings will depend on both grid emissions intensity and the price of fossil fuels. By 2030, we expect savings of 0.2–1.0 tCO_2e/year for propane backup, 0.3–1.4 tCO_2e/year for gas backup, and 0.6–1.6 for oil backup.

Note that these benefits are based on homes receiving basic single-speed units rather than more efficient and effective variable-speed units. Many homes will likely opt for these higher performance models, especially if government incentives encourage their uptake. In that case the emissions reductions are likely to be even larger.

Figure 3: *Average Annual GHG Savings per Household in 2030 (tCO_2e)*



Market transformation would have a particular benefit for Canadians who rent, and who therefore do not control their own HVAC equipment. Every renter whose landlord would have previously bought a central air conditioner would get a heat pump instead. This would increase equity in heat pump deployment, since low-income Canadians are more likely to rent. And since low-income Canadians are more likely to suffer from energy poverty and be more vulnerable during extreme weather events, there is extra value in helping them obtain heat pumps. *See "Environmental Justice"*.

49 Provinces where all electricity is generated by clean sources will see no emissions difference between electric resistance and heat pumps, though there will still be a financial savings.

Environmental Justice

Home decarbonization is out of reach for many equity-deserving populations. Depending on the definition, between 6% and 19% of Canadian households are living in energy poverty.[50] Energy poverty is especially common among people living in older homes, people whose homes require major repairs, and people who rent their homes. Older households and ones that include a person with a long-term illness or disability are also significantly more likely to live in energy poverty, as are households that contain one person living alone.

At the same time, poorer and older Canadians are more likely to be vulnerable to climate change-driven weather extremes. More than three-quarters of those who died in the 2021 heat dome in British Columbia were 65 or older.[51] Poverty doubled the risk of death.[52] People who lived alone or suffered from an illness or disability were also at greater risk. Access to reliable space heating and cooling is especially important for these vulnerable populations.

Many Canadians who rent do not control their building's HVAC equipment choices. If a landlord does not pay the utility bills, then there is little financial incentive for them to choose to buy a heat pump rather than a central air conditioner, because they do not profit from the reductions in heating costs. Landlords purchasing heating equipment but neglecting cooling leads to vulnerability during extreme heat events, leading tenant rights organizations to call for maximum temperature standards and a right to active cooling.[53]

Programs in Canada that offer free heat pumps to income-qualified consumers are available in PEI, Nova Scotia, New Brunswick, and federally for the limited number of Canadians that heat with fuel oil.[54] By providing heat pumps, these programs are also providing access to cooling services for low-income Canadians. Yet, Canada still lacks a national solution for all low-to-moderate income Canadians to access energy efficiency services.[55] Such a program could use heat pumps to reduce GHGs and provide cooling services, coupled with building envelope and non-energy upgrade measures required to make sure bills are reduced, health is improved, and that those heat pumps work effectively.

In addition to customer-focused programs for low-to-moderate income Canadians, upstream strategies that impact the supply chain can also have an environmental justice lens. This could include ensuring a wider suite of heat pump options are available when low-to-moderate income Canadians need to make an emergency air conditioner purchase. Strategies to ensure low-to-moderate income Canadians are not saddled with a one-way air conditioner can include online product markets with greater appliance choices, vouchers, and microfinance options that prevent the use of predatory lenders.

50 Riva et al. (2021).

51 HRW (2021).

52 https://www.theenergymix.com/2023/07/02/poverty-doubled-the-odds-of-dying-in-b-c-heat-dome-provincial-study-shows/.

53 https://www.efficiencycanada.org/tenant-report/.

54 https://www.princeedwardisland.ca/en/service/free-heat-pump-program; https://novascotia.ca/news/release/?id=20221213002; https://www.saveenergynb.ca/en/for-home/enhanced-energy-savings-program/; https://natural-resources.canada.ca/energy-efficiency/homes/canada-greener-homes-initiative/oil-heat-pump-affordability-program-part-the-canada-greener-homes-initiative/24775.

55 https://www.efficiencycanada.org/low-income-energy-efficiency/.

Impact Across the Supply Chain

The technological similarity between central air conditioners and heat pumps would minimize economic disruption and create benefits across the entire supply chain.

All major **manufacturers of HVAC equipment** make both central air conditioners and heat pumps. There is no major technical barrier to switching production lines, and the cost difference is small.[56] There is little reason for manufacturers to resist switching from central air conditioners to heat pumps, as long as they are assured that consumer demand will switch as well. But if the whole industry shifts at the same time, then there wouldn't be a demand question. Manufacturers can also count the reduced heating emissions towards their Scope 3 climate goals.[57]

For **distributors of HVAC equipment**, it is common to carry both central air conditioners and heat pumps. There is little difference in the practice of selling them. But carrying many different kinds of products makes inventory management more difficult, increasing costs and reducing the chance that the right heat pump for a given household is available locally. By reducing the number of one-way air conditioning products distributors need to carry, distributors could optimize their inventory more easily and carry a wider selection of heat pumps.[58] Large distributors also have their own Scope 3 climate goals that this change would help them meet.[59]

For **HVAC contractors**, market transformation would offer a clear signal about the future of their business. Selling and installing heat pumps is not vastly different from selling and installing central air conditioners. But the change does require additional training, and contractors need to prepare to help consumers navigate incentive programs and use their new HVAC systems. As long as sales of central air conditioners outpace those of comparable heat pumps, contractors have less incentive to commit to selling heat pumps. A market transformation strategy would provide a clear incentive to build familiarity with heat pumps, and certainty that investing in appropriate training and sales processes is worthwhile.

Many of these benefits would accrue from transforming the supply chain upstream, rather than relying on downstream incentives focused on individual consumers and contractors. Manufacturers can be confident about demand, distributors can rationalize their inventory, contractors can adapt their training: all because they know how the whole market is moving.

56 Pantano et al. (2021) and U.S. Department of Energy (2016).

57 It is common for HVAC manufacturers to set Scope 3 emissions reduction targets that take into account greenhouse gasses emitted by the products they sell. For example, Carrier has set a goal of reducing emissions from its products by 1 gigaton by 2030 (Carrier 2023). Mitsubishi (2022) has a Scope 3 emissions reduction goal, as does Lennox (2023), which is targeting a 14% reduction in Scope 3 emissions per product sold by 30% by 2034.

58 This process is also known as "SKU Rationalization."

59 See, for example, one major distributor's claim that "Watsco's Sales of High Efficiency Equipment from January 1, 2020 - December 31st, 2022 has Reduced Future CO_2e Emissions by 17.1 Million Metric Tonnes" (Watsco 2023).

Menu of Implementation Routes

There are multiple policy routes available to substitute heat pumps for new central air conditioners. Above, we described the benefits of working upstream to transform the supply chain by making two-way heat pumps the norm. Below, we present policy avenues that could help capture this opportunity.

Equipment Regulation

The most straightforward way to transform the market would be a national mandate that all central air conditioners sold in Canada also have heating capabilities. This would start to deliver on the Federal Government's 2030 Emission Reduction Plan's mandate to "develop regulatory, standards, and an incentive framework to support the transition off fossil-fuels for heating systems" as part of a Canada Green Building Strategy.[60] This approach would be consistent with the emphasis on "mandating change" and electric heat pumps as "the right solution" for most buildings in Canada.[61]

Installing heat pumps instead of central air conditioners could be the first step along a path towards full heating decarbonization. In general, **regulations should take advantage of easy opportunities in the short term while also building momentum towards more transformative change**. Installing heat pumps instead of central air conditioners is an excellent candidate for early action because it does not require changes to existing heating systems (except using them less), and it can be implemented at the point of sale. This would immediately begin reducing emissions, while further regulatory actions address thornier issues around the timing of heating replacement, the choice of backup systems, and whole building performance.[62]

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60 https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030/sector-overview.html.

61 https://natural-resources.canada.ca/sites/nrcan/files/engagements/green-building-strategy/CGBS%20Discussion%20Paper%20-%20EN.pdf, p. 13.

62 For discussion see https://policyoptions.irpp.org/magazines/june-2023/heating-cooling-solutions/.

There is precedent for Canada to require higher performance HVAC systems than other countries given the importance of heating in Canada's climate. For example, Amendment 15 to the Energy Efficiency Act in 2019 went above American standards to require higher efficiency gas furnaces, based on Energy Star performance levels.[63]

Federal policymakers should explore implementing such a mandate through the Energy Efficiency Act. This could be accomplished by defining air conditioning equipment as also requiring the ability to provide heating services at a certain level of Heating Seasonal Performance Factor (HSPF2) energy efficiency. Such a definition makes sense within Canada's geography, where heating services are a basic requirement.

Natural Resources Canada, consistent with the U.S. Environmental Protection Agency, has recently signaled an intention to sunset Energy Star certification for residential central air conditioners by December 2024, with no new certifications accepted after December 2023.[64] This would effectively make heat pumps the only Energy Star certified residential cooling technology. The federal government could require that any cooling technology sold must meet this Energy Star standard, as was previously done for gas furnaces.

Provinces also have the authority to enact equipment regulation to require heating capabilities for central air conditioners. British Columbia, Ontario, Quebec, New Brunswick, and Nova Scotia already have standards for central air conditioners.[65]

Building Codes and Building Performance Standards

Local governments, provinces, and territories have their own performance standards and building codes they can use to encourage market transformation. Vancouver has already implemented such a policy: starting in 2023 "new air conditioning systems in detached 1–2 dwelling homes must be able to provide both low carbon heating and cooling (electric heat pumps)."[66] This covers all "permanently installed" air conditioners. Such a policy effectively requires all new central air conditioners to be heat pumps.[67] *See "The Vancouver Experience"*.

In addition, the federal Ministers of Natural Resources and Science, Innovation and Industry have a mandate to develop a model "retrofit code" triggered when alterations occur to existing buildings.[68] This model code could require the installation of heat pumps instead of new central air conditioners.[69]

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63 https://canadagazette.gc.ca/rp-pr/p2/2019/2019-06-12/html/sor-dors164-eng.html.

64 https://www.energystar.gov/sites/default/files/asset/document/HVAC%20Sunset%20Letter.pdf.

65 https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/energy-efficiency-regulations-province/20986.

66 https://vancouver.ca/home-property-development/mechanical-permit.aspx. British Columbia has also announced that space heating will need to be 100% efficient by 2030, which in practice means new heating systems must be heat pumps or electric resistance.

67 Denver, Colorado has passed a similar policy requiring commercial and multi-family buildings to replace central air conditioners with heat pumps after 2025. See https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/High-Performance-Buildings-and-Homes/Energize-Denver-Electrification-Program.

68 https://www.pm.gc.ca/en/mandate-letters/2021/12/16/minister-natural-resources-mandate-letter.

69 One caveat here is that replacing or installing a central air conditioner in many cities does not require a building permit, and therefore may not trigger retrofit building codes on its own. Governments would need to make sure that central air conditioner installation or replacement triggers the appropriate code.

The Vancouver Experience

Vancouver's requirement that households install heat pumps instead of air conditioners not only illustrates the value of local building codes, but also serves as a helpful test case for a similar national program.

According to Chris Higgins, Senior Green Building Planner at City of Vancouver, "the transition has been smooth." Calling it a "no-regrets move", he said that "moving to a regulation that only allows heat pumps is one of the easiest things a regulator can do to rapidly improve the market for heat pumps and work to address climate change."[70]

Distributors were given seven-and-a-half months to transition, which allowed them to turn over their existing stock of central air conditioners. Only a few years ago, it was reportedly difficult for consumers in Vancouver to find a contractor interested in installing a heat pump. But following the introduction of the program, all local contractors are now able to do so. Higgins also reported that though the program does not impose any performance requirements, demand has shifted from single-stage equipment to variable-speed or five-speed models. If replicated nationally, this consumer demand for higher-performance equipment would mean even better savings and emissions reductions than we currently project.

Upstream Incentives

Regulations are the most straightforward way to transform the market. But federal or provincial governments could also use upstream incentives, either alongside regulation or as an alternative pathway, to encourage the shift from central air conditioners to heat pumps. Manufacturers or distributors could be paid an incentive for every heat pump they sell above a baseline, provided they transition away from selling central air conditioners. Since Canada imports most of its heat pumps, it may be best to target such an incentive at distributors rather than manufacturers.

As discussed above, the cost differential for manufacturers and distributors would be relatively small. Based on typical equipment costs and previous studies, an incentive of C$250–400 would more than cover additional costs to manufacturers, and a subsidy of C$550–650 would do the same for distributors.[71] This subsidy could decline over time to keep costs low and encourage firms to participate early. Though requiring more government funding than a stand-alone regulatory approach, the initial costs would be much smaller than the long-term benefits to consumers and the climate. The U.S. Senate is currently considering its own incentive program along these lines.[72]

70 Personal communication with authors.

71 These estimated costs are derived from a supply chain analysis in Pantano et al. 2021, based on U.S. Department of Energy (2016) data on manufacturing cost differences and interviews with HVAC manufacturers and distributors.

72 https://www.congress.gov/bill/117th-congress/senate-bill/4139.

Complementary Policies

Installing heat pumps instead of residential central air conditioners is a clear "no regrets" policy. But it doesn't address every issue. Complementary policies could help get heat pumps into large commercial and multi-unit residential buildings, speed up the development of new window unit technology, encourage uptake of more efficient and effective heat pump models, and support contractor training.

Larger commercial and multi-unit residential buildings can also benefit from heat pumps, but they have more complex HVAC systems that make point-of-sale strategies harder to implement. One option is to require large buildings owners to meet minimum performance standards for things like energy use, emissions intensity, indoor environmental quality, and protection against extreme heat and cold, which would indirectly encourage heat pump adoption.[73] Another is to mandate directly that large commercial and multi-unit building owners buy heat pumps when they replace their central air conditioners, as Denver, Colorado will require starting in 2025.[74]

Many households will continue to rely on window air conditioners, but heat pump replacement options for window units remain limited. Governments and utilities can help encourage alternatives like ductless heat pumps and technological substitutes for window units. For instance, New York's "Clean Heat for All Challenge" was an industry competition for manufacturers to develop heating and cooling technologies for multi-family buildings, with the winners awarded an initial purchase contract for installation in public housing. Both winners delivered cold-climate heat pump window units, an exciting new technological option for renters.[75]

Our proposal would make sure households got more heat pumps, but it wouldn't guarantee they were the most efficient models available. Energy efficiency programs, whether run by governments or utilities, could help. Instead of focusing primarily on consumer choices, such programs can offer upstream and midstream incentives to promote variable-speed heat pumps among manufacturers, distributors, and contractors.[76] Vouchers and micro-finance solutions can also help lower-income consumers afford heat pump purchase and installation costs during emergency replacement periods. Any help with comprehensive retrofits should combine envelope upgrades with heat pumps wherever possible.

In some jurisdictions, heat pump promotion is difficult because electric and gas utilities run separate efficiency programs which focus on reducing consumption within each "fuel silo". These jurisdictions should consider minimum energy savings requirements regardless of fuel,[77] and electric and gas utilities should create joint programs to encourage fuel switching.[78] For example, the Ontario Energy Board required its major gas utility Enbridge to offer incentives for electric heat pumps, regardless of whether customers installed a hybrid gas-electric system or were exiting the gas system entirely.

Finally, Canada is facing a deficit of workers in skilled trades, including HVAC installation and repair.[79] Governments can do more to support training more HVAC contractors to ensure households can get heat pumps installed quickly and properly, especially through well-funded vocational education.

73 For discussion in Canada, see https://www.efficiencycanada.org/making-the-case-why-we-need-mandatory-building-performance-standards-in-canada/. For a discussion on integrating indoor environmental quality with building performance standards, see https://www.euractiv.com/section/energy-environment/opinion/fit-for-55-with-healthy-buildings/. For more on the implications for tenant rights, see https://www.efficiencycanada.org/tenant-report/.

74 https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/High-Performance-Buildings-and-Homes/Energize-Denver-Electrification-Program.

75 https://nychanow.nyc/70-million-initial-investment-will-decarbonize-nycha-buildings-with-new-heat-pump-electrification-technologies/.

76 2019 review finding that heat pumps were the most popular technology for midstream and upstream incentive strategies: https://www.esource.com/429191azeh/sending-your-dsm-measures-upstream.

77 Gold, Gilleo, and Berg (2019).

78 Quebec offers an example of this joint approach in action: https://climateinstitute.ca/publications/hybrid-heat-in-quebec.

79 https://thoughtleadership.rbc.com/powering-up-preparing-canadas-skilled-trades-for-a-post-pandemic-economy/.

Conclusion

Without these specific interventions, heat pump sales would probably overtake central air conditioner sales eventually, perhaps within a few decades. But in the meantime, millions more homes would install a one-way air conditioner and get locked out of the opportunity to get a two-way heat pump instead. Each time that happens, the goal of residential decarbonization slips further out of reach. It's time to take a better path.

Installing heat pumps instead of central air conditioners is a rare "win-win" opportunity. Technological development over the last few decades means that for only a nominal increase in production costs, we could be decarbonizing millions more Canadian homes over the next decade. Across the value chain, from manufacturers to distributors to contractors to consumers, everyone has something to gain. It's time for governments at all levels to make a clear commitment to this transformation.

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Appendix

Modelling Strategy

Our province-level model assumes that, starting in 2025, units that would have been newly sold central air conditioners become comparable ducted heat pumps instead. To estimate future central air conditioner sales in the business-as-usual case, we start with annual data on the number of central air conditioners in each province, which we obtain from the Comprehensive Energy Use Database (CEUD).[80] We calculate the historical year-on-year growth in the share of provincial dwellings that have central air conditioners. We then assume that future growth is equal to the average growth rate from 2010–2020 (the last year for which CEUD data are available). We then scale provincial sales of central air conditioners in 2020 by the projected number of central air conditioners present in each province in each year.[81] This procedure gives us a projected number of central air conditioners sold annually by province from 2021–2050. This estimate is likely to be conservative, since demand for active cooling is likely to increase above historical levels as climate change intensifies.

We assume that everyone keeps their backup heat source, even though in some locations a heat pump of this size could potentially meet all a home's heating load on its own, depending on the local climate, home size, and the efficiency of the building envelope. We assume that a heat pump paired with fossil fuel backup is only operated down to 5C, even if it could be operated below this temperature, to account for the most cautious installers. We assume that heat pumps paired with electric resistance heat are set up to maximize use of the heat pump, since the fact that the energy source (and price) is the same means there is no reason not to use the more efficient equipment as much as possible. We assume the following efficiencies for the backup heat sources: 100% for electric resistance, 95% for high-efficiency gas or propane furnaces, 85% for oil furnaces, and 80% for low-efficiency gas or propane furnaces. We assume that the share of each backup source matches its current share among homes in each province.

To represent central air conditioners and heat pumps, we use the performance characteristics of a Goodman GSXN4 Air Conditioner and a Goodman GSZB Heat Pump, both sized at 2.5 tonnes. They are both single-stage units, they both use R-410A refrigerant, and they both have a SEER2 of 14.3. The heat pump HSPF2 is 7.5. At time of writing their list prices were C$2,307.15 (for the air conditioner) and C$3,097.15 (for the heat pump), a difference of C$790.[82] Because the Goodman unit is rated down to -5C, we are only using some of its potential capacity. In reality some households are likely to use it below our assumed switchover temperature of 5C, especially when doing so produces cost savings. And some households will decide to purchase even more efficient models, like a variable-speed or cold-climate unit, instead.

80 NRCan (2022).

81 Data from HRAI.

82 FurnacePrices.ca https://furnacestore.ca/product/goodman-gszb4-heat-pump/ and https://furnacestore.ca/product/goodman-gsxn4-air-conditioner/.

We obtain estimates of future energy prices from modelling by ESMIA of a scenario in which heat pump deployment rises rapidly. For gas and electricity, fixed charges often represent a non-trivial portion of energy bills. But because we do not assume that households will stop using these energy sources, we do not include the fixed portion of prices. This is also conservative, since some households may pursue full electrification and therefore be able to stop using gas entirely.

We obtain emissions intensities of electricity, gas, propane, and heating oil from Environment and Climate Change Canada.[83] Since electricity emissions are changing over time, we assume that provincial electrical grids make steady annual progress towards the existing 2035 net zero target.[84] To calculate monetized benefits from climate action, we use the Social Cost of Carbon with a 2% Near-term Ramsey discount rate.[85] We follow Environment and Climate Change Canada to apply the same 2% discount rate to the bill savings in our model.

Model Results

Average Annual Bill Savings per Household by Backup Type in 2030 (C$)

Province	Electric	Efficient Gas	Gas	Oil	Efficient Propane	Propane
BC	608.20	297.97	392.81	833.87	333.20	434.65
AB	1,102.65	162.76	224.88	609.61	235.64	311.41
SK	1,373.60	92.90	139.32	455.73	162.35	221.80
MB	980.84	100.53	142.13	496.52	199.57	259.74
ON	1,359.49	113.36	170.81	482.09	157.61	223.35
QC	644.02	165.87	212.35	534.43	238.16	298.19
NB	1,161.72	298.69	382.34	482.25	179.62	240.94
NS	1,606.87	443.87	573.47	563.08	173.57	252.50
PE	1,495.66	N/A	N/A	521.61	172.44	243.19
NL	1,955.47	N/A	N/A	568.49	176.02	255.54

Average Annual GHG Savings per Household by Backup Type in 2030 (tCO_2e)

Province	Electric	Efficient Gas	Gas	Oil	Efficient Propane	Propane
BC	0.04	1.18	1.40	1.61	0.86	1.03
AB	2.20	0.55	0.72	0.88	0.32	0.44
SK	3.09	0.33	0.46	0.60	0.17	0.26
MB	0.01	0.69	0.81	0.96	0.52	0.62
ON	0.11	0.74	0.88	1.04	0.55	0.66
QC	0.01	0.69	0.82	0.96	0.52	0.62
NB	1.17	0.55	0.68	0.83	0.38	0.48
NS	2.86	0.46	0.63	0.82	0.24	0.37
PE	1.26	N/A	N/A	0.96	0.44	0.55
NL	0.09	N/A	N/A	1.26	0.68	0.81

83 ECCC (2023a).

84 Government of Canada (2022b).

85 ECCC (2023b).

Total Bill Savings by Backup Type, 2025-2035 (million C$)

Prov.	Electric	Efficient Gas	Gas	Oil	Efficient Propane	Propane	Total
BC	423.56	139.98	97.18	66.75	0.13	4.29	731.90
AB	260.31	171.41	152.62	7.83	0.08	4.80	597.05
SK	305.60	118.06	23.76	23.56	1.69	2.33	475.01
MB	738.35	85.79	22.33	15.10	0.25	1.57	863.41
ON	4,870.89	1,229.27	411.83	513.25	3.06	128.01	7156.32
QC	231.74	4.68	0.45	44.32	0.03	0.57	281.79
NB	138.67	1.36	0.13	12.04	0.10	0.33	152.64
NS	108.20	1.83	0.18	29.92	0.10	0.45	140.67
PE	1.62	#N/A	#N/A	0.85	0.01	0.00	2.48
NL	2.14	#N/A	#N/A	0.11	0.00	0.00	2.26

Total GHG Savings by Backup Type, 2025-2035 (thousand tCO_2e)

Prov.	Electric	Efficient Gas	Gas	Oil	Efficient Propane	Propane	Total
BC	20.23	632.45	397.49	150.99	0.39	12.10	1,213.64
AB	405.17	831.14	671.38	14.87	0.18	10.18	1,932.92
SK	514.07	701.41	121.81	44.26	3.49	5.08	1,390.12
MB	4.43	679.38	149.11	34.18	0.78	4.43	872.31
ON	307.38	9,193.71	2,448.11	1,297.86	12.95	455.62	13,715.63
QC	1.87	21.71	1.93	93.07	0.08	1.39	120.05
NB	106.09	3.12	0.29	25.82	0.30	0.88	136.49
NS	145.76	2.83	0.27	60.92	0.26	1.12	211.17
PE	1.00	#N/A	#N/A	1.95	0.03	0.00	2.99
NL	0.07	#N/A	#N/A	0.29	0.00	0.00	0.36