ONTARIO'S ELECTRICITY FUTURE

# QUESTION 15

# How much of Ontario's energy system must be electrified to meet Ontario's legal greenhouse gas limits?

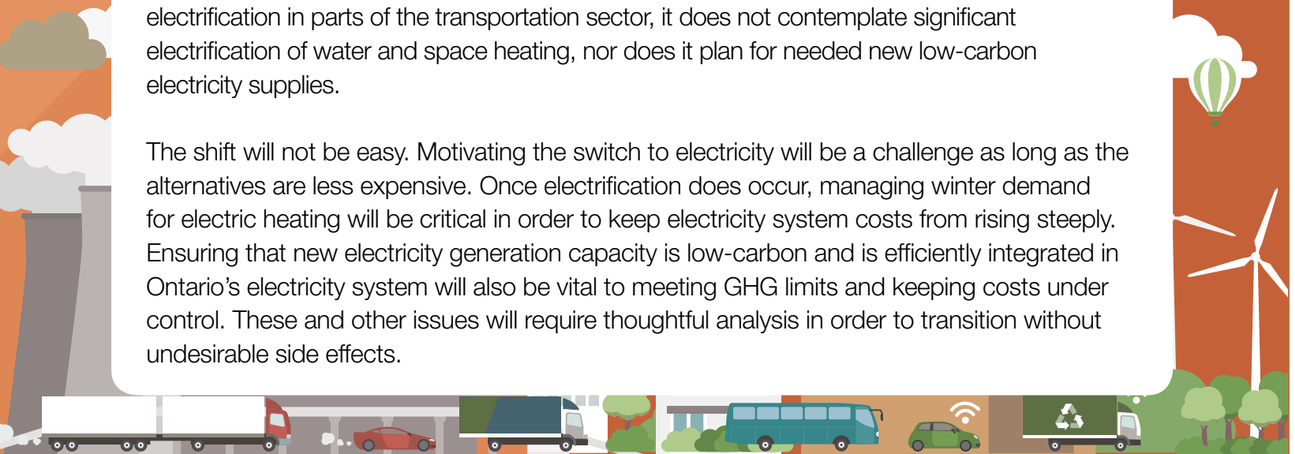
**Much more than is currently planned. The needed electrification could increase Ontario electricity demand by one-third in the next twelve years; the Long-Term Energy Plan ignores Ontario's climate obligations when it forecasts relatively stable demand.**

Ontario's energy system requires a major transition, for which the province's energy system plan (the Long-Term Energy Plan, or LTEP) fails to prepare. As we move towards 2030, Ontario's Climate Change Mitigation and Low-carbon Economy Act ('the Climate Act') will increasingly limit fossil fuel use (e.g., gasoline, diesel, natural gas and oil). The Climate Act's annual limits on greenhouse gas (GHG) emissions will require emissions from burning fossil fuels for energy to drop by about 45% in the next 12 years.

What can replace these fuels? Much more conservation, more efficient use of fossil fuels, direct use of renewable energy, and low-carbon renewable fuels (e.g., bioenergy) will all help, but are not enough. Significant electrification – switching from fossil fuels to low-carbon electricity – will also be needed. This will require new electricity capacity, as electricity use may need to increase roughly 35% by 2030.

The LTEP does not prepare Ontario for this shift. It contemplates significant (but not sufficient) electrification in parts of the transportation sector, it does not contemplate significant electrification of water and space heating, nor does it plan for needed new low-carbon electricity supplies.

The shift will not be easy. Motivating the switch to electricity will be a challenge as long as the alternatives are less expensive. Once electrification does occur, managing winter demand for electric heating will be critical in order to keep electricity system costs from rising steeply. Ensuring that new electricity generation capacity is low-carbon and is efficiently integrated in Ontario's electricity system will also be vital to meeting GHG limits and keeping costs under control. These and other issues will require thoughtful analysis in order to transition without undesirable side effects.





## Contents

# The details…

## Climate law requires reduced fossil fuel use

Burning fossil fuels for energy (mostly petroleum products such as gasoline, diesel and oil, as well as natural gas) was responsible for 75% of Ontario's 2015 GHG emissions, about 126 Mt. That cannot continue.

As we move towards 2030, Ontario's Climate Act will increasingly limit fossil fuel use.[i] The Act and its regulations set legal limits to ensure that Ontario's emissions do not exceed 37% below 1990 GHG emissions in 2030.[1]

37% below 1990 GHG emissions is about 115 Mt of province-wide GHG emissions in 2030; or about 31% below Ontario's emissions in 2015. Within that 115 Mt, there is a cap of 88.5 Mt on the GHG allowances that will be available in 2030 for all capped emissions, including industrial process and product use (explained below) and fossil fuel use emissions (see Figures 15.1 and 15.2).[2] As a result of that cap on allowances, the ECO estimates there could be about 35% more demand for low-carbon electricity by 2030. Even in the absence of Ontario's cap and trade program, the federal government's proposed mandatory minimum carbon tax could still drive a similar shift.

**As we move towards 2030, Ontario's Climate Act will increasingly limit fossil fuel use.**

The government can start planning for this transition now, and ensure the transition is strategic and minimal cost, or can do it later, under greater time pressure, with less opportunity for strategic planning, and likely higher overall costs.

At the time of writing, the provincial government has not planned for this low-carbon energy system future.


[i] In this answer, the ECO assumes that Ontario's capped emitters will meet their compliance obligations with the legal maximum of offset credits and with cap and trade allowances issued by Ontario. Ontario emitters cannot count on continued access in 2030 to surplus allowances from California, for the reasons described in our 2017 climate report, From Plan to Progress, Appendix B.





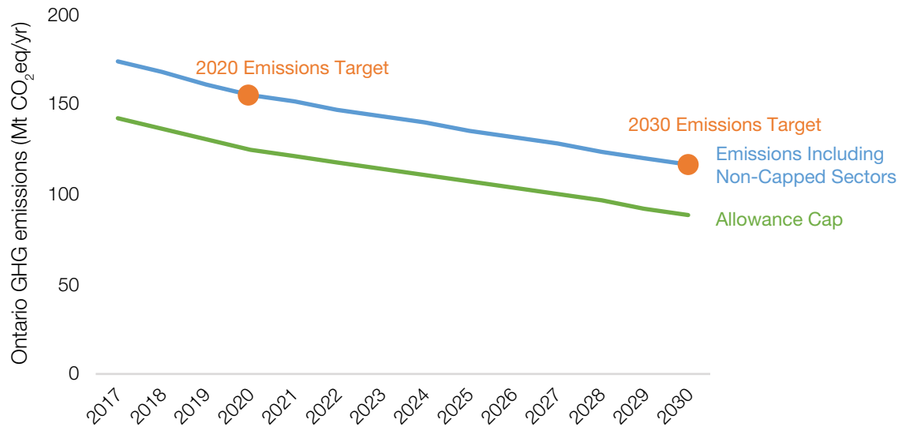



**Figure 15.1.** Ontario's emission reduction targets, cap on allowances for capped emitters, and estimate for non-capped sectors.

Source: Section 6(1) of the Climate Change Mitigation and Low-carbon Economy Act, 2016, for Ontario emission reduction targets; Section 54 of The Cap and Trade Program, O Reg 144/16 for Ontario's allowance caps to 2030.

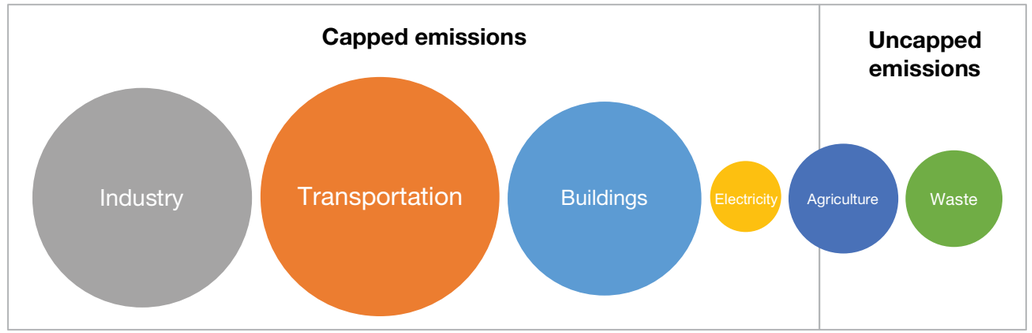



**Figure 15.2.** Ontario's emissions by economic sector, grouped according to whether they are capped under Ontario's cap and trade program.

Note: (a) Industry includes emissions from energy use and industrial processes and product uses. (b) Transportation and buildings are exclusively from energy use. (c) Agriculture includes emissions from energy use (capped) plus manure and fertilizer (uncapped).

Source: Environment and Climate Change Canada, National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada (2017), Part 3, Table A12-7, at 82.

Some of Ontario's capped emissions, about 22 Mt in 2015, come from industrial processes (e.g., $CO_2$ release from conversion of limestone to lime for cement production) and product use (e.g., solvents). At present, industrial non-combustion emissions may have few cost-effective reduction options.[3] Annual industrial process and product use emissions may therefore not drop significantly by 2030, with emissions increases due to economic growth offset by small reductions where opportunities do exist.

Deducting these 22 Mt from the cap of 88.5 Mt would leave only about 66.5 Mt of emission allowances for all other capped sources in Ontario in 2030, namely all fossil fuels used for energy. Ontario's fossil fuel suppliers will have a little more flexibility than this, because they can use up to 8% offset credits (and possibly some allowances from outside Ontario) to meet part of their compliance obligations. In total, emitters will be able to use up to 7 Mt of offset credits to increase their allowable emissions.

**88.5 Mt** ⇢ **2030 cap on GHG allowances**

**-22 Mt** ⇢ **assumed to stay constant from industrial processes & product use**

**≈66.5 Mt** ⇢ **2030 max GHG allowances for fossil fuel (plus up to 7 Mt of offset credits)**

| | 2015 GHGs | | 2030 limit |
|---|---|---|---|
| **Fossil fuel emissions:** (i.e., natural gas, gasoline, diesel, oil) | **126 Mt** | ⇢ | **66.5-73.5 Mt** |

66.5 Mt is approximately half of the emissions released through fossil fuel combustion in 2015, and 2030 is only 12 years from now. Ontario's population is expected to increase by about 13% in that time.[4]

As discussed below, the ECO estimates GHGs from Ontario's energy system (including transportation and heating) may need to drop about 45% in the next 12 years (see Figure 15.3). The 2050 GHG target of 80% reduction from 1990 levels will require an even more substantial drop in GHGs from the energy system, requiring dramatic changes over the following 20 years. We need to start planning for these changes today.

**GHGs from Ontario's energy system (including transportation and heating) may need to drop about 45% in the next 12 years.**



Q15
How much of Ontario's energy system must be electrified to meet Ontario's legal greenhouse gas limits?

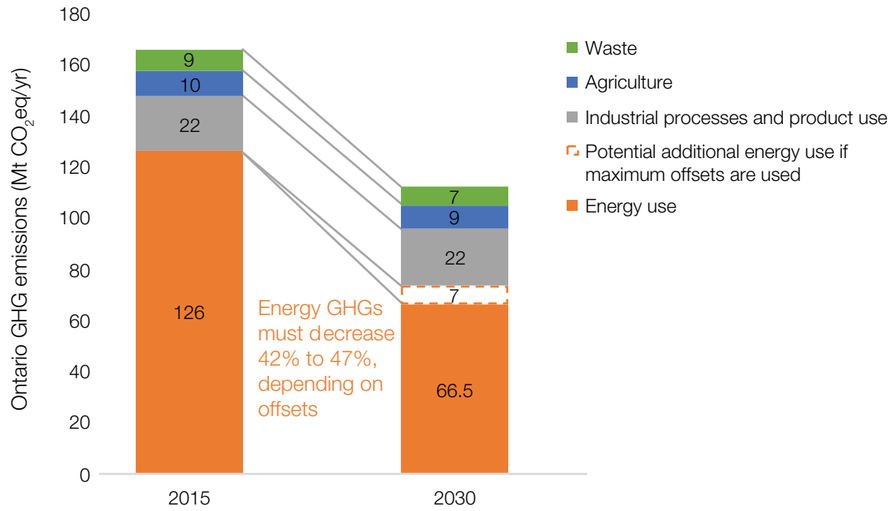



**Figure 15.3.** Ontario emissions by sector in 2015 compared to emissions by sector needed to meet cap and trade program requirements and satisfy Ontario's GHG-reduction target in 2030.

Note: The 2030 scenario assumes industrial process and product use emissions are constant and assumes waste and agriculture will achieve maximum potential reductions as outlined by the Trottier Energy Futures Project (linearly interpolated for 2030).[5] The scenario shown assumes Ontario will meet its 2030 emission reduction target with domestic emission reductions (including up to 7 Mt of offsets). However, Ontario's cap and trade system allows for allowances and offset credits from outside the province.

Source: ECO's analysis, using data from (1) Environment and Climate Change Canada, National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada (2017); (2) Section 6(1) of the Climate Change Mitigation and Low-carbon Economy Act, 2016; and (3) the Trottier Energy Futures Project.

**What can reduce fossil fuel emissions so much in so short a time?**

## What can reduce fossil fuel use?

What can reduce fossil fuel emissions so much in so short a time? More conservation, more efficient use of fossil fuels, and more renewable energy use (e.g., bioenergy) will all help.[6] But they are not likely to be enough, without substantial fuel switching to low-carbon electricity, because:

- the technical potential for conservation of natural gas is limited[7]
- there is limited potential to improve the efficiency of gasoline and diesel use for transportation, because current technology is approaching the technical limits of internal combustion engines[8]
- many current internal combustion engines for transportation have limited potential to use high levels of common biofuels (e.g., ethanol and biodiesel)[9]
- it is difficult to scale up other forms of low-carbon renewable fuels (e.g., renewable natural gas and renewable diesel) to replace a significant share of fossil fuel use, because potential supplies are small

and/or would have adverse environmental or societal impacts,[10] and

- direct uses of renewable energy like passive solar heating (i.e., uses excluding renewable electricity generation) are not able to scale up to meet existing needs in existing buildings (particularly during winter).

In contrast, Ontario could substantially scale up its supply of low-carbon electricity, although this would have its own challenges, including:

- motivating the switch to electricity despite its cost
- managing the winter peaks from additional electricity use in space heating
- finding environmentally appropriate generation sites (Q10), and
- ensuring that new low-carbon electricity (and any supporting transmission upgrades) are as efficient as possible to minimize the cost to customers.

## The Long-Term Energy Plan does not plan for this future

Ontario's 2017 Long-Term Energy Plan (LTEP) should have explored how Ontario can reduce its fossil fuel use enough to comply with the legally binding Climate Act, and selected a plan to do so. Instead, the Ministry of Energy chose to ignore the problem.

As shown in Q13, the LTEP is a critically important policy document. It is the government's "road map of the province's energy system over the next 20 years"[11] – and therefore essential information for businesses, the broader public sector, and the provincial government. It is the only document that outlines the province's macro-level, long-term energy policies. The LTEP is updated every three to four years, and is supposed to take into account, among other things, advancements in technology, evolving government policy, updated energy use data and supply and demand forecasts.

**Ontario's 2017 Long-Term Energy Plan should have explored how Ontario can reduce its fossil fuel use enough to comply with the Climate Act.**

In 2016, the province released two background documents to inform the 2017 LTEP, one about the electricity system (the Ontario Planning Outlook), the other about the remaining energy system fuels (the Fuels Technical Report). Each analyzed several future demand scenarios and their GHG impacts.[12] The ECO looked at the implications of these various scenarios for meeting Ontario's GHG targets in Developing the 2017 Long-Term Energy Plan.[13] Only by combining the most aggressive GHG reduction scenarios from both documents (which assumed that Ontario would have 2.4 million EVs by 2035, significant electrification of heating, and some electrification in the industrial sector), would Ontario's energy sector come close to providing a proportional share of GHG emissions reductions in 2030 (i.e., about 31% below 2015 emissions).[14] However, as mentioned above, the energy sector will actually have to decrease emissions 42% to 47% by 2030, significantly more than its proportional share of reductions, because some other GHG sources (e.g., industrial process and product use emissions) cannot feasibly be reduced.

The 2017 LTEP did not explore what it would take for Ontario's energy sector to reduce its annual emissions 31% – let alone what is actually needed (at least 42%) – by 2030. The government also did not facilitate informed public debate on the topic during the plan's development. The LTEP did not disclose the data and assumptions it depends on until 5 months after its release. More importantly, it did not (and still does not) provide energy or GHG forecasts for the energy sector as a whole. Because of the lack of data on fuels other than electricity, we cannot directly compare the LTEP's forecasted emissions for the energy sector as a whole to the scenarios in the background documents, but it appears to fall between two of the intermediate scenarios in the Ontario Planning Outlook and Fuels Technical Report (Outlook B and Outlook C). Both have much higher emissions than can be accommodated within Ontario's emissions cap.

Thus, the LTEP falls far short of the GHG reductions that must come from the energy sector.

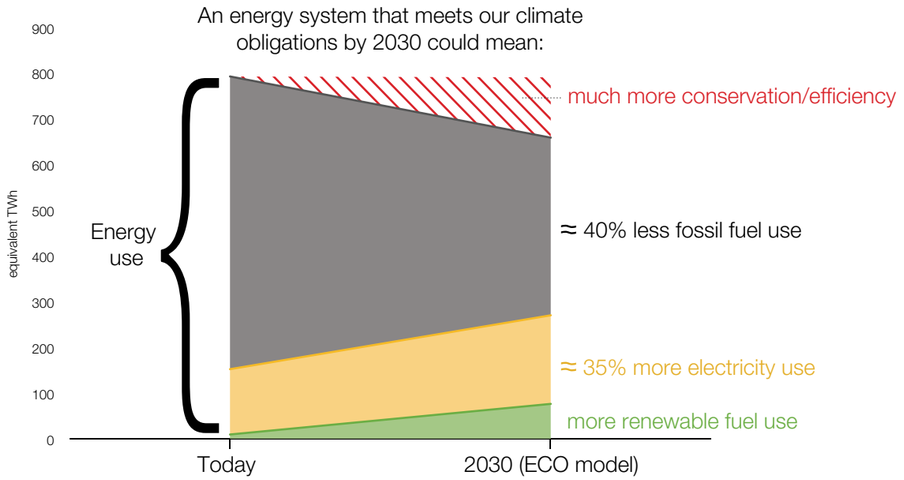
## Possible scenario to meet 2030 GHG limit

Since the LTEP failed to assess how Ontario can reduce its fossil fuel energy use enough to comply with its Climate Act, the ECO has illustrated the scale of the challenge by modelling one potentially-compliant scenario. What this scenario shows is that to meet legal GHG limits in 2030, Ontario will need to meet its energy needs by way of significant low-carbon electrification, and increased levels of conservation and renewable fuels (assuming no major developments in carbon capture and storage technology). Other scenarios are possible, for example, scenarios with even greater electricity conservation and renewable fuels, all of which should be rigorously analyzed by the province.

As discussed in other chapters, conservation can be the lowest cost (Q19) and the most environmentally friendly (Q10) option to meet increases in electricity demand, so should be prioritized in energy system planning.

The potentially-compliant scenario in Figure 15.4 shows one way in which Ontario could meet its 2030 GHG emissions target, through a combination of conservation, renewable fuels and electrification. It is based on our calculation that Ontario's energy sector

**To meet legal GHG limits in 2030, Ontario will need significant low-carbon electrification, conservation and renewable fuels.**



(including both fuels and electricity generation) can emit 73.5 Mt in 2030, at most. This is based on the same assumptions as Figure 15.3, namely:

- the 88.5 Mt allowance cap for that year set by O.Reg. 144/16
- minus 22 Mt for industrial process and product use emissions
  - (assuming they will remain at their current level (22 Mt) through 2030, with increases due to economic growth offset by small reductions in emission intensity for some uses)
- which leaves about 66.5 Mt in allowances for the energy sector
- plus up to 7 Mt in offset credits
  - (capped emitters can meet up to 8% of their compliance obligations from offset credits (7 Mt), if all possible offset credits were used by the energy sector, it would result in about 73.5 Mt in 2030).

In 2015, Ontario's energy sector emitted approximately 126 Mt, so 73.5 Mt in 2030 represents a 42% reduction.

The starting point for the potentially-compliant scenario in Figure 15.4 is a combination of Outlook F in the Fuels Technical Report and Outlook D in the Ontario Planning Outlook. Together, these two outlooks assume aggressive levels of conservation (of both fossil fuels and electricity), public transit ridership, alternative fuels (renewable natural gas, biodiesel, etc.), and moderate amounts of low-carbon electrification (electric cars, space heating). These two outlooks would result in energy sector emissions of 92 Mt in 2030 (87 Mt from fuels and 5 Mt from electricity generation). This exceeds maximum allowable energy sector emissions in 2030 by at least 19 MT. In order to stay within the GHG limit outlined above (i.e., 73.5 Mt), the scenario in Figure 15.4 assumes further emission reductions in 2030 would have to be achieved through a combination of:

- **Fuels conservation:** doubling of the conservation measures assumed in the Fuels Technical Report's Outlook F (more home insulation, more transit, etc.)
- **Electricity conservation:** of an extra 7 TWh a year of electricity demand (i.e., about 5% of overall demand[15]) that is additional to Ontario's existing electricity conservation target
- **Electrification:**[16]
  - of an additional 12 TWh a year worth of transportation fuel use,[17] and
  - of an additional 17 TWh a year worth of natural gas used for residential and commercial space heating.[18]

In this scenario, annual electricity demand in 2030 would be 194 TWh: 29 TWh from additional electrification minus 7 TWh of additional conservation equals a net increase of 22 TWh, on top of the 172 TWh from the most aggressive GHG-reduction scenarios considered in the LTEP background technical reports. 194 TWh in 2030 is about a third larger than the 2017 LTEP forecast of 145 TWh in 2030.

Increasing supply to meet this demand is well within the capabilities of Ontario's electricity industry if planning and development began immediately. More challenging could be persuading Ontario consumers and businesses to purchase heat pumps and electric vehicles in the required numbers.

The current LTEP plan, the most aggressive government planning scenarios, and the ECO's potentially-compliant scenario are illustrated in Figure 15.4 (energy use) and Figure 15.5 (emissions).

**In this scenario, annual electricity demand in 2030 would be 194 TWh, about a third larger than the 2017 LTEP forecast for 2030.**



How much of Ontario's energy system must be electrified to meet Ontario's legal greenhouse gas limits?
Q15

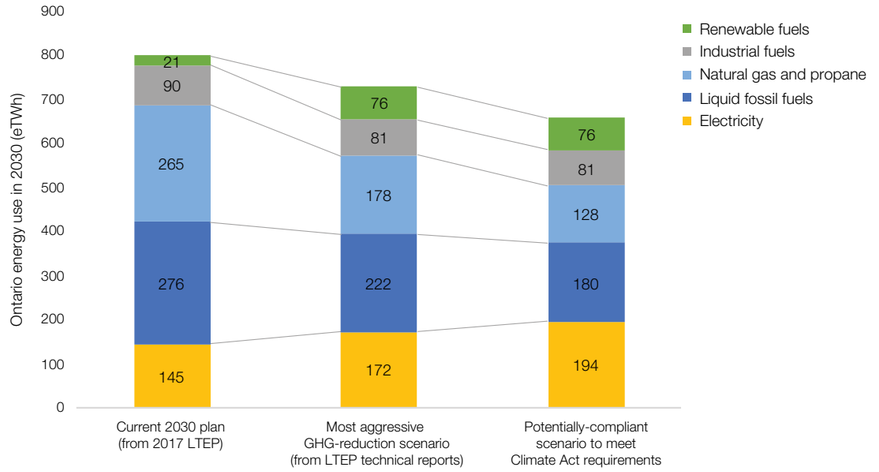



**Figure 15.4.** Ontario's 2030 energy use scenarios: (1) the 2017 LTEP, (2) the most aggressive GHG reduction scenario considered in the LTEP background technical reports, and (3) a potentially-compliant scenario developed by the ECO that could meet Climate Act requirements.

Notes: Because only the electricity sector is considered in the 2017 LTEP, Current 2030 plan assumes business-as-usual for other fuels (as per Fuels Technical Report Scenario B). The 'most aggressive GHG-reduction scenario' is a combination of Outlook D of the Ontario Planning Outlook (electricity) and Outlook F of the Fuels Technical Report.

Source: ECO's analysis.

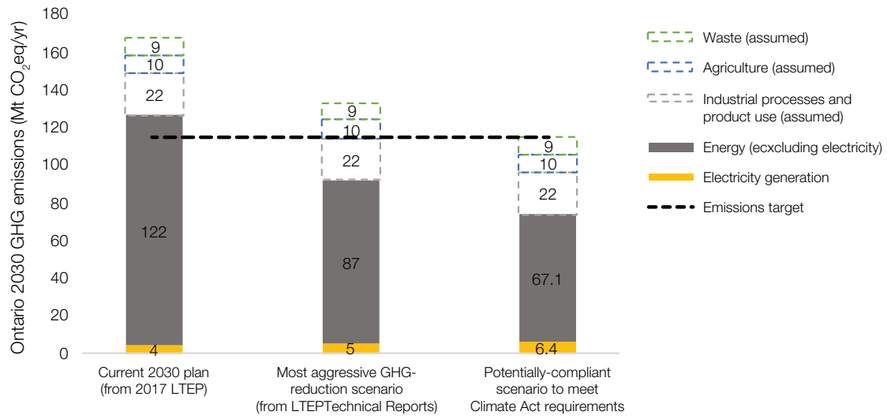



**Figure 15.5.** Ontario 2030 GHG emission scenarios: (1) 2017 LTEP, (2) the most aggressive GHG reduction scenario considered in the LTEP background technical reports, and (3) a potentially-compliant scenario that could meet Climate Act requirements.

Note: Industrial processes and product use, agriculture, and waste are assumed based on the findings of the Trottier Energy Futures Project.[19] For 'energy (excluding electricity)' and 'electricity generation', the 2017 LTEP is based on a combination of the electricity analysis from the 2017 LTEP and Outlook B of the Fuels Technical Report. The 'most aggressive GHG-reduction scenario' is a combination of Outlook D of the Ontario Planning Outlook and Outlook F of the Fuels Technical Report.

Source: ECO's analysis.

**The 2017 LTEP does not plan for adequate levels of electrification.**

What this modelling exercise makes clear is that the 2017 LTEP does not plan for adequate levels of electrification:

- the LTEP assumes 2.4 million electric vehicles using 8 TWh a year of electricity by 2035; the ECO's potentially-compliant scenario assumes more than three times this level in 2030, and
- while the LTEP mentions electric heat pumps, and their potential to reduce fossil fuel use for space and water heating, it does not plan for any related increase in electricity demand.

### Note to reader

This is only one possible scenario. **This scenario does not include a cost or feasibility analysis; it is provided for conceptual purposes only.** Other potentially-compliant scenarios could and should be considered, but any scenario that includes less growth in electricity demand would also need to include correspondingly greater conservation of fuels and/or conventional electricity uses. This is because the ECO's research suggests that any development of alternative fuels significantly beyond that assumed in the Fuels Technical Report's Outlook F would result in environmental damage.[20] The requirement for electrification would be even higher if the assumed levels of conservation and alternative fuels development were not achieved.

## Is the ECO scenario plausible?

Ontario has at least two major opportunities for substantial switching from fossil fuels to electricity:

- transportation of passenger vehicles, and
- space and water heating.[21]

Electrification of industry is not discussed below, as it requires a more detailed, complex, and industry-specific analysis. Much of industry's carbon footprint is due to process reactions and related high-temperature process heating, which cannot feasibly be electrified.[22] However, some lower temperature space and water-heating electrification potential also exists within industry.[23]

**Ontario has at least two major opportunities for substantial switching from fossil fuels to electricity.**

### Transportation

Transportation is Ontario's largest source of greenhouse gas emissions (39% in 2015), and it has grown an average of 1.4% per year since 1990.[24] Within transportation, passenger vehicles are Ontario's largest single source of greenhouse gas emissions (21% of total 2015 emissions), although emissions from freight are the fastest growing.[25]

The 2017 Long-Term Energy Plan assumes that 2.4 million EVs will be on Ontario's roads by 2035.[26] This would mean about 25% of all cars, trucks and other vehicles on the road,[27] and 50% of new vehicle sales, are electric by 2035. Note that this is merely an assumption, not an official target, and Ontario does not have a plan to achieve it. The ECO model suggests that three times this level of planned transportation electrification is needed. (In contrast, EVs made up only 1.6% of new vehicle sales in 2017,[28] despite subsidies that already make EV ownership cost-competitive, especially for those who drive longer distances or keep their cars longer than 5 years.)

**Subsidies already make EV ownership cost-competitive.**

Ontario's only official EV target is for 5% of new car sales to be electric or hydrogen by 2020.[29] The need for a longer-term, more ambitious target is clear.

Electrifying transportation is recognized across the globe as good public policy, and is a prominent feature of countries' pledges to the Paris Agreement. These targets mean many jurisdictions are far ahead of Ontario. Many countries have announced that they will be banning the sale of gasoline- and diesel-fueled vehicles altogether, some as early as 2025, others by 2040.[30] These planned bans are driven both by national climate targets, and by local air pollution and health objectives. Fossil-fueled vehicles are a major cause of urban air pollution. For example, in 2017, 39% of Norway's new vehicle sales were plug-in electric vehicles, including hybrid vehicles, it was 52%.[31]

Electric vehicles might also provide important electricity grid-balancing opportunities. For example, if EVs charge during low demand periods (e.g., overnight), they can provide a productive use of Ontario's surplus capacity of clean electricity during low demand periods (Q16). The amount of power curtailed in 2017 due to lack of demand was enough to power the projected 2.4 million EVs, and the Ontario government has committed to providing four years of free overnight charging.[32] EVs may also provide electricity storage for homes or the grid, though this might shorten the life of the vehicle's expensive battery (Q16).[33] Ontario's electricity grid operator and local electricity distribution companies are working on how to manage this intricate new relationship, but overall, it appears that EVs can be a net benefit to the grid.[34]

### Space and water heating

Ontario's Independent Electricity System Operator (IESO) identified space and water heating as having the largest quantitative potential for electrification.[35] Despite this, the 2017 LTEP forecast, though it discusses low-carbon fuel alternatives for heating at several points, does not appear to assume any significant electrification of heating, beyond the minimal, short-term commitments in the five-year Climate Change Action Plan.[36]

**Electrification of building heating is critical.**

Buildings generate about 22% of Ontario's GHG emissions, primarily due to the use of natural gas for space and water heating.[37] In 2015, three expert reports to the Canadian government advised that electrification of building heating is critical to achieving a low-emissions energy system.[38] This is particularly true in Ontario, which has a higher ratio of natural gas to electricity use for space and water heating than most other provinces (Q8), and a low-carbon electricity supply.

Because heat pumps can replace both furnaces and also offer air conditioning, their capital costs can be comparable (at least for air source heat pumps; ground source heat pumps have higher upfront costs but lower operating costs, due to their higher efficiency).[39] Air conditioning may be increasingly attractive to both residents and businesses as summer heat waves become more common. The Government of Ontario also subsidizes some of the capital costs for electric heat pumps for homes heated by propane,

**Heat pumps also offer air conditioning, which will be increasingly attractive as summer heat waves become more common.**

oil or electricity through the Green Ontario Fund and saveONenergy electricity conservation programs. However, homes heated by natural gas (the largest share of space heating by far) are not currently eligible for incentives for air source heat pumps.[40] As a result, electrification of heating will likely be more challenging than electric vehicles particularly for residents without the capital or tenants without permission to make the change.

The operating costs of electric pump heating are high compared to natural gas heating. Although heat pumps typically use less than half as much energy to heat than natural gas furnaces, electricity is far more than twice the price of natural gas (although the price differential is not as great during off-peak hours, and the Fair Hydro Plan has further reduced this disparity, $ Q8) (see Figure 15.6).[41] Heat pumps are already cost-competitive against less-efficient fuel oil, propane or electric baseboard heating,[42] especially when buildings are more energy efficient.

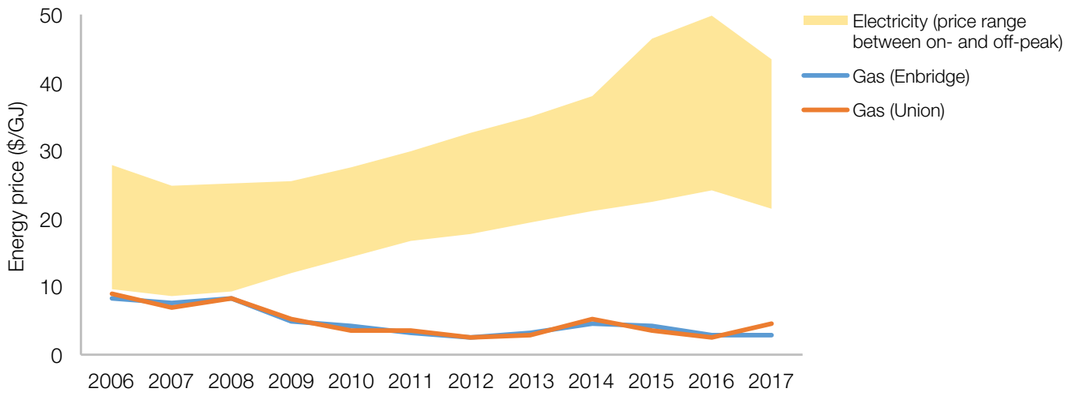



**Figure 15.6.** A comparison of recent electricity and natural gas prices in Ontario.

Note: Rates do not include delivery charges. Union Gas includes transportation charges as of January 2017.

Source: "Historical natural gas and electricity rates", online: Ontario Energy Board <www.oeb.ca/rates-and-your-bill/natural-gas-rates/historical-natural-gas-rates>. [Accessed December 2017]





Carbon pricing can help incent fuel switching to lower carbon energy sources.[43] However, forecasted carbon prices from Ontario's cap and trade program are too low to stop fuel switching away from electricity in the space heating sector, let alone incent fuel switching towards electricity.[44] Carbon pricing is projected to add less than $1/GJ natural gas by 2020. Currently, electricity is about $30/GJ on average, while natural gas is about $5/GJ (see Figure 15.6). In other words, current carbon prices alone are unlikely to make switching to electric heating financially attractive.

A second challenge with electric heating (if not managed carefully) is related to the electricity grid. Electricity used for heating would be concentrated in the coldest months of the year, and could increase the use of Ontario's electricity in periods of peak demand. Since Ontario currently uses natural gas-fired electricity to meet peak demand, this could increase emissions. Existing technologies, such as smart thermostats and thermal storage (e.g., ceramic heaters), have some ability to reduce peak demand, and thus use of natural gas power plants. These technologies can help spread heating loads over the course of a day. There would be little GHG benefit, and a considerable cost penalty, to converting heating from direct use of natural gas to natural gas-fired electricity, so it is important that the additional electricity source at the margin be low-carbon.

How to meet incremental winter electricity demand without ramping up natural gas-fired electricity generation? One option is to use natural gas furnaces as backup heaters on the coldest days, when heating demand is at its highest and heat pump performance would be at its worst. The rest of the heating (and cooling) load would be provided by small, add-on heat pumps, supplying the majority of the energy needed over the course of the year from low-carbon electricity (see Figure 15.7.).[45]

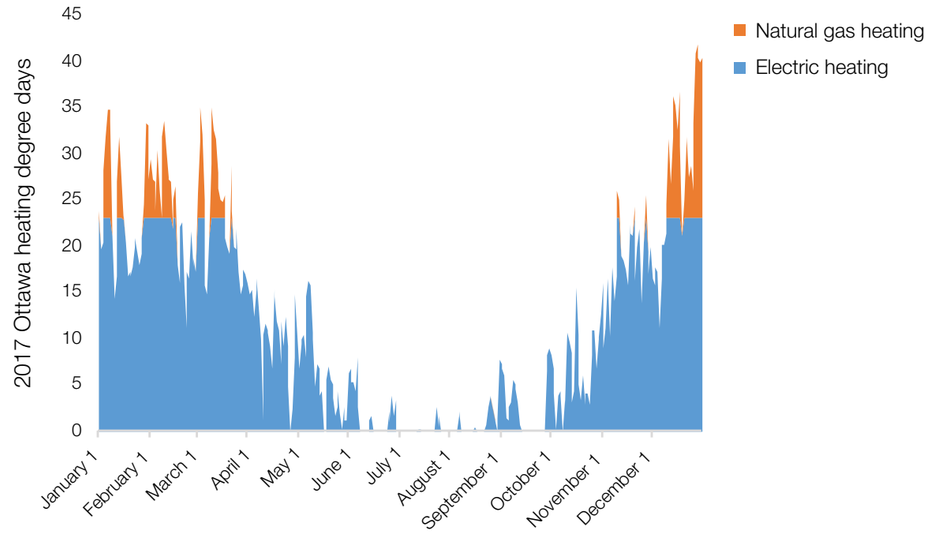



**Figure 15.7.** Electric and natural gas heating systems can work together to reduce the costs of emission reductions.

Note: -5 degrees is assumed to be the threshold at which the natural gas furnace takes over heating.

Source: "Data Download for Ottawa", online: Weatherstats.ca <ottawa.weatherstats.ca/download.html>. [Accessed 20 March 2018]

More opportunities exist in new buildings. They can be built to higher energy efficiency levels so that the cost premium for using electric heating (and the grid impact) is not as great. They can also be designed to make better use of building or neighbourhood-scale thermal storage, and higher-efficiency ground source heat pumps, to reduce winter peak demand.[46]

## Conclusion

Ontario is facing a major transformation of its energy system. In order to comply with the limits on fossil fuel emissions in the Climate Act, and to meet Ontario's GHG reduction targets, Ontario must plan for a future where electricity use rises steadily (about 35% by 2030), in addition to aggressive increases in conservation and in renewable fuel production. This is a big shift in a short time. The average life span of a vehicle and a furnace is 15 to 25 years. If Ontario is to meet its climate targets and emissions caps, serious planning needs to start now.

This transformation to electricity offers important benefits but also hard choices, which the government should make openly and in full consultation with Ontarians. The 2017 Long-Term Energy Plan does not do these things, and does not fulfill the Ministry of Energy's legal obligation to plan Ontario's energy system, which includes planning for all fuels (not just electricity).

**If Ontario is to meet its climate targets and emissions caps, serious planning needs to start now.**





## Endnotes

1. Section 6(1) of the Climate Change Mitigation and Low-carbon Economy Act, 2016.
2. Section 6(1) of the Climate Change Mitigation and Low-carbon Economy Act, 2016, for Ontario emission reduction targets; Section 54 of The Cap and Trade Program, O.Reg 144/16 for Ontario's allowance caps to 2030.
3. Trottier Energy Futures Project Partners, Canada's Challenge and Opportunity, Transformations for Major Reductions in GHG Emissions, Full Technical Report and Modelling Results (Ottawa: The Canadian Academy of Engineering, April 2016) at 18.
4. Ontario's population in 2015 was 13,797,038, and the reference case projection for 2030 is 15,606,083 ("Ontario Population Projections Update, 2016-2041", online: Ministry of Finance <www.fin.gov.on.ca/en/economy/demographics/projections/table1.html>. [Accessed 15 March 2018])
5. All sectors need to make changes in order to meet Canada's 2050 climate change target, but there are limits for some sectors. By 2050, potential industrial process emissions reductions are negligible, agricultural emissions reductions are not likely to exceed 15%, and the most ambitious waste emission reductions are 50%. (Trottier Energy Futures Project Partners, Canada's Challenge and Opportunity, Transformations for Major Reductions in GHG Emissions, Full Technical Report and Modelling Results (Ottawa: The Canadian Academy of Engineering, April 2016) at 12, 15, 19 and 22.)
6. Carbon capture and storage from fossil fuel combustion, if and when it becomes commercially available, could also help.
7. By 2030, the technically achievable potential for natural gas conservation in Ontario is considered to be up to 45%, though not in a manner that is economic, that looks more like 26%, a manner that is practical looks more like 18%. (ICF International, Natural Gas Conservation Potential Study (Toronto: Ontario Energy Board, 7 July 2016) at ii and iv); In high electrification scenarios, the economic conservation potential is lower. (Navigant, Fuels Technical Report (Ministry of Energy: Toronto, September 2016) at 36.)
8. David Chandler, "Explained: The Carnot Limit", MIT News (19 May 2010), online: <news.mit.edu/2010/explained-carnot-0519>; However there remains some potential efficiency gains within that limit, e.g., through the use of lighter-weight car manufacturing materials ("Technology Collaboration Programmes: Advanced Materials for Transportation", online: International Energy Agency <www.iea.org/tcp/end-use-transport/amt/>. [Accessed 23 February 2018])
9. Provincial renewable content requirements for gasoline (10%) and diesel (4%) are approximately the quantities of ethanol and biodiesel, respectively, that can be widely used in conventional vehicles. Relatively low cost vehicle modifications can enable the use of higher quantities of ethanol or biodiesel.
10. The Ontario Planning Outlook forecasts 20% alternative fuels penetration by 2035 as the most aggressive future scenario, however this assumes significantly lower fossil fuel demand (Navigant, Fuels Technical Report (Ministry of Energy: Toronto, September 2016) at 38); Only 5.6% of 2010 natural gas distribution in Ontario is the estimated renewable natural gas potential in Ontario (Environmental Commissioner of Ontario, Every Drop Counts: Reducing the Energy and Climate Footprint of Ontario's Water Use (Toronto: ECO, May 2017) at 120).
11. Ontario Government, News Release, "Backgrounder: 2017 Long-Term Energy Plan" (26 October 2017).
12. The Ontario Planning Outlook considers four scenarios for electricity to 2035, called "A" (lowest level of electricity use) to "D" (highest level of electricity use, due to electrification of transportation and heating). The Fuels Technical Report considers five scenarios for all other fuel use, called "B" (highest level of fossil fuel use) to "F" (lowest level of fossil fuel use). Scenarios "B" through "D" for the fuels sector make the same assumptions about electrification of fossil fuel use that are in the electricity scenarios "B" through "D". Fuel sector scenarios "E" and "F" both assume the same level of electrification as Scenario "D", but also assume additional measures to reduce fossil fuel use.
13. Environmental Commissioner of Ontario, Developing the 2017 Long-Term Energy Plan, Special Report (Toronto: ECO, December 2016).
14. Ibid, at Figure 3.
15. Based on projected electricity demand in Ontario Planning Outlook's Outlook B.
16. The potentially-compliant scenario in Figure 15.4 is based on the estimate that electrification can reduce energy sector GHG emissions by approximately 1 Mt for every additional 2 TWh of electricity generation. This estimate is based on the following:
    - electric vehicles and heat pumps are more efficient than conventional vehicles and furnaces (EVs can be up to 3 times more efficient than combustion engines, whereas heat pumps can only be up to 2 times more efficient than natural gas furnaces), and
    - additional electricity grid supply can be provided with a combination of wind, solar, Ontario and imported hydro and some natural gas generation (to supplement when demand is high and wind/renewables are low). Comparing Outlook B and Outlook D in the IESO's Ontario Planning Outlook, an additional 29.6 TWh of electricity generation is estimated to increase emissions by 1.5 MT, suggesting an emissions intensity factor of 51 g/kWh or 14 g/MJ. This is significantly lower than the emissions intensity factors for natural gas (50 g/MJ) and liquid fossil fuels (around 71 g/MJ), and the difference is even greater considering that each unit of electric energy can replace 2 to 3 units of fossil energy.
17. i.e., a further 15% reduction in transportation fuel use from the Fuels Technical Report's Outlook F.
18. i.e., a further 34% reduction in natural gas and renewable natural gas use for space heating. The Fuels Technical Report's Outlook F already assumes that the use of other fuels for space heating will be almost eliminated in 2030 through electrification and conservation.
19. Trottier Energy Futures Project Partners, Canadas' Challenge & Opportunity, Transformations for major reductions in GHG emissions (Ottawa: The Canadian Academy of Engineering, April 2016) at 12, 15, 19 and 22.
20. Environmental Commissioner of Ontario, "Ethanol in Gasoline" in Facing Climate Change, Annual Greenhouse Gas Progress Report 2016 (Toronto: ECO, November 2016) at 121.
21. Independent Electricity System Operator, Ontario Planning Outlook (IESO: Toronto, 1 September 2016) at 7.
22. International Energy Agency, World Energy Outlook 2017 (OECD/IEA: Paris, 2017) at 318-320.
23. Ibid.
24. Environmental Commissioner of Ontario, Every Joule Counts, Annual Energy Conservation Progress Report 2016/2017 (Volume Two) (Toronto: ECO, August 2017) at 24.

25. Environmental Commissioner of Ontario, Ontario's Climate Act: From Plan to Progress, Annual Greenhouse Gas Progress Report 2017 (Toronto: ECO, January 2018) at 32-33.

26. Ministry of Energy, Delivering Fairness, Ontario's Long-Term Energy Plan 2017 (Toronto: Ministry of Energy, 26 October 2017) at 37.

27. In 1999, just over 6 million light-road motor vehicles (vehicles weighing less than 4,500 kgs) were registered, and in 2016 it had risen to just over 8 million, a linear forecast estimates that if the same year-over-year growth continues, by 2035, it would reach 9.8 million. (Calculations by the ECO, based on historical car registration data from Statistics Canada, Table 405-0004 - Vehicle Registrations, annual (number).)

28. Eric Schmidt, "Electric Vehicle Sales in Canada: 2017 Final Update", FleetCarma (8 February 2017), online: <www.fleetcarma.com/ev-sales-canada-2016-final/>.

29. Government of Ontario, 2016 Ontario Climate Change Action Plan (Toronto: Government of Ontario, 2016) at 19.

30.

**Examples of jurisdictions that have committed to ban the sale or use of combustion-engine vehicles (non-exhaustive)**

| Jurisdiction | Ban details | Source |
|---|---|---|
| Norway | Bans sales of fossil fuelled cars by 2025 | Jess Staufenberg, "Norway to 'completely ban petrol powered cars by 2025'", Independent (4 June 2016), online: <www.independent.co.uk/environment/climate-change/norway-to-ban-the-sale-of-all-fossil-fuel-based-cars-by-2025-and-replace-with-electric-vehicles-a7065616.html>. |
| India | Selling only electric vehicles by 2030 | Jackie Wattles, "India to sell only electric cars by 2030", Money.CNN (3 June 2017), online: <money.cnn.com/2017/06/03/technology/future/india-electric-cars/index.html>. |
| Britain | ban sale of all new petrol and diesel cars and vans from 2040 | Anushka Asthana and Matthew Taylor, "Britain to ban sale of all diesel and petrol cars and vans from 2040", The Guardian (25 July 2017), online: <www.theguardian.com/politics/2017/jul/25/britain-to-ban-sale-of-all-diesel-and-petrol-cars-and-vans-from-2040>. |
| France | ban sales of petrol and diesel cars by 2040 | Angelique Chrisafis and Adam Vaughan, "France to ban sales of petrol and disel cars by 2040", The Guardian (6 July 2017), online: <www.theguardian.com/business/2017/jul/06/france-ban-petrol-diesel-cars-2040-emmanuel-macron-volvo>. |
| Paris | Bans use of all combustion-engine cars by 2030 | "Corrected- Paris plans ban on combustion-engine cars by 2030", Reuters (12 October 2017), online: <www.reuters.com/article/france-paris-autos/corrected-paris-plans-ban-on-combustion-engine-cars-by-2030-idUSL8N1MN13H>. |
| Netherlands | All new sales to be emissions free by 2030 | Fred Lambert, "The Dutch government confirms plan to ban new petrol and diesel cars by 2030", Electrek (20 October 2017), online: <electrek.co/2017/10/10/netherlands-dutch-ban-petrol-diesel-cars-2030-electric-cars/>. |

31. Camilla Knudsen and Alister Doyle, "Norway powers ahead (electrically): over half new cars sales now electric or hybrid", Reuters (3 January 2018), online: <www.reuters.com/article/us-environment-norway-autos/norway-powers-ahead-over-half-new-car-sales-now-electric-or-hybrid-idUSKBN1ES0WC>.

32. 10 TWh of power was curtailed in 2017 (Q7). Typically, an electric vehicle with a daily commuting distance of 40km requires 6-8kWh of energy to recharge (Eric Schmidt, The Impact of Growing Electric Vehicle Adoption on Electric Utility Grids (Fleet Carma, 28 August 2017), online: <www.fleetcarma.com/impact-growing-electric-vehicle-adoption-electric-utility-grids>); 8kWh x 365 days x 2.4 million EVs ≈7 TWh; The province also predicts 8 TWh to be the electricity demand of 2.4 million EVs. (Independent Electricity System Operator, Ontario Planning Outlook (Toronto: IESO, 1 September 2016) at 7.)

33. Ontario Society of Professional Engineers, Ontario's Energy Dilemma: Reducing Emissions at an Affordable Cost (Toronto: OSPE, March 2016) at 22.





34. Fleet Carma is running various pilots across North America to examine different ways to manage the grid impacts of EV charging (see Q16 for further details).

35. About 58 TWh by 2035 of additional electrification is considered in Outlook D of the OPO in the combined residential, commercial and industrial sectors, as compared to an additional 6 TWh considered in Outlook D for electric vehicles. (Independent Electricity System Operator, Ontario Planning Outlook (Toronto: IESO, 1 September 2016) at 7.)

36. The 2017 LTEP electrification assumptions for the residential and commercial sectors are considered to be equivalent to those in the 'Business-as-Usual' scenario, OPO, Outlook B. (Independent Electricity System Operator, Ontario Planning Outlook (Toronto: IESO, 1 September 2016) at 7; Ministry of Energy, Delivering Fairness, Ontario's Long-Term Energy Plan 2017 (Toronto: Ministry of Energy, 26 October 2017) at 42.)

37. In 2015, GHG emissions from Ontario's residential sector were due primarily to space and water (20.4 of 20.7 Mt), as were commercial/institutional sector GHG emissions (11.9 of 12.3 Mt). Data not available for Ontario's industrial sector. ("Comprehensive Energy Use Database: Ontario", online: Natural Resources Canada <oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm>. [Accessed 15 March 2018])

38. Trottier Energy Futures Project Partners, Canada's Challenge and Opportunity, Transformations for Major Reductions in GHG Emissions, Full Technical Report and Modelling Results (Ottawa: The Canadian Academy of Engineering, April 2016) at 166, 171-175; Expert Panel on Energy Use and Climate Change, Technology and Policy Options for a Low-Emission Energy System in Canada (Ottawa: Council of Canadian Academies, 2015) at 84; C Bataille et al., Pathways to deep decarbonization in Canada (SDSN & IDDRI, September 2015) at 26.

39. Without considering the impact of existing subsidies. (ICF, Marginal Abatement Cost Curve for Assessment of Natural Gas Utilities' Cap and Trade Activities (EB-2016-0359) (Toronto: ICF, 20 July 2017) at A-2.)

40. Homes heated by natural gas are eligible for incentives for ground source (geothermal) heat pumps.

41. Independent Electricity System Operator, An Examination of the Opportunity for Residential Heat Pumps in Ontario (Toronto: IESO, 6 March 2017) at 3; Based on 2017 prices in Toronto, electric heat pumps are still more expensive to operate than a gas boiler based on calculations by the Canadian Green Building Council, even when assuming a carbon tax of $50/tonne. (Canada Green Building Council, A Roadmap for Retrofits in Canada: Charting a path forward for large buildings (Ottawa: CGBC, 2017) at 19.)

42. Cold climate air source heat pumps have paybacks less than 5 years vs. fuel oil or electric baseboard heating. (Independent Electricity System Operator, An Examination of the Opportunity for Residential Heat Pumps in Ontario (Toronto: IESO, 6 March 2017) at 19.

43. Ministry of Energy, Delivering Fairness, Ontario's Long-Term Energy Plan 2017 (Toronto: Ministry of Energy, 26 October 2017) at 42.

44. Dave Sawyer, Jotham Peters & Seteon Stiebert, Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program, Overview of Macroeconomic and Household Impacts of Ontario's Cap and Trade Program (Ottawa: EnviroEconomics, 27 May 2016) at 10. (The 2017 price impact of Ontario's cap and trade program on the cost of a 1 m3 of natural gas is assumed to be $0.033. As 26.853 m3 are in 1 GJ, then $0.033 X 26.853 m3 = $0.886/GJ).

45. Tyler Hamilton, "Is reducing natural gas the key to hitting Ontario's climate targets?", TVO.org (3 May 2016) online: <tvo.org/article/current-affairs/climate-watch/is-reducing-natural-gas-the-key-to-hitting-ontarios-climate-targets>.

46. Enbridge is considering a geothermal utility model for new building developments in Ontario. (Jennifer Runyon, "Canadian-Based Enbridge Embark on Geothermal Plan" Renewable Energy World (18 April 2017), online: <www.renewableenergyworld.com/articles/2017/04/canadian-based-enbridge-embarks-on-geothermal-plan.html>.)