# Decarbonizing Residential Heating

Pollution Probe

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# Decarbonizing Residential Heating

To attain a net-zero energy system by 2050, we must transition away from fossil fuels. Heating is significant in Canada due to its cold climate, with space and water heating accounting for roughly 81% of residential energy consumption (see Figure 1).[1]

Residential heating is a significant user of fossil fuels. Natural gas provides more than half the heat in Canada (see Figure 2). Natural gas use varies across the country, with Ontario (76%), Manitoba (61%) Saskatchewan (87%), Alberta (91%) and British Columbia (55%) relying on it the most.[2] Given this reliance on natural gas, emissions from heating are responsible for over two-thirds of residential emissions.[3] Between 1990 and 2020, emissions from residential buildings increased by 5.8% due to rising population and larger living spaces.[4]

Decarbonizing our heating system is essential for a net-zero future. In addition, burning natural gas indoors can pose health risks.[5] However, transitioning to low-carbon heat in cold nations such as Canada is challenging due to the seasonal demand for heat, with high peaks during winter, and the associated costs of such a transition.

This paper explores Canada's low-carbon heating system options that protect consumers and saves money in the long run. It suggests pathways to move to a net-zero energy system by 2050.

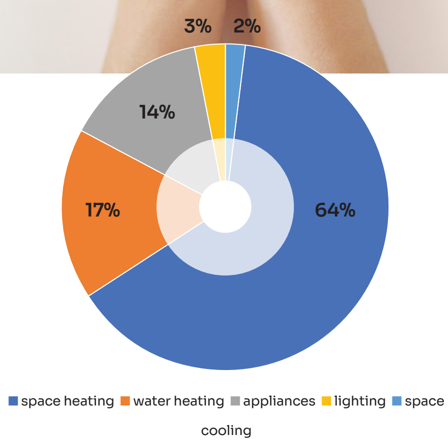


Figure 1: Secondary energy use in residential buildings in Canada in 2019[6]

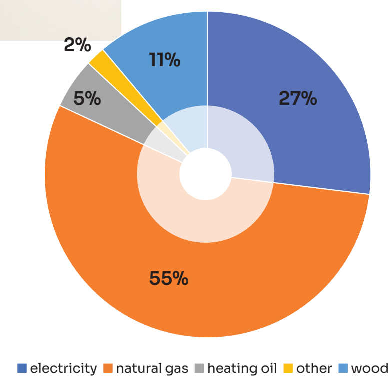


Figure 2: Space heating secondary energy use in Canada 2019[7]

1 Natural Resources Canada, "Table 2: Secondary Energy Use and GHG Emissions by End-Use, Residential Sector Canada," Comprehensive Energy Use Database, 2019. https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_ca.cfm.

2 Statistics Canada, "Table 2: Type of main heating fuel used, by province, 2011," Households and the Environment: Energy Use, 2011, September 19, 2013, https://www150.statcan.gc.ca/n1/pub/11-526-s/2013002/t002-eng.htm

3 Including emissions from electricity. Natural Resources Canada, "Table 2: Secondary Energy Use and GHG Emissions by End-Use, Residential Sector Canada," Comprehensive Energy Use Database, 2019. https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_ca.cfm.

4 Environment and Climate Change Canada, Canada's 8th National Communication and 5th Biennial Report, December 31, 2022, https://unfccc.int/documents/624782.

5 T. Gruenwald, BA Seals, LD Knibbs, HD Hosgood, "Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States" International Journal of Environmental Research and Public Health, December 2022, doi: 10.3390/ijerph20010075.

6 Natural Resources Canada, "Table 2: Secondary Energy Use and GHG Emissions by End-Use, Residential Sector Canada," Comprehensive Energy Use Database, 2019. https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_ca.cfm.

7 Natural Resources Canada, "Table 7: Space Heating Secondary Energy Use and GHG Emissions by Energy Source, Residential Sector Canada," Comprehensive Energy Use Database, 2019, https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_ca.cfm.

# Challenges with Moving to Low-Carbon Heat

### Heat is very peaky

One challenge with heat is seasonal demand characterized by relatively short peaks followed by months of very low demand. For example, in 2015, Ontario gas demand peaked on a very cold day in January at approximately 80 GW. In comparison, the summer electricity peak (mostly driven by air conditioning) that same year was less than 25 GW.[8] Similar phenomena occurred in the UK in 2018. During a severe winter storm, the gas system demand peaked at 214 GW, compared to an electricity peak of 53 GW during the same period.[9] Gas can provide this flexibility and meet peaks needs as it can be easily stored and provided when needed. Any substitute would also need to be able to provide this flexibility.

### Costs

Access to dependable and reasonably priced heating is crucial, particularly in regions like Canada where winter temperatures regularly drop to -20°C and even -30°C.[10] Inadequate access to affordable heating is associated with increased mortality.[11] In the UK, low-income customers with health issues are even given free home heating as a prescription to decrease healthcare expenses.[12]

8 Enbridge Gas, 2017 LTEP Submission, December 16, 2016.

9 Grant Wilson, Ramsay Taylor and Paul Rowley, "Challenges for the decarbonisation of heat: local gas demand vs electricity supply Winter 2017/2018," UK Energy Research Council, August 2018, http://www.ukerc.ac.uk/publications/local-gas-demand-vs-electricity-supply.html

10 Climate Atlas of Canada, "Very Cold Days," https://climateatlas.ca/map/canada/minus30_2030_85#

11 Janjala Chirakijja, Seema Jayachandran, and Pinchuan Ong, Inexpensive Heating Reduces Winter Mortality, June 27, 2019. At http://faculty.wcas.northwestern.edu/~sjv340/heating_mortality.pdf.

12 Marina Jenkins, "The people getting their heating bills paid for on prescription," ITV, February 24, 2023, https://www.itv.com/news/westcountry/2023-02-23/the-people-getting-their-heating-bills-paid-for-on-prescription

# Low-Carbon Heating Options

The options to provide low-carbon heat are electrification, district heating and cooling, and low-carbon gases.

## Electrification

**BENEFITS**

Electric-resistive heating has long been used as a primary heating source in some areas of Canada, especially in Quebec. But it is with heat pumps where the real opportunity for the transition lies.[13]

The heat pumps are very efficient and their advantage over electric-resistive heating is that they extract heat from the ambient air and they can deliver more heat per unit of electricity provided. For example, depending on the weather, in many cases 1 kWh of electricity can be used to deliver 3 kWh of heat, meaning that it is 300% efficient (this is described as having a coefficient of performance (COP) of 3).[14] An additional advantage of heat pumps is that they can also provide cooling, and thus a heat pump could replace both heating and cooling.

There are two main types of heat pumps: air source heat pumps (ASHPs), which absorb heat from the outside air; and ground-source heat pumps (GSHPs), which absorb heat from the ground. GSHPs are more efficient than ASHPs as the temperature below ground is more constant, but they have much higher upfront costs, and the need for land for drilling and placing an underground heat exchange loop makes it difficult to add them to existing buildings or in dense urban settings. ASHPs are likely to become the dominant form of heating in the future due to lower costs and ease of installation.[15]

**CHALLENGES**

Meeting the increased demand for electricity on peak heating days in cold climates is the main challenge with the electrification of heating. Heat pumps don't perform as well in colder temperatures.[16] Special cold climate heat pumps can operate at -15°C to -25°C, but they do so at much lower performance, near the same efficiency as electric-resistive heating, and thus require more electricity to deliver the heat when it is cold.[17] While less than 10% of Canadian total heat demand occurs below -10°C, and in some parts of the country it is unlikely to get this cold, it is still necessary to be able to meet cold peak heating days.[18]

13 IEA, Heating, June 2020, https://www.iea.org/reports/heating.

14 IRENA, IEA and REN21, Renewable Energy Policies in a Time of Transition: Heating and Cooling November 2020, pp. 50-51, https://www.irena.org/publications/2020/Nov/Renewable-Energy-Policies-in-a-Time-of-Transition-Heating-and-Cooling.

15 IEA, The Future of Heat Pumps, 2022, https://iea.blob.core.windows.net/assets/4713780d-c0ae-4686-8c9b-29e782452695/TheFutureofHeatPumps.pdf

16 IEA, Heating and Cooling Strategies in the Clean Energy Transition: Outlook and Strategies from Canada's Provinces and Territories, May 2019, https://www.iea.org/reports/heating-and-cooling-strategies-in-the-clean-energy-transition; Natural Resources Canada, Heating and Cooling With a Heat Pump, February 11, 2021, https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817

17 Manitoba Hydro, "Wondering about your energy options for space heating?," February 2022, https://www.hydro.mb.ca/your_home/heating_and_cooling/space_heating_costs.pdf

18 IEA, Heating and Cooling Strategies in the Clean Energy Transition

For an all-electric future, electric-resistive backups are an option. Yet electric-resistive heating requires significant amounts of power. As an example, due to its reliance on electric-resistive heating, Quebec has the highest winter electricity demand in Canada, over 40 GW in 2023.[19] In comparison peak summer demand in Quebec is usually around 12-14 GW, and 22 GW in Ontario.

Electrification with ASHPs could thus lead to the unusual situation of having lower annual energy demand for heating due to the higher efficiency of heat pumps, but higher peak demand due to the need for backup on very cold peak heating days. As an example, even if Quebec moves fully to heat pumps, the winter peak demand on really cold days would not be reduced as there would still be the need for electric-resistive backup.

In a study on the effects of electrification in Ontario, peak demand in the province was seen as more than doubling to 45 GW due to space heating under a net-zero mandate.[20] Also, in the US, many states in the north-east that currently rely on fossil fuels for heating could see peak loads more than double with electrification.[21] In another US model, peak demand was expected to increase by 40-60% by 2050, requiring an extra US$15-20 billion in investments in electricity systems in the 2020s. In the UK, peak winter demand could rise to between 135 and 148 GW; in comparison, average winter peak demand in Great Britain is currently around 60 GW.[23]

## District heating and cooling

### BENEFITS

District heating and cooling (DHC) is the centralized production and supply of thermal energy that is distributed through a "district" or a region of a city or even a single building.

DHC is based more on infrastructure than a single technology. Low-carbon fuel options for DHC networks include solar thermal, geothermal, and biomass.[24] But to date most networks have used fossil fuels as their primary energy source.

Development is also underway on fourth- and fifth-generation low-temperature DHC networks that use waste heat, which is heat produced from other processes.[25] Some systems in place use waste heat from a crematorium in Aalborg, Denmark; from the underground subway in London, UK; and from wastewater in Cologne, Germany.[26] In Canada, Vancouver has a system recovering heat from wastewater,[27] and in Toronto, a hospital is using a similar system to get heat from wastewater.[28]

### CHALLENGES

DHC's primary constraint is its need for substantial infrastructure, making it more suitable for densely populated urban areas. This infrastructure requirement means that DHC can be difficult to retrofit into existing communities and is best installed at the stage of major new developments or redevelopments. Yet, where it can be installed, DHC can be more cost-effective than other low-carbon options for individual buildings.[29]

19 René Bruemmer, "Quebec sets record for electricity consumption during cold snap," Montreal Gazette, February 4, 2023, https://montrealgazette.com/news/quebec/quebec-tops-record-for-electricity-consumption-during-cold-snap

20 John E T Bistline et al, "Deep decarbonization impacts on electric load shapes and peak demand," Environmental Research Letters, 2021, https://iopscience.iop.org/article/10.1088/1748-9326/ac2197

21 Michael Waite and Vijay Modi, "Electricity Load Implications of Space Heating Decarbonization Pathways," Joule 4, issue 2 (2020), pp. 382-385, 389, https://doi.org/10.1016/j.joule.2019.11.011.

22 E. Larson et al., Net-Zero America: Potential Pathways, Infrastructure, and Impacts, interim report, December 15, 2020, p. 66, https://environmenthalfcentury.princeton.edu/sites/g/files/toruqf331/files/2020-12/Princeton_NZA_Interim_Report_15_Dec_2020_FINAL.pdf

23 S.D. Watson, K.J. Lomas and R.A. Buswell, "Decarbonising domestic heating: What is the peak GB demand?," Energy Policy 126 (March 2019), pp. 533-544, https://doi.org/10.1016/j.enpol.2018.11.001.

24 IRENA, IEA and REN21, Renewable Energy Policies in a Time of Transition: Heating and Cooling, pp. 123-124.

25 IEA, Heating.

26 Nicola Jones, "Waste Heat: Innovators Turn to an Overlooked Renewable Resource," Yale Environment 360, May 29, 2018, https://e360.yale.edu/features/waste-heat-innovators-turn-to-an-overlooked-renewable-resource.

27 City of Vancouver, "Southeast False Creek Neighbourhood Energy Utility," 2019, https://vancouver.ca/home-property-development/southeast-false-creek-neighbourhood-energy-utility.aspx.

28 "UHN reducing emissions with huge new wastewater energy system," University Health Network, April 2021, https://www.uhn.ca/corporate/News/Pages/UHN_reducing_emissions_with_huge_new_wastewater_energy_system.aspx

29 Sofia Lettenbichler and Alessandro Provaggi, 100% Renewable Energy Districts: 2050 Vision, August 2, 2019, p. 7, www.euroheat.org/wp-content/uploads/2019/08/RHC-ETIP_ District-and-DHC-Vision-2050.pdf.

## Low-carbon gases

**BENEFITS**
Rather than changing the system entirely, another option is to change the gas supplied. Broadly speaking there are two options for low-carbon gases: renewable natural gas (RNG), which is methane derived from natural sources; and hydrogen.

RNG is gas that comes from sources like decomposing organic matter from agriculture, landfills, and wastewater treatment plants.[30] RNG is not new and is collected across Canada and internationally. Some provinces promote low-carbon gas, with Quebec having a target of 5% RNG use by 2025,[31] and BC having a target of meeting 15% of its gas consumption from low-carbon gas by 2030.[32]

Hydrogen serves as an alternative low-carbon fuel, depending on its production source. There is increasing interest in hydrogen, with 22 countries, including Canada and the European Union, having released hydrogen strategies as of the end of 2022.[33]

Low-carbon hydrogen can be produced from natural gas if the carbon produced in doing so is stored (this is sometimes referred to as 'blue' hydrogen). Another technique is using low-carbon electricity to power an electrolyzer which separates water into hydrogen and oxygen (this is sometimes referred to as 'green' hydrogen).[34]


The hydrogen can then be blended with natural gas and thereby reduce emissions, but this is not a zero-emissions option. The GRHYD project in France has been blending 20% hydrogen with natural gas since 2019.[35] HyDeploy, a UK initiative, started a trial of blending 20% hydrogen with natural gas starting in 2019 at a private gas network at Keele University.[36] In Canada, Enbridge Gas is starting a trial blending of 2% hydrogen in Ontario.[37] Another option is to fully convert a gas network to hydrogen or to build a new pipeline. The UK's Northern Gas Networks is examining the potential to convert a section of their territory to 100% hydrogen.[38]

**CHALLENGES**
Many studies show that RNG could only meet up to 10-15% of current gas demand, while this could increase with new technology, supply is limited.[39] Methane leakage is also a worry as methane is a very potent greenhouse gas, with twenty-eight times the global warming potential of carbon dioxide for 100 years.[40]

Hydrogen is limited first by a lower energy density than natural gas. Hydrogen has around a third of the energy density of fossil natural gas, meaning that even blending 20% hydrogen into natural gas would only reduce emissions by 6-7%.[41]

30 Pollution Probe, The Future of Natural Gas, 2019, p. 36, https://www.pollutionprobe.org/wp-content/uploads/Future-of-Natural-Gas-November-2019.pdf
31 Regulation respecting the quantity of renewable natural gas to be delivered by a distributor, CQLR c R-6.01, r.4.3, Canlii, July 1, 2019, https://www.canlii.org/en/qc/laws/regu/cqlr-c-r-6.01-r4.3/latest/cqlr-c-r-6.01-r4.3.html.
32 BC Government, CleanBC, March 2019. At https://blog.gov.bc.ca/app/uploads/sites/436/2019/02/CleanBC_Full_Report_Updated_Mar2019.pdf.
33 IEA, Hydrogen, September 2022, https://www.iea.org/reports/hydrogen
34 IEA, The Future of Hydrogen, pp. 39-40; 42-44; 103.
35 IEA, Hydrogen.
36 HyDeply, Positive progress to reduce UK C02 emissions, 2019, https://hydeploy.co.uk/.
37 "Renewable Hydrogen," Enbridge Gas, accessed February 7, 2021, https://www.enbridgegas.com/Natural-Gas-and-the-Environment/Enbridge-A-Green-Future/Renewable-hydrogen.
38 Committee on Climate Change, Hydrogen in a low-carbon economy (London: CCC, November 2018), p. 29, https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf
39 Deloitte and WSP, Renewable natural gas production in Québec: A key driver in the energy transition -- Assessment of technical and economic potential in Québec (2018–2030), October 2018, https://www.energir.com/~/media/Files/Corporatif/Publications/181120_Potentiel%20GNR_Rapport%20synth%C3%A8se_ANG.pdf?la=en. Assuming a purchase price of $15/GJ. See also Jonathan Stern, Narratives for Natural Gas in Decarbonising European Energy Markets (Oxford: Oxford Institute of Energy Studies, February 2019), p. 6, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/02/Narratives-for-Natural-Gas-in-a-Decarbonisinf-European-Energy-Market-NG141.pdf
40 Government of Canada, Global Warming Potential, 2022, https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/quantification-guidance/global-warming-potentials.html
41 IEA, The Future of Hydrogen, 2019, p. 71

Infrastructure's potential to accommodate hydrogen has to be assessed when deciding on hydrogen's role, since hydrogen can lead to the embrittlement of steel pipe, which is commonly used in long-distance gas pipelines. Other forms of pipe, such as polyethylene (PE), polyvinyl chloride (PVC) or elastomeric pipes currently used in gas distribution networks, do not have that problem but need to be tested under high concentrations.[42]

One option could be to produce synthetic methane, which combines hydrogen with $CO_2$, and could be transported by current gas pipelines. One such project operating in Germany since 2013 produces 300 $m^3$ per hour of synthetic methane, with $CO_2$ being provided from a biogas-fired power plant.[43]

Another concern is cost for additional electricity generation. In Germany it has been estimated that 500-600% more renewable electricity generation would be required to switch heating to hydrogen compared to using heat pumps.[44] Due to this cost, almost all European studies do not foresee a large role for hydrogen in heating,[45] although the colder weather in parts of Canada may change those calculations.[46]

## Hybrid heating

**BENEFITS**

While in many parts of Canada, especially the west coast, conversion to electrification with heat pumps is possible with little concern for the electricity system impacts though local constraints might exist. In regions where the weather makes electrification difficult or requires expensive grid investments, hybrid solutions that use two fuels – electricity and another form, usually natural gas – to deliver heating and cooling could help reduce emissions while giving the electricity system time to adapt. Another hybrid option would be to pair a heat pump with thermal energy storage.[47]

A hybrid approach could allow faster roll-out of low-carbon heating given that building up the electricity grid to accommodate a full transition could take years. The Atmospheric Fund, a Toronto-based climate agency, ran a number of successful hybrid heating trials and views hybrid solutions as a "stopgap to an electric future."[48] Hybrid solutions where gas provided peak heating needs were identified in a UK study as an effective way for introducing low-carbon heating and meeting peak heating needs while transitioning from fossil gas to low-carbon gases.[49] The IEA in its Sustainable Development Scenario similarly sees biogas and hydrogen as fuels to reduce the electricity demand through hybrid systems.[50] The limited availability of low-carbon gases may not be as large a constraint if they are used in hybrid systems.

**CHALLENGES**

The primary challenge with hybrid systems is the need to preserve two energy systems – the electrical and the gaseous system. Also, as long as conventional natural gas is used, and while there may be substantial reductions in gas use, the system will not be net-zero. Either a plan to shift to low-carbon gases or to electricity would be required to get to net-zero.

42 Zen and the Art of Clean Energy Solutions, BC Hydrogen Study, 2019, https://www2.gov.bc.ca/assets/gov/government/ministries-organizations/ministries/zen-bcbn-hydrogen-study-final-v5_noappendices.pdf.

43 IEA, The Future of Hydrogen, pp. 57-63.

44 Norman Gerhardt et al., Hydrogen in the Energy System of the Future: Focus on Heat in Buildings, Fraunhofer Institute for Energy Economics and Energy System Technology, May 2020, https://www.iee.fraunhofer.de/content/dam/iee/energiesystemtechnik/en/documents/Studies-Reports/FraunhoferIEE_Study_H2_Heat_in_Buildings_final_EN_20200619.pdf.

45 Jan Rosenow, "Is heating homes with hydrogen all but a pipe dream? An evidence review," Joule, October 19, 2022, https://doi.org/10.1016/j.joule.2022.08.015

46 The UK Committee on Climate Change estimated that it would cost GBP50-100 billion to convert to 100% hydrogen. Committee on Climate Change, Hydrogen in a Low Carbon Economy, November 2018.

47 See IRENA, Innovation Outlook: Thermal Energy Storage (Abu Dhabi, IRENA, November 2020), https://www.irena.org/publications/2020/Nov/Innovation-outlook-Thermal-energy-storage.

48 Erik Janssen, "Hybrid heat pumps can be a stopgap to an electric future," The Atmospheric Fund, February 2, 2022, https://taf.ca/hybrid-heat-pumps-can-be-a-stopgap-to-an-electric-future/

49 Waite and Modi, "Electricity Load Implications of Space Heating Decarbonization Pathways," p. 389.

50 IEA, Energy Technology Perspectives 2020, p. 97.

# Paths Forward

There is likely no one specific pathway for a transition to low-carbon heating. Every region of Canada will have to consider options based on local circumstances, heating needs and the costs to make the transition. While greater electrification is likely, it may not be the solution in every case.

But uncertainty should not be an excuse for inaction as we can implement low-regret actions that can be taken in the short- and medium-term that will start to get Canada closer to a net-zero energy system.

### Plan for change

While we need to start moving now, we also need to plan for how the energy system, especially the electricity system, will need to adapt and expand to meet rising demand, and we need to consider the role of low-carbon gases and the gas system.

Some of what needs to be explored is clearly a technical exercise, but social equity also needs to be considered. Homes and buildings need to be warm for occupants' comfort, safety and at an affordable cost.

There will be costs to decarbonize heat and these costs need to be allocated fairly to ensure those experiencing energy poverty are not further disadvantaged.

### Promote energy efficiency

Before making any changes to heating, the first step is to reduce demand as much as possible through improving building efficiency.

Energy efficiency plays a central role in most models for decarbonizing space heating. In the International Energy Agency's Sustainable Development Scenario, energy efficiency technologies and services contribute 40% of the GHG emission reductions by 2070, with energy consumption in buildings halved. Upgrading the existing building stock will be crucial. 50 % of existing global building stock that will be around in 2050. In the IEA's Clean Technology Scenario for Canada, approximately 60% of the current residential floor area will need major energy renovations by 2050.[52] Improving building efficiency and reducing demand are central to any low-carbon heating future.

51 IEA, Energy Technology Perspectives 2020, pp. 73, 61.

52 IEA, Heating and Cooling Strategies in the Clean Energy Transition.


**Set low-carbon heating timelines**

It is easier to introduce low-carbon heating into a new building than an existing building. As such, no new buildings should be constructed with fossil gas as their heating source, although hybrid systems that use low-carbon gases might be useful in areas with colder winters. Dense urban areas may have other options, such as low-carbon district energy systems.

A clear cut-off date for the replacement of fossil heating should be set to allow the industry time to transition. Hybrid solutions and systems that rely on low-carbon gases such as hydrogen may be possible if sufficient resources are available. Incentives will help households to transition, and specific support will need to be targeted at low-income households.

**Promote electrification where it makes sense**

Electrification with heat pumps is likely to be the leading decarbonized space heating choice in the future. The International Energy Agency sees heat pumps as the "leading" source of heat by 2040.[53] National net-zero scenarios for both the UK[54] and the US[55] likewise see a much higher share of electrification and heat pumps than currently.

At the same time the needs and the costs of building the electricity infrastructure to deal with electrification needs to be considered.

53 IEA, Energy Technology Perspectives 2020, p. 161
54 CCC, The Sixth Carbon Budget, p. 115,
55 E. Larson et al., Net-Zero America.

# Getting to Net-zero

Canada's size and range of climatic conditions produce varying heating needs.[56] Transitioning to low-carbon heating will be challenging and will require planning for new and existing buildings. Regulators, policymakers and utilities will need to ensure affordability and equity. In a northern country where heat is an essential service, that challenge should not be underestimated.

Given the timelines, we cannot afford to wait and need to start on low-regret options while planning for a net-zero system that considers all potential options.

Pollution Probe continues to identify and push for the most efficient, effective and equitable transition pathways to cleaner heating methods and a low-carbon future. We do this by working to improve energy planning, expanding the use of innovative approaches in the energy system, and helping Canadians understand the changes that are going on in their communities.

Everyone in Canada can help participate in the transition, and there is help available. The federal government's Canada Greener Homes Grant program provides funding for energy efficiency and the move to lower-carbon options.[57] Various provinces, territories and municipalities also offer incentive programs. The federal government has a searchable database of all programs you can search to find one for you.[58]

56 NatCen Social Research, Transforming Heat – Public Attitudes Research: A survey of the GB public on the transition to a low-carbon heating future, BEIS Research Paper Number 2020/024, January 2020, pp. 4-6, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/913541/transforming-heat-public-attitudes-research-report.pdf

57 https://natural-resources.canada.ca/energy-efficiency/homes/canada-greener-homes-initiative/canada-greener-homes-grant/canada-greener-homes-grant/23441

58 https://natural-resources.canada.ca/energy-efficiency/homes/20546