An Analysis of the Potential for

Air Source Heat Pumps

to Reduce the Energy Costs and Greenhouse Gas Pollution of Ontario's Electrically-Heated Homes

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Executive Summary

Installing cold climate air source heat pumps (ASHPs) or cold climate multi-split heat pumps (mASHP) in Ontario's electrically-heated single family homes will reduce Ontario's greenhouse gas (GHG) emissions and save households money on their electricity bills.

There are currently 450,000 electrically-heated single detached and attached homes in Ontario. Using the Independent Electricity System Operator's (IESO's) forecasted electricity supply mix in 2030, our analysis shows that the GHG pollution of Ontario's gas-fired power plants could be reduced by up to 18% by shifting these homes to highly efficient heat pumps by that date. This would directly reduce Ontario's GHG pollution in 2030 by 2.2 megatonnes, and 4.0 megatonnes when lifecycle emissions are counted.

Installing heat pumps in all electrically heated homes could:

Reduce homeowners' electricity costs by almost **one billion dollars** per year ($960 million)

Reduce the electricity generation and GHG pollution of **Ontario's gas-fired power plants by 18%** by 2030

Increase GDP by **16-18 billion dollars**

Create **99 to 112 thousand** person-years of employment

A switch to heat pumps would reduce the electricity costs of an average electrically heated home by $2,144 per year by heating homes far more efficiently. That comes to $960 million per year for all electrically-heated homes in Ontario. That is, the electric heating and cooling costs for Ontario's electrically heated homes would fall by 54%. Such a move would reduce energy poverty for many of our most vulnerable households who disproportionately live in electrically-heated homes. Our electricity cost savings estimates are based on 2021 electricity rates. If electricity rates continue to rise, the actual dollar savings in 2030 would be even greater.

Installing heat pumps in Ontario's electrically heated homes would cut electric cooling and heating costs by

54%

Heat pumps are a highly attractive option because they provide heating and cooling in one unit and provide major efficiency gains. Consumers are most likely to install high-efficiency heat pumps when they are replacing their old air conditioning unit or when they want to add air conditioning to a building. In these cases, the incremental costs of the heat pumps are estimated at $8,600 to $11,840 per home. For a detached home, the payback can be as low as 3.2 years if the cost is incremental to replacing the central air conditioner, or 5.8 years if the electricity cost savings from the greater efficiency cover the full cost. This is far less than the 15-year life expectancy of a heat pump system.

Nevertheless, the significant upfront capital costs of heat pumps are a market barrier to their rapid and widespread adoption for many homeowners. The Government of Ontario could offer no down payment, low or zero interest loans and tie the loans to the homeowner's utility bills over the 15-year lifespan of the heat pump systems. Such a program would also address the significant gap in consumer and industry awareness of the performance and reliability of cold climate heat pumps. We modeled the annual net financial benefits of installing heat pumps and found that the installation of air source heat pumps in all of Ontario's electrically heated homes would provide a net financial saving (electricity cost savings – loan repayment costs) of $460 to $530 million for homeowners per year assuming current electricity rates.

For homeowners this is a win-win – they pay nothing up front and immediately benefit from reduced energy bills. Why replace your air conditioner with a standard unit when you could pay nothing to start saving immediately with a high-efficiency heat pump?

A program to promote heat pump adoption in electrically-heated homes also has the potential to stimulate the economy by $16.1 to $18.8 billion, create 99 to 112 thousand person- years of employment, and help Ontario households adapt to the increasing number of deadly extreme heat events that are already being experienced as a consequence of climate change.

In summary, heat pumps can cost-effectively cut our greenhouse gas emissions, save homeowners money, reduce energy poverty, stimulate our economy, create green jobs, build the capacity for heat pump installation, and save lives during extreme heat events. Now is the time to roll out programs to put heat pumps in every electrically-heated home.

The installation of air source heat pumps in all of Ontario's electrically heated homes would provide a net financial saving of up to

$530 Million

for homeowners per year

[i] The spreadsheet model used in this analysis is available for download on the Ontario Clean Air Alliance website. Users are welcome to use the model to change the input assumptions and observe the impacts on the outcome parameters.

Introduction

Two issues that are bound to be top of mind for Ontarians as they head into the 2022 provincial election are housing affordability and climate change. A program to promote heat pump adoption in electrically-heated homes has the potential to cost-effectively address both of these concerns while also creating green jobs.

Heat pumps work by moving heat from one location to another using the same refrigeration cycle used in a fridge, freezer or air conditioner. The units are reversible, however, moving heat into a home in winter and out of a home in summer. Modern cold climate heat pumps are capable of moving several units of heat energy for every unit of electrical energy. In Ontario's climate they can have overall efficiencies of 200-300% or more. Electric baseboard heaters, electric furnaces, even fuel-based furnaces, however cannot generate more heat energy than the energy contained in the fuel or electricity so their maximum theoretical efficiency is 100%. Modern heat pumps can also have higher operational cooling efficiencies than many existing and replacement air conditioners.

There are 450,000 electrically-heated detached or attached single family homes in Ontario[1], many of which experience energy poverty. In Ontario, 22% of households experience energy poverty, defined as spending 6% or more of after-tax income on energy needs[2]. The stresses and hardships that a household in energy poverty may endure can have far reaching social, physical health and mental health consequences[3]. It has been estimated that 35-40% of households seeking Ontario Energy Board (OEB) assistance with paying electricity bills through the Ontario Electricity Support Program live in electrically-heated homes[4].

Indeed, heat pumps are seen by all levels of government as a key technology for a low carbon future. The buildings sector was responsible for 19% of Ontario's total 2016 emissions plus a share of the of emissions that came from electricity production[5]. Ontario has a target of reducing emissions by 30% over 2005 levels by 2030 and Ontario's Made in Ontario Environment Plan includes a commitment to encourage the use of heat pumps[6]. The City of Toronto's TransformTO climate action plan calls for fuel switching all buildings to "electric heat pumps or alternative sources of low emissions heating" (p56)[7]. Furthermore, countless other municipalities are committing to promoting residential heat pump adoption and would welcome a provincial program that could help their efforts.

A program to promote heat pump adoption in electrically-heated homes has the potential to cost-effectively address both housing affordability and climate change while creating green jobs

Shifting electrically-heated homes to heat pumps will not only reduce emissions from the operation of buildings, but it will also help Ontario to decarbonize its electricity supply. Heat pumps, with their greater efficiencies reduce overall electricity demand and cost-effectively free up capacity. Freeing up this capacity reduces the demand for power from gas-fired plants making it easier to find alternatives that allow for their phase out as demanded by thirty-two Ontario municipalities[8].

Public and industry awareness of the ability of cold climate heat pumps to meet heating needs in cold climates is low

Heat pumps are currently the main source of heat for roughly 6.6 % of Ontario homes[9], yet public and industry awareness of the ability of cold climate heat pumps to meet heating needs in cold climates is low[10]. To achieve greater adoption in line with our climate targets, it will be necessary to build awareness and trust in the reliability of modern cold climate heat pumps, grow the installation capacity, and drive costs down through greater economies of scale. Homes that rely on baseboard resistance heaters and electric furnaces for their heat are a great place to start.

Any program that promotes heat pumps in electrically-heated homes must include a strong awareness campaign and attractive financing. This is necessary to overcome the significant up-front costs and the lack of public knowledge.

To ensure the shortest pay back, electrically-heated homeowners would make the switch to heat pumps when a central air conditioning system is first installed or replaced. The Government of Ontario could provide loans through the electric utilities at its current incremental cost of debt (1.9%[11]). To further incentivize heat pump uptake in electrically-heated homes, the Government of Ontario could offer these loans at zero interest for the homeowner.

This report explores the GHG and financial impacts of promoting the adoption of cold climate air source heat pumps (ASHPs) in all electrically-heated homes in Ontario. The analysis does not include ground-source heat pumps (GSHPs). The author recognizes that although more expensive upfront, GSHPs are more efficient, especially at very high and very low outdoor temperatures and can therefore have greater impacts on electricity load management and GHGs.

Outcomes

The following analysis assumes that all electrically-heated detached and attached homes in Ontario shift to cold climate heat pumps to meet their heating and cooling needs. The heat pumps modeled are EnergyStar rated ASHPs that use existing ductwork, and EnergyStar multi-split heat pumps (mASHP) for homes without ducting. Homes with central air conditioning are assumed to have ducting and all other homes are assumed to be without ducting. It was also assumed that homes installing multi-split heat pumps would size their systems to cover 70% of the total heating load in order to save on installation costs while homes installing ducted ASHPs would be sized to meet all heating needs. In all cases, the best available data for Ontario's housing stock and energy needs were used.

For a full description of the methodology used, see Appendix B. A list of all assumptions made is found in Appendix C while Appendix A contains data tables showing the outcomes by housing type. The spreadsheet model used in this analysis is available for download on the Ontario Clean Air Alliance website. Users are welcome to use the model to change the input assumptions and observe the impacts on the outcome parameters.

By 2030, heat pumps could reduce Ontario's GHG emissions by

2.2 Mt

per year

GHG and Climate Impacts in 2030

Switching all of our electrically-heated homes to heat pumps would reduce the demand for electricity and therefore reduce the GHG pollution from our gas plants' smokestacks by up to 2.2 megatonnes (Mt) per year in 2030. That works out to a total 18% reduction in total GHG from gas-powered electricity in 2030[12] (See Table 3 in Appendix A for a detailed breakdown by housing type). Yet the total climate impact is greater than that. According to The Atmospheric Fund, the lifecycle total GHG pollution of our gas plants (e.g., including methane emissions during gas drilling, extraction, transportation and distribution) are 1.83 times greater than their smokestacks' pollution[13] (total climate impact of 4.0 Mt/yr).

On a per home basis, the direct emissions savings are in the range of 2.7 to 6.1 tonnes per household per year by 2030, a significant fraction of a household's emissions in 2030.

The increased reliance on gas generation for electricity, as outlined in the IESO's (Independent Electricity System Operator) 2021 *Annual Planning Outlook* forecast[14], will result in greater emissions associated with operating electric resistance heating systems. This is a concern for municipal and provincial climate targets. With pressure to decarbonize

the electricity grid, electric heat pumps are one of the best energy efficiency solutions that can guarantee eventual net zero emissions from the residential sector.

Yet the climate mitigation impacts are far greater than these GHG emissions values would suggest. If Ontario is to decarbonize its economy, the majority of homes must switch to electric heat pumps in the coming decades. By investing now in electrically-heated homes where heat pumps are already highly cost-effective, we can help to build the needed workforce, build awareness of the technology, and build industrial capacity to meet the looming need. Electrically-heated single family homes are a logical sector to increase the market for heat pumps as the technology can guarantee high monthly electricity cost savings (see the Annual Electricity Cost Savings section below).

Heat pumps can also help Ontario to build resilience to the changes already under way due to climate change. Our province is expected to see an increase in the number of extreme heat events as a consequence of climate change. Toronto, for example, could see the number of heat waves per year rise from an average 1.5 between 1976 and 2005 to 5 to 6.2 per year by 2051-2080 and even Thunder Bay could experience 1.8-3.1 heat waves per year by 2051-2080 (0.2 heat waves for 1976-2005)[15]. Extreme heat events are not only uncomfortable, they are deadly: British Columbia's coroner's office reported 569 heat-related deaths during the summer of 2021[16]. Seniors, young children, those with chronic illnesses, newcomers to Canada and socially disadvantaged groups are particularly vulnerable to heat events[17] and often live in electrically-heated homes without air conditioning. Adding heat pumps to these homes is an opportunity to increase climate resilience and save lives.

Adding heat pumps to Ontario homes is an opportunity to increase climate resilience and save lives

Electricity Cost Savings

Single family homes have the potential to save an average $2,144 per year as a direct result of the greater energy efficiency of heat pumps as compared to conventional electric heating with the existing air conditioning. Indeed, our analysis shows that in Ontario, cold climate heat pumps can reduce the energy needed for heating by 57% and the energy needed for cooling by 20% compared to conventional electric heating and air conditioning (see the methodology section for a discussion of the efficiency of the heat pumps used in this analysis). If all electrically-heated homes in Ontario were converted, the total annual electricity customer cost savings would be $960 million. These annual savings are calculated using 2021 electricity prices. If electricity rates continue to rise, the dollar savings in 2030 would be even greater. See table 4 in Appendix A for the detailed breakdown by housing type.

The higher energy efficiency of heat pumps and the associated financial savings can reduce energy poverty in Ontario. Households that experience energy poverty struggle to heat, cool and operate their homes, and this can have far reaching social, physical health and mental health consequences[18]. Households in electrically-heated homes are far more likely than other households to experience energy poverty. In 2020, the Ontario government directed the IESO to target low income customers for conservation demand management programs[19]. The Ontario Electricity Support Program (OESP) operated by the Ontario Energy Board (OEB) provides monthly on-bill credits to lower-income households. On average, 30,000 to 44,000 applications from such households that use electricity for heating are accepted for OESP support per year . This is 5% of all electrically-heated homes in Ontario yet may be an underestimation since households must apply for and qualify for the credit. Ultimately, these households are unlikely to be able to cover the upfront cost of installing the very heat pumps that can reduce their energy poverty and help some households break free from cycles of poverty. Low- or no-interest loans, are therefore essential.

Households in electrically-heated homes are far more likely than other households to experience energy poverty

Capital Costs and Payback Periods

Consumers are most likely to purchase a high-efficiency heat pump when their existing air conditioner is at the end of its service life or they are looking to install a new air conditioning system. A high-efficiency cold climate heat pump costs approximately $8,600 more than a traditional central air conditioning system while high efficiency multi-split heat pumps cost $11,460 to $11,840 more than window air conditioners that meet the cooling needs of a home. The cost is expected to decrease as the market grows through economies of scale. For details on the capital cost estimates, see Appendix B and Table 5 in Appendix A.

In all cases, electrically-heated detached and attached homes that install a heat pump will see a large reduction in their annual electricity cost since heat pumps are much more energy efficient than electric resistance baseboard heaters. The payback periods depend on factors such as the type of home and whether it has an air conditioner due for replacement.

Detached homes with central air conditioning are the most common electrically-heated home (an estimated 48%) and have the lowest payback period. For these homes, the savings will pay for the additional cost of a heat pump compared to a traditional air conditioner in just 3.2 years. The energy bill savings would cover the full upfront cost of a heat pump in just 5.8 years. This is far less than the 15-year expected lifespan

[ii] The number of accepted OESP applications may slightly exceed the number of unique households receiving assistance since households need to reapply if their circumstances change.

of the heat pump, making heat pumps a cost-effective choice in the long term in all detached and attached homes. For details on all housing types, see Table 5 in Appendix A.

As outlined in the following section, many of these homes will still require low- or no- cost loans if they are to contemplate making such a large investment. This is because the up-front cost is $12,600 to $15,600 on average. That is more than many homeowners can afford at one time (even if they know the costs will be recovered in the coming years). Wide-spread adoption will therefore require additional up-front support and measures to address non-financial barriers such as low consumer and installer awareness of cold climate heat pumps, installer capacity, low energy literacy, and others.

A heat pump that replaces conventional electric heating can pay for itself in as little as

3.2

years

Annual Net Financial Benefits for Customers

Table 1 shows the annual net financial benefits to homeowners if heat pumps are installed in all of Ontario's electrically heated houses.

The net financial benefits for homeowners are their electricity cost savings minus their loan payments for the purchase of the heat pumps. We have estimated the annual loan payments under two scenarios. Under both scenarios, there is no down payment and the loans are provided by the Government of Ontario and are repaid over fifteen years.

Under the first scenario, the homeowner pays the full cost of the loan including interest at Government of Ontario's cost of new debt (1.9%)[20] and there is no net cost to the taxpayer or utility ratepayer.

Under the second scenario, the homeowner repays the principal of the loan while the interest portion of the loan is paid by the Government of Ontario.

As Table 1 shows that annual net financial benefit to homeowners is $460 to $530 million per year.

Table 1: Annual homeowner net financial benefit from heat pumps (HP) assuming low and zero interest financing

	Current AC system	Loan amount per home	Annual electricity cost savings due to HP	Annual low interest loan payments	Net savings with low interest loans	Annual zero interest loan payments	Net savings with zero interest loans
Detached homes	No AC	$12,600	$1,793	$966	$827	$840	$953
	Central AC	$15,600	$2,676	$1196	$1,480	$1040	$1,636
	Window AC	$12,600	$1,863	$966	$897	$840	$1,023
Attached homes	No AC	$12,600	$1,142	$966	$176	$840	$302
	Central AC	$15,600	$1,718	$1196	$522	$1040	$678
	Window AC	$12,600	$1,201	$966	$235	$840	$361
Ontario total		$6,600 million	$960 million	$510 million	$460 million	$440 million	$530 million

Ideally, these loans would be in the form of electric utility on-bill financing and would be tied to the property, not the property owner. The average housing tenure in the US is 13 years[21] so it is likely that many homeowners will move before a 15-year loan is repaid and may therefore be reluctant to invest in a heat pump even if the utility bill savings are significant. When loans are tied to the property, the owner who enjoys the ongoing energy savings from a heat pump is also responsible for making outstanding payments. Utility on-bill financing that is tied to the property is enabled in Ontario[22,23], and there are many examples of utility-based programs in Canada: Manitoba Hydro, Newfoundland Power, NL Hydro, Nelson Hydro, and Penticton (BC) Electric Utility all operate, or have operated on-bill financing.

Ideally, these loans would be tied to the property, not the property owner

Loan considerations

Government of Ontario loans for the full up-front cost of heat pumps for all electrically-heated detached and attached homes would total $6.6 billion. The loans would be repaid over the 15- year lifespan of the heat pump systems, and set at the Government of Ontario's 2021 cost of new debt (1.9%). If the Government of Ontario were to provide zero interest loans to increase the market penetration of heat pumps in electrically-heated homes, this would cost the Government of Ontario up to $66 million per year in interest subsidies. Table 7 in Appendix A shows the breakdown of this loan by housing type.

Further implications

Installing heat pumps in electrically-heated homes benefits far more than these homeowners. Households that save money as a result of energy efficiency gains tend to increase other forms of consumption that stimulate the economy. For every program or participant dollar invested in electrical energy efficiency, the local Gross Domestic Product (GDP) is estimated to increase by 2.4 to 2.8 dollars[24]. That represents $30,240 to $43,680 per household that invests in a heat pump, or a $15.8 to $18.5 billion increase in GDP if all electrically-heated homes in Ontario were to switch to heat pumps.

Installing heat pumps also creates green jobs. An estimated 15-17 job years are created for every million dollars spent on electrical energy efficiency[25,26]. For Ontario's electrically-heated homes, this represents a potential for 99 to 112 thousand person years of employment.

A heat pump program for electrically-heated homes can stimulate the economy and create green jobs: to the tune of $15.8 to $18.5 billion and 99-112 thousand job years

Conclusions

This report shows how developing a program to promote the installation of heat pumps in electrically-heated detached and attached homes has huge economic and climate benefits. For a household, the greater energy efficiency of heat pumps over conventional heating systems means that an average extra $1,022 a year for each electrically heated home could be available to purchase non-energy related goods and services (electricity bill savings – loan repayments). Across Ontario, this translates to an extra $460 to $530 million per year in the pocketbooks of consumers for non-energy related spending. By 2030, that same increase in energy efficiency will avoid an estimated 2.2 megatonnes of GHG per year in electrically-heated homes, a projected 18% reduction in emissions from Ontario's gas-fired power plants. If all electrically-heated homes were to adopt heat pumps, that investment would increase the GDP by $15.8 to $18.5 billion while creating 99 to 112 thousand person-years of employment. This is a climate and housing affordability measure worth investing in, and low- or no-interest utility on-bill financing could be a very effective way to address the upfront cost barrier of adding a heat pump while ensuring that loan repayments remain below the electricity cost savings. What is more, such a program has the potential to reduce vulnerability to extreme heat events while building the heat pump installation capacity needed to meet our climate goals. With citizens, governments and organizations demanding greater housing affordability and meaningful climate action, we must plan for a decarbonized electricity system coupled with heat pumps installed in nearly every home in Ontario. It is time to build the capacity to make this transition and electrically-heated homes where the technology is already cost-effective is a great place to start.

This is a climate and housing affordability measure worth investing in

Appendix A: Data tables

Table 2 shows the number of Ontario homes of each type and their respective heating and cooling loads[27]

Table 2: Ontario's electrically-heated housing stock and their heating and cooling loads

	Current AC system	Number of home	Heating load per home (GJ)	Cooling load per home (GJ)
Detached homes	No AC	66,250	90.6	0
	Central AC	215,000	90.6	26.8
	Window AC	31,250	90.6	25.7
Attached homes	No AC	29,150	58.4	0
	Central AC	94,600	58.4	16.8
	Window AC	13,750	58.4	17.2
Ontario total		**450,000**		

Table 3 shows the 2030 GHG impacts of switching electrically-heated homes to heat pumps for individual homes and for all Ontario homes using the projected Ontario electricity supply mix in 2030.

Table 3: Projected 2030 greenhouse gas emissions impacts of shifting electrically-heated homes in Ontario to heat pumps

	Current AC system	kg GHG avoided/yr/home	kt GHG avoided/yr for all homes
Detached homes	No AC	4132	274
	Central AC	6073	1306
	Window AC	3986	125
Attached homes	No AC	2663	78
	Central AC	3915	370
	Window AC	2750	38
Ontario total			**2190**

Table 4 shows the annual operational costs for single family homes that switch from conventional electric heating to heat pumps. Cost savings are relative to their existing systems.

Table 4: Annual Electricity Cost Savings for Ontario's Electrically-Heated Homes Due To Installation of Air Source Heat Pumps

		Per home ($/yr)	For all electrically-heated homes ($M/yr)
Detached homes	No AC	$1,793	$119 Million
	Central AC	$2,676	$575 Million
	Window AC	$1,863	$58 Million
Attached homes	No AC	$1,142	$33 Million
	Central AC	$1,718	$163 Million
	Window AC	$1,201	$17 Million
Ontario total			**$960 Million**

Table 5 shows the total upfront cost and payback period for installing heat pumps. Because these heat pumps are most likely to be installed when a home is looking to replace an end of life air conditioning system, we also calculated the incremental cost and payback period. For homes without AC, the incremental cost was calculated relative to installing window air conditioning units.

Table 5: Total and incremental upfront costs and payback periods for installing heat pumps in homes.

	Current AC system	Total upfront cost	Payback Period (years)	Incremental cost	Payback Period (years)
Detached homes	No AC	$12,600	7.0	$11,460	6.2
	Central AC	$15,600	5.8	$8,600	3.2
	Window AC	$12,600	6.8	$11,460	6.2
Attached homes	No AC	$12,600	11.0	$11,840	9.9
	Central AC	$15,600	9.1	$8,600	5.0
	Window AC	$12,600	10.5	$11,840	9.9
Ontario total		**$6,600 Million**	**7.2**	**$4,300 Million**	**4.9**

Table 6 shows the annual loan repayment costs for loans that cover the full upfront cost of heat pumps for electrically-heated homes. The loans are designed to be paid back over 15 years: the anticipated lifespan of the heat pump system[28]. This analysis measures the financial benefit relative to the existing heating and cooling systems.

Table 6: Annual homeowner net financial benefit from heat pumps (HP) assuming low and zero interest financing

	Current AC system	Loan amount	Annual electricity cost savings due to HP	Annual low interest loan payments	Net savings with low interest loans	Annual zero interest loan payments	Net savings with zero interest loans
Detached homes	No AC	$12,600	$1,793	$966	$827	$840	$953
	Central AC	$15,600	$2,676	$1196	$1,480	$1040	$1,636
	Window AC	$12,600	$1,863	$966	$897	$840	$1,023
Attached homes	No AC	$12,600	$1,142	$966	$176	$840	$302
	Central AC	$15,600	$1,718	$1196	$522	$1040	$678
	Window AC	$12,600	$1,201	$966	$235	$840	$361
Ontario total		**$6,600 Million**	**$970 Million**	**$510 Million**	**$460 Million**	**$440 Million**	**$530 Million**

Table 7: Total loan amounts and annual interest costs for Government of Ontario loans to homeowners to install heat pumps in all of the province's electrically-heated houses

	Current AC system	Loan amount	Annual interest costs
Detached homes	No AC	$835 Million	$8.4 Million
	Central AC	$3,354 Million	$33.6 Million
	Window AC	$394 Million	$3.9 Million
Attached homes	No AC	$367 Million	$3.7 Million
	Central AC	$1,476 Million	$14.8 Million
	Window AC	$173 Million	$1.7 Million
Ontario total		**$6,600 Million**	**$66.0 Million**

Appendix B: Methodology

Model transparency

The spreadsheet model used in this analysis is available for download on the Ontario Clean Air Alliance website. Users are welcome to use the model to change the input assumptions and observe the impacts on the outcome parameters.

Data sources

The NRCan Comprehensive Energy Use Database for Ontario in 2018 was used as a data source for the number of each type of electrically-heated home, the gigajoule (GJ) heating or cooling load, and the heating and cooling system efficiencies.

The 2018 IESO Residential Energy Use Survey provided information on the percent of single family homes with central and room air conditioning (AC).

EnergyStar certified air source heat pumps must have a rated HSPF (heating seasonal performance factor) of at least 8.5 (SCOP – seasonal coefficient of performance of 2.5) and a SEER (seasonal energy efficiency ratio) of at least 15 (EER - energy efficiency ratio of 12.5) in climate zone IV[29]. EnergyStar also recommends selecting a system with an HSPF value greater than 12.0 (SCOP of 3.5) when used as the primary heating system in colder climates[30]. To stay on the conservative side, we used an HSPF cut off of 10.5 for climate zone IV (SCOP of 3.1)[31]. A conversion factor of 1.15[32] was used to convert HSPF factors from climate zone IV to climate zone V where the majority of Ontario's population is located according to NRCan[33] (HSPF and SCOP become 9.1 and 2.7 respectively). Heat pumps with these HSPF values typically have SEER values of 18 or greater. Since cooling loads vary less across climate zones, the SEER value was not adjusted.

Heat pump life expectancies were estimated at 15 years based on values used by the Rocky Mountain Institute for their analysis of the economics of electrification with heat pumps[34]. We believe this is a conservative estimate as the IESO study on heat pumps estimated 15 to 20 years[35].

We estimated the installation costs based on secondary sources and information gathered from installers and distributors. For a detached or attached home with central ducting, we arrived at $15,600[36,37] while a multi-split heat pump system with 3 heads capable of supplying 70% or more of all heating needs in a home without ducting was set at $12,600[38,39]. These are conservative figures. For example, a recent Dunsky report[40] estimated the cost of a ducted system at $11,500 for a ducted home and the IESO estimated the average cost at $5,000 to $16,000[41]. Also, prices are expected to decline as the market continues to expand.

Heat pump maintenance costs were set at $40 per year to cover filter replacement or cleaning. Maintenance costs for central and window air conditioners were set at $20 per year.

For detached homes, three window air conditioner units were needed to meet the cooling load of the home while two were required for attached homes.

For homes that start with no air conditioning, the cooling costs for the heat pump were not included in the operational cost savings.

Hydro One rates were used to calculate the cost/kWh of electricity for space heating and cooling using time of use rates averaged over a full week.

Seasonal marginal emissions factors for Ontario's electricity system in 2030 were supplied to Jack Gibbons, Chair, Ontario Clean Air Alliance by Sunny Kim, Advisor, Customer Relations, IESO, (October 29, 2021).

Ontario's incremental cost of new long-term cost of debt (1.9%) was sourced from Ontario's 2021 budget.

Appendix C: Assumptions

An average of 3 multi-split heads in detached/attached homes can provide 70% of an average home's heating

Cooling energy loads are proportional to heating energy loads (total cooling load values for all homes were used to calculate a proportional value for each housing type based on their proportional heating loads)

Detached and attached homes with room AC use three and two AC units on average respectively

Homes with central AC have ducting and all homes without central AC use baseboard heaters (Kai Millyard of Green Communities Canada estimates that that 1/3 of electrically-heated (non-MURB) homes have electric furnaces based on proprietary EnerGuide audit database – these were assumed to be homes with central AC)

Total lifetime cost of current system only includes operational and maintenance costs

Hydro One TOU prices are used for all of Ontario

Capital costs include the installed cost of an ASHP or multi-split but does not include any additional electrical or other costs

Loan repayments are made monthly and interest is compounded on a monthly basis

Heat pump SCOP efficiency figures for region 5 are representative of Ontario's average housing stock

Sources

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