

Phasing-Out Ontario's Gas-Fired Power Plants:

A ROAD MAP

April 9, 2020




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Introduction

According to Ontario's Independent Electricity System Operator (IESO), **the greenhouse gas (GHG) pollution from Ontario's gas-fired power plants will increase by more than 300% by 2025 and by more than 400% by 2040** as the province uses gas to replace aging nuclear plants and to meet growing demand for electricity from population growth and increased electrification. If this occurs, Ontario will lose 35% of the pollution reduction benefits it achieved by phasing-out its dirty coal plants.

This report provides an alternative road map for how Ontario can phase-out its gas plants by importing Quebec waterpower and by investing in energy efficiency and cost-effective Made-in-Ontario renewable energy while meeting future electricity demand.

This report will show that if we ramp up our expenditures on energy efficiency and renewable energy and ramp down our expenditures on much higher cost nuclear re-build projects, we will be able to simultaneously phase-out the gas plants, achieve Ontario's 2030 climate target, move our province towards a 100% renewable electricity grid and lower our electricity bills.

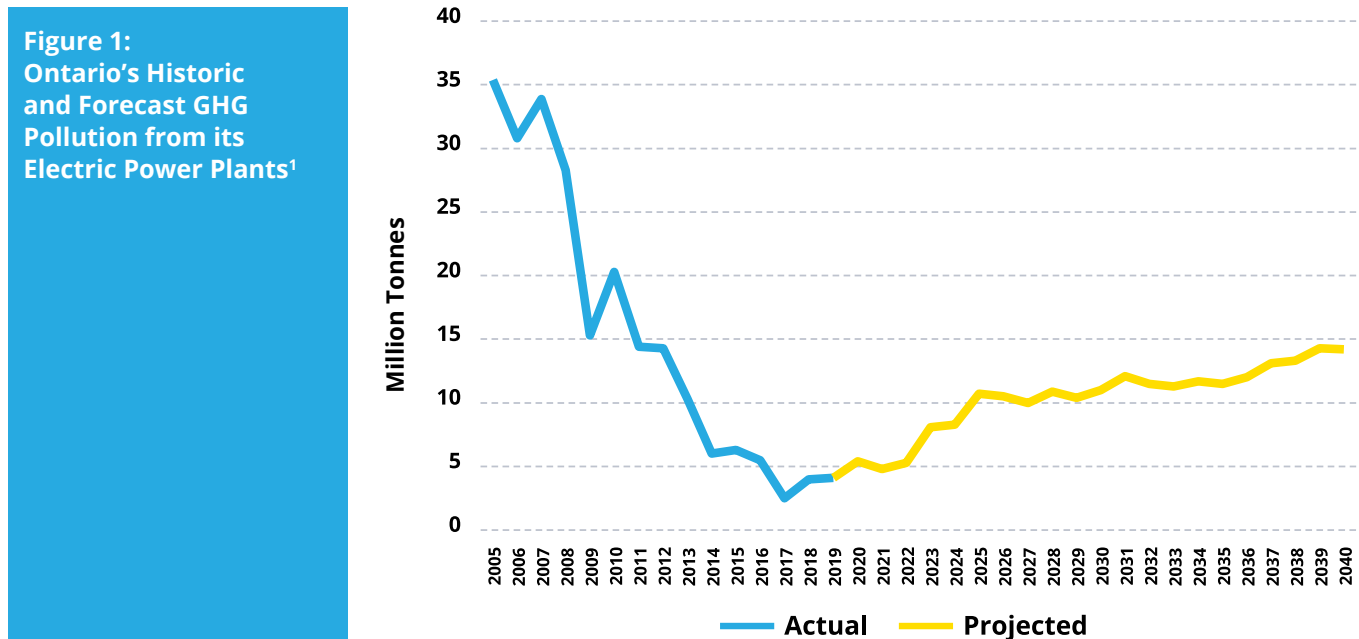


Thanks to the M.H. Brigham Foundation, the Green Sanderson Family Foundation and the Taylor Irwin Family Fund at the Toronto Foundation for their generous support.

Ontario Power Generation's Lennox Gas-Fired Power Plant, near Napanee.

Historic and Forecast GHG Pollution from Ontario's Electric Power Plants

As Figure 1 shows the **GHG pollution from our electricity system fell by 93% between 2005 and 2017** due to the phase-out of Ontario's coal plants. Specifically, it fell from 35.4 million tonnes in 2005 to 2.5 million tonnes in 2017.



Unfortunately, as Figure 1 reveals, in 2018 the GHG pollution from Ontario's power plants started to rise again – a rise that the IESO is forecasting will continue for the next 20 years. Specifically, the IESO is forecasting that the GHG pollution from Ontario's gas-fired power plants will rise by more than 300% by 2025 and by more than 400% by 2040, relative to the 2017 baseline.

The IESO's forecast is based on the following three assumptions.

1. Ontario's demand for electricity will rise by approximately 1% per year.²
2. The Pickering Nuclear Station will close in 2024.³
3. Virtually all of our need for new electricity resources due to rising demand and the closure of the Pickering Nuclear Station will be met by ramping up the output of the province's gas-fired power plants.⁴

The IESO's forecast is a reasonable assessment of the implications of the Ford Government's electricity plan, which is described on page 4.

The Ford Government's Electricity Plan

The Ford Government is planning to meet Ontario's electricity needs between 2020 and 2040 by:

1. **Ramping up the output of the province's existing gas-fired power plants;**⁵
2. **Re-building 10 of Ontario's aging nuclear reactors at a forecast cost of \$25.8 billion;**⁶
3. **Working with New Brunswick and Saskatchewan to develop and deploy small modular nuclear reactors;**⁷ and
4. **Upgrading Hydro One's transmission system to enable it to import up to 1,650 megawatts (MW) of firm power from Quebec by December 2022.**⁸

The Ford Government's plan does **not** include:

1. **Any new energy efficiency investments to reduce electricity demand post-2020⁹ ;**
2. **Any new electricity supply agreements with Hydro Quebec; or**
3. **Any new investments in Made-in-Ontario renewable electricity projects.**

Since new small modular nuclear reactors and re-building the Darlington and Bruce Nuclear Stations are the highest cost options to keep our lights on, the Ford Government's plan will lead to **rising electricity rates** as well as **rising GHG pollution**.

Enbridge's proposed fracked gas Hamilton pipeline



To help fuel the planned ramp up of Ontario's gas plants, Enbridge is seeking permission from the Ontario Energy Board **to build a large pipeline in Hamilton to enable it to import more fracked gas from Pennsylvania.**

In addition, the Hamilton pipeline would allow Pennsylvania fracked gas to flow through Canada to U.S. utilities in Maine and New Hampshire. According to a report prepared for Enbridge, this gas must be routed through Canada because U.S.

regulatory authorities will not permit the construction of new pipelines to deliver fracked Pennsylvania gas to New England.

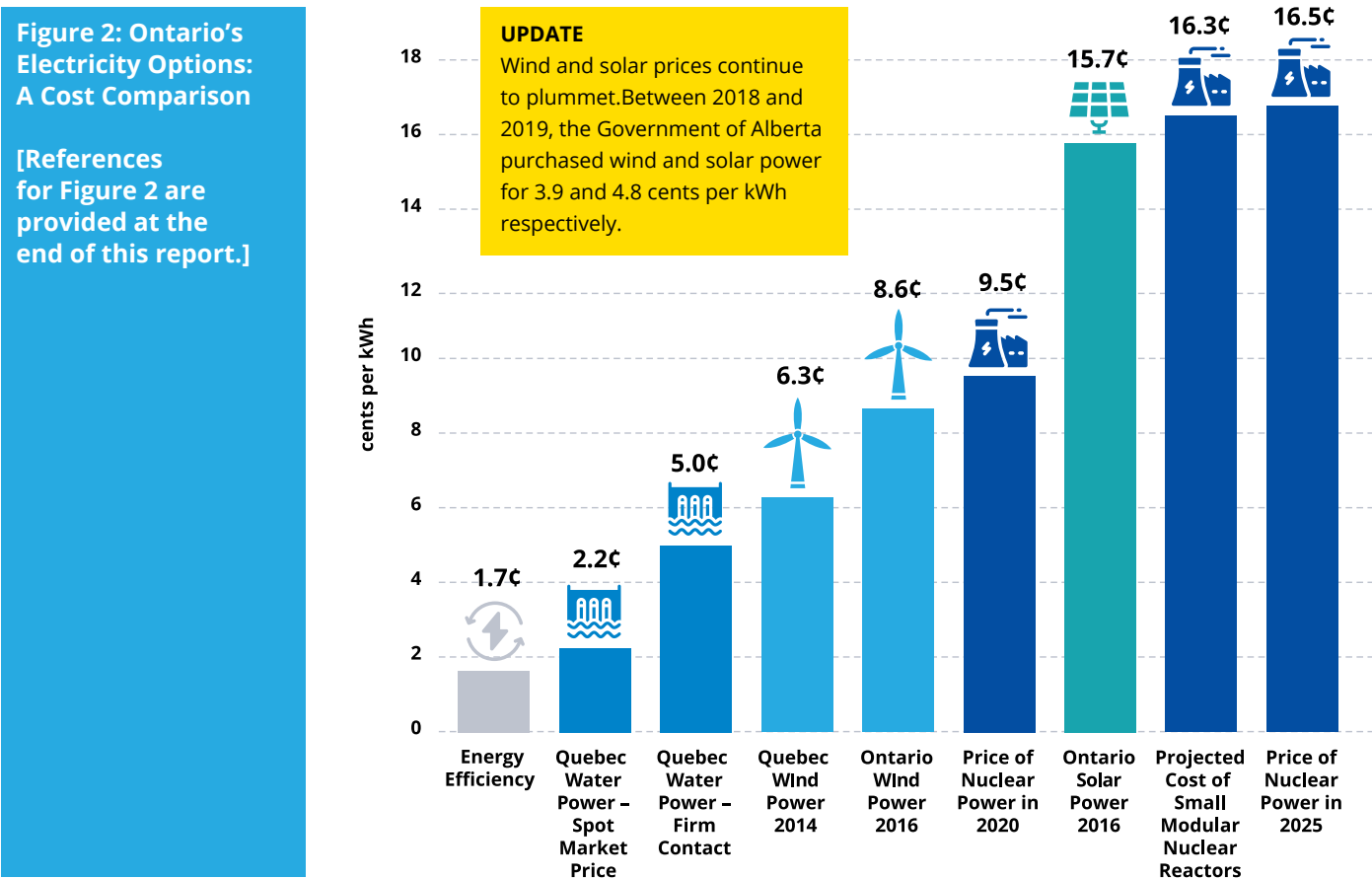
To add insult to injury, Enbridge's proposed pipeline is not financially self-sustaining. As Enbridge admits, its forecast revenues are \$120 million less than its forecast costs. Instead of proposing to raise rates for the Ontario gas plants and U.S. utilities the pipeline is designed to serve, **Enbridge is proposing to raise rates for all**

Canadian gas consumers by \$120 million to subsidize the cost of the pipeline.

The capital cost of the proposed Hamilton Pipeline is \$204 million. If Enbridge were to spend \$204 million on energy efficiency programs instead of the proposed pipeline, it could reduce its customers energy bills by \$963 million to \$3.4 billion and also reduce their GHG pollution.¹⁰

How Ontario can phase-out its gas plants and lower our electricity bills

Figure 2 compares the costs of various options to keep our lights on. Specifically, it shows that the Ford Government’s preferred nuclear options are significantly more costly than energy efficiency, Quebec power and Made-in-Ontario renewable electricity.



As Figure 2 shows, Ontario Power Generation's (OPG) price for nuclear power in 2020 is 9.5 cents per kilowatt-hour (kWh). **According to OPG, its price of nuclear electricity must rise to 16.5 cents per kWh by 2025 to pay for the re-building of the Darlington Nuclear Station.**

Small modular nuclear reactors are also a very high-cost option. The Canadian nuclear industry is forecasting that their cost will be **16.3 cents per kWh**. However, they note that if there is a 3% capital cost overrun, the cost will rise to 21.5 cents per kWh. They are hoping that the first commercial small nuclear reactor will be in-service by 2030, but currently no commercial designs have been approved in Canada and proponents have not explained what will be done with radioactive waste from these new reactors. (After 50 years of commercial operation of nuclear reactors, Canada still has no long-term storage site available).

In contrast, in 2017, the IESO purchased electricity savings from residential, commercial and industrial consumers at an average cost of only **1.7 cents per kWh**, which is less than one-eighth OPG's forecast price of nuclear power in 2025.

Our lowest-cost source of renewable electricity is spot market purchases of Quebec water power, which had an average cost of **2.2 cents per kWh** in 2017.

Hydro Quebec is offering to sell us a firm supply of **waterpower at a price of only 5 cents per kWh** under a long-term contract. Hydro Quebec's proposed price for a 20-year firm supply is less than one-third of OPG's forecast price of nuclear electricity in 2025.

In the past, wind and solar were very high-cost sources of electricity supply, but in recent years their costs have fallen dramatically due to technological improvements and economies of scale. Ontario procured new wind and solar resources in 2016 for 8.6 and 15.7 cents per kWh respectively. However, the costs of these options have continued to fall and in 2018 the Province of Alberta **procured wind power for a cost of only 3.9 cents per kWh**; and in 2019 it **procured solar power at a cost of only 4.8 cents per kWh**. Bloomberg New Energy Finance is forecasting that the cost of wind and solar power will fall by an additional 48% and 63% respectively by 2050.¹¹

As a consequence, if Ontario ramps down its planned expenditures on high-cost nuclear reactor re-builds while it increases its imports of Quebec water power and invests in energy efficiency and Made-in-Ontario renewable electricity, it will be able to simultaneously phase-out its gas plants and lower our electricity bills.



Our Energy Efficiency Potential

In 2018 Ontario’s Independent Electricity System Operator and the Ontario Energy Board retained Navigant Consulting to estimate the potential for energy efficiency investments to reduce the demand for electricity at an average cost of 3.9 cents per kWh or less. Table 1 below summarizes their findings.

Table 1: Ontario’s Achievable Energy Savings for 3.9 cents per kWh or less¹²

Year	Energy Savings	Average Cost per kWh Saved
2023	6.9 billion kWh	2.7 cents per kWh
2030	17.1 billion kWh	3.3 cents per kWh
2038	23.8 billion kWh	3.9 cents per kWh

As Table 1 shows energy-efficiency investments could reduce Ontario’s electricity demand by 17.1 billion kWh per year by 2030 at an average cost of 3.3 cents per kWh. This is equivalent to 60% of the forecast output of Ontario’s gas plants in 2030. [See Table 3 below]

By 2038, energy efficiency investments could lower our electricity demand by 23.8 billion kWh. This is equivalent to 68% of the forecast output of Ontario’s gas plants in 2038.

But there is no reason why our energy efficiency investments should be capped at an average cost of 3.3-3.9 cents per kWh. **To minimize our electricity costs the Government of Ontario should pursue all energy efficiency investments that can keep our lights on at a lower cost than nuclear power.** As we have noted above, in 2020 OPG’s price of nuclear power is 9.5 cents per kWh and OPG says it will need to raise its price of nuclear electricity to 16.5 cents per kWh by 2025 to pay for the re-building of its aging Darlington nuclear reactors. If the Government of Ontario were to pay up to just 9.5 cents per kWh for electricity savings, it is reasonable to assume that the resulting reduction in our electricity demand would save more energy than Ontario’s gas plants are forecast to produce in 2030.



Quebec Water and Wind Power

Existing interconnections

As Figure 3 shows, there are seven interconnections between the Ontario and Quebec electricity transmission systems. Using these existing interties, Ontario can import 16.5 to 18.5 billion kWh per year from Quebec.¹⁴

In 2019, Ontario’ net electricity imports from Quebec were only 5.4 billion kWh.¹⁵ As a result, Ontario could increase its electricity imports from Quebec by up to 13.1 billion kWh per year using existing transmission lines. This is equivalent to 45% of Ontario’s forecast gas-fired electricity generation in 2030.¹⁶

Furthermore, by expanding its transmission links with Quebec, Ontario could import even more low cost, clean and safe renewable electricity.

Potential new interties

In 2017 the IESO issued a report that described three options to increase our ability to import power from Quebec. The report’s key findings are summarized in Table 2.

All of these potential new transmission lines would be built in existing Hydro One transmission corridors.¹⁸

If just one of these interties was built, our total import capability would rise to approximately 35 billion kWh per year, which would be equivalent to 122% of Ontario’s forecast gas-fired generation in 2030.¹⁹

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Quebec generates a large surplus of electricity, primarily from emissions free hydroelectric generating stations, and electricity prices in Quebec are the lowest in Canada. The proximity of Quebec to Ontario’s major cities presents an attractive opportunity for Ontario to meet its electricity needs with imports from Quebec.”¹³

-Financial Accountability Office of Ontario

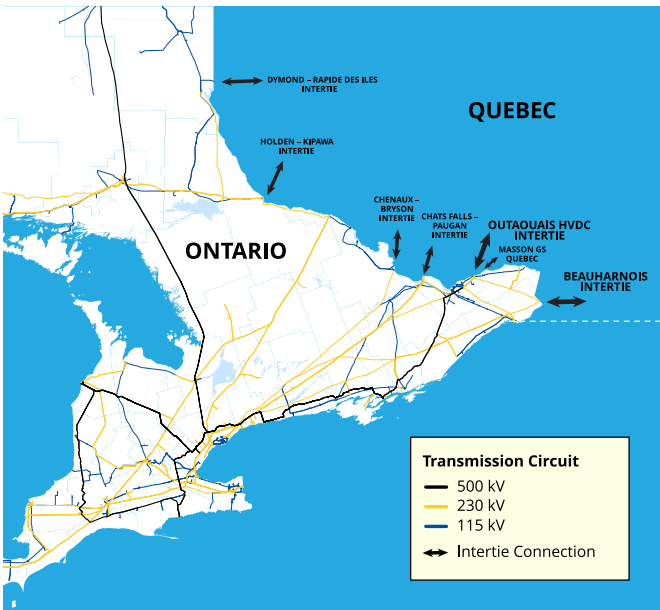


Figure 3: Existing Ontario-Quebec Interconnections²⁰

Table 2: Potential new interties to allow Ontario to import more power from Quebec¹⁷

Option	Length	Peak Capacity	Maximum Annual Electricity Imports	Cost
New Intertie in Ottawa	20 km	2,000 megawatts (MW)	17.52 billion kWh	Approximately \$80 million
New Intertie near Beauharnois	100 km	2,000 MW	17.52 billion kWh	Approximately \$400 million
New Intertie at Chats Falls	350 km	2,000 MW	17.52 billion kWh	Up to \$1.4 billion

Quebec's existing exports

In 2019, Hydro Quebec exported 35 billion kWh of electricity at an average price of 4.3 cents per kWh.²¹ Most of Quebec's exports are spot market sales to the U.S., which could be easily diverted to Ontario.

Quebec energy efficiency investments can increase export potential

Quebec's electricity consumption per person is the highest in the world.²² As a consequence, Quebec could export even more waterpower by investing in low-cost energy efficiency measures, which would reduce the electricity bills of its domestic customers and free up even more of its existing heritage water power capacity for export.

According to Professor Pierre-Olivier Pineau of the University of Montreal, cost-effective energy efficiency investments could increase Quebec's export potential by approximately 30 billion kWh per year.²³

New wind power projects can increase export potential

Hydro Quebec prices are low thanks to its heritage waterpower facilities. But developing new hydro dams would be expensive and environmentally damaging.

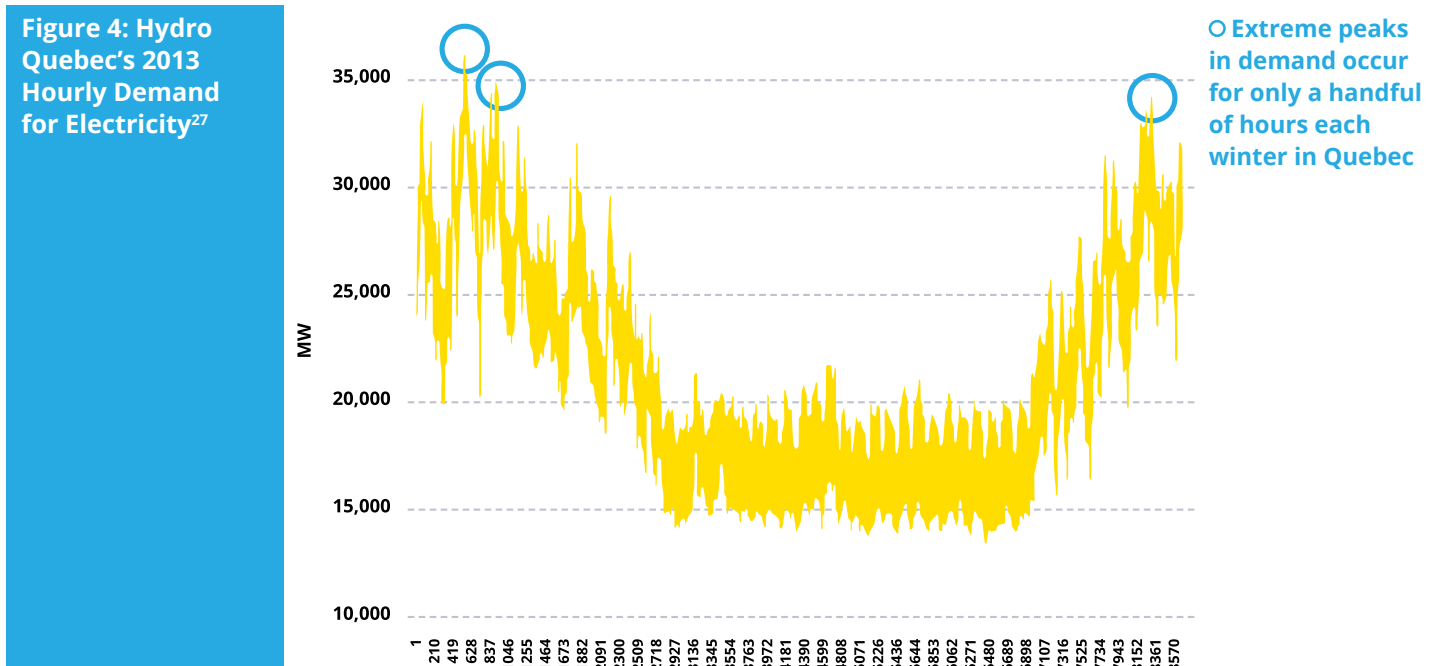
Fortunately, Quebec's lowest cost source of new electricity is now wind power.²⁴ Quebec has enormous wind power potential and could produce approximately 300 billion kWh of wind power per year at a cost of approximately 6 cents per kWh.²⁵ That is, Quebec's wind power potential is more than double Ontario's total annual electricity consumption.

Because of its large system of waterpower reservoirs that can be operated like giant batteries (water stored when wind is blowing, released to generate power when it is not), Quebec can turn intermittent wind power into firm exportable power, available 24/7.

Availability of Quebec power

According to a spokesperson for Canada's nuclear industry, Quebec power is not a viable option for Ontario since it is not available in the winter.²⁶ Fortunately, this claim has no basis in fact.

Figure 4 shows Quebec's demand for electricity during every hour of the year from January to December in 2013.



As Figure 4 shows Quebec’s demand for electricity spikes sharply upwards on a few very cold winter days. When these needle peaks occur Quebec may not have power available for export. But these needle peaks last for less than 1% of the hours of the year. As a result, **during at least 99% of the hours of the year Quebec has surplus power available for export.**

In 2019 Hydro Quebec introduced time-of-use pricing for its residential and business customers to provide them with a financial incentive to reduce their electricity demands

on very cold winter days.²⁸ By ramping up its energy conservation and efficiency programs and by providing its customers with financial incentives to reduce their electricity demands during very cold winter hours, Hydro Quebec can ensure that it will be able to export power to Ontario and the U.S. during 100% of the hours of the year.

In this context, it is important to remember that nuclear generating stations are not available for 100% of the hours of the year either. In fact, **the Darlington Nuclear Station’s average annual capacity factor is only 83%.²⁹**

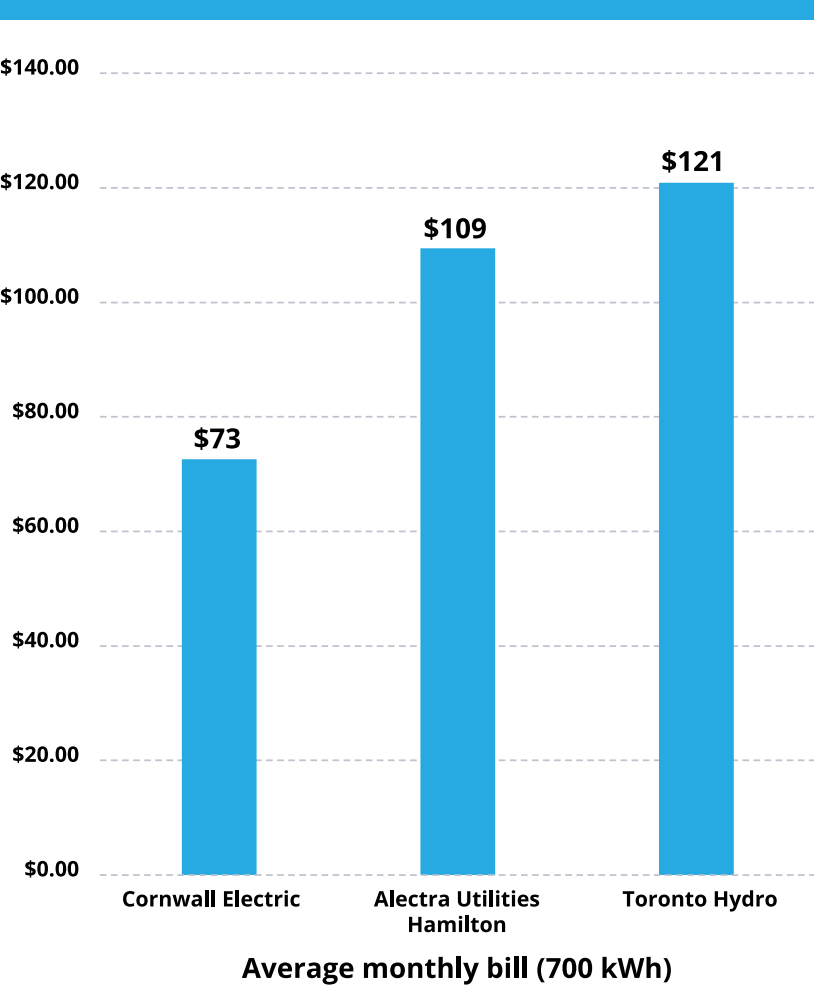
City of Cornwall

The City of Cornwall’s electricity rates demonstrate the economic benefits of Quebec waterpower. **Cornwall has obtained 100% of its electricity from Hydro Quebec for 50 years and it has the lowest electricity rates in Ontario.**

As Figure 5 shows the average residential electricity bills in Hamilton (Alectra Utilities) and Toronto are 50% and 66% higher respectively than Cornwall’s.

In addition, during the 2003 blackout the lights did not go out in Cornwall, whereas in the rest of Ontario it took more than eight days to return our electricity system to full power due to our dependency on nuclear power.³¹

Figure 5: Average Monthly Residential Electricity Bills³⁰



Ontario Wind and Solar Power

Ontario also has a large potential supply of wind and solar energy that could be developed to help phase-out Ontario's gas-fired power plants. For example, a report prepared for the Ontario Power Authority identified 64 potential off-shore wind power sites in the Great Lakes that could produce 111.5 billion kWh of electricity per year.³² This is equivalent to 82% of Ontario's total electricity consumption in 2019.³³

However, since the wind doesn't always blow and the sun doesn't always shine, these intermittent renewable energy resources must be combined with storage systems if they are to displace gas-fired generation during every hour of the year.

According to a recent Massachusetts Institute of Technology (MIT) report, Hydro Quebec's existing hydro-electric reservoirs are the best storage (load balancing) option for wind and solar power in New England and New York State. For example, when wind power production is above average in the U.S northeast, the surplus wind energy could be exported to Quebec to keep the lights on in Montreal, and as a consequence Hydro Quebec could store more water in its reservoirs. Conversely when U.S. wind power generation is below average, Hydro Quebec could use the extra water in its reservoirs to produce hydro-electricity for export to the U.S.

"Two-way trading of electricity with Quebec helps Northeastern states balance renewable intermittency at multiple time scales, mitigating the daily mismatch between solar and evening peak demand, the synoptic (multi-daily) mismatch between demand and wind output, and the seasonal mismatch between high summer demand and low summer wind output."³⁴

According to the MIT report, an extra 4,000 megawatts of electricity transmission capacity needs to be built between Quebec and New England to enable New England to take full advantage of Quebec's hydro-electric reservoirs to balance its intermittent wind and solar generation.

This extra transmission capacity would permit New England to fully decarbonize its electricity grid and it would lower New England's and Quebec's costs of achieving a zero-emissions power system by 17 to 28%.³⁵

It is reasonable to assume that Hydro Quebec's reservoirs are also the lowest-cost storage option for Ontario's wind and solar generation.³⁶

The good news is that Hydro Quebec wants to expand its transmission links with Ontario and the U.S. northeast so that its hydro-electric reservoirs can provide load balancing for wind and solar power in Ontario, New York and New England.

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"To step up our exports and help decarbonize northeastern North America, we need to build new transmission infrastructure and promote the load balancing capability of our hydroelectric generating fleet as a means of supporting the growth of intermittent renewables such as wind and solar power."³⁷

- Hydro Quebec

Stopping Gas-Fired Electricity Exports

In 2019 Ontario exported approximately 3.4 billion kWh of gas-fired electricity.³⁸ This represents 35% of the total output of Ontario's gas plants in 2019. Ontario can reduce its greenhouse gas pollution by curtailing its exports of gas-fired electricity.

Ontario's 2030 Climate Target

The Government of Ontario has promised to reduce Ontario's greenhouse gas pollution by 30% by 2030 relative to the 2005 level. But according to the Ontario's Auditor General, the province does not have a plan that will achieve even this modest goal. Specifically, according to the Auditor General, Ontario needs to implement measures that will reduce Ontario's GHG pollution by an additional 7.3 to 14 million tonnes per year to meet its 2030 climate target.³⁹

As Table 3 shows the forecast GHG pollution from Ontario's gas-fired power plants in 2030 is 11 million tonnes. Therefore, **a phase-out of Ontario's gas plants would provide our province with all or virtually all of the incremental GHG pollution reductions that it needs to achieve its 2030 climate target.**

Table 3: Historic and Forecast GHG Pollution and Electricity Generation from Ontario's Gas-Fired Power Plants⁴⁰

Year	2017	2018	2019	2020	2025	2030	2040
GHG Pollution (Million Tonnes)	2.5	4.0	4.1	5.4	10.7	11.0	14.2
Electricity Generation (Billion kWh)	5.9	9.6	9.5	13.6	28.0	28.6	37.0



Phasing-Out Ontario's Gas-Fired Power Plants

Ontario can phase-out its gas plants and lower its electricity costs by aggressively pursuing all of our energy efficiency and renewable energy options that can keep our lights on at a lower cost than continuing to operate the Pickering Nuclear Station and re-building 10 of the Darlington and Bruce Nuclear Stations' aging reactors.

Therefore, we recommend that the Government of Ontario take the following actions to achieve: i) a complete gas plant phase-out by 2030; and ii) an interim 2.5 million tonne per year cap on the gas plants' GHG pollution as soon as possible.

1. **Direct the IESO to maximize its spot market purchases of Quebec water power before it dispatches gas-fired generation.**
2. **Direct the IESO to stop its spot market gas-fired electricity exports (except for emergency exports).**
3. **Direct the IESO to pay residential, commercial, institutional and industrial consumers up to the price of nuclear electricity (e.g., 9.5 cents per kWh in 2020) for each kWh they save by investing in energy efficiency.**
4. **Direct Hydro One to build a new 20 km transmission line in Ottawa, to increase our ability to import Quebec power by 17.5 billion kWh per year, at a cost of approximately \$80 million.**
5. **Direct the IESO to seek to negotiate long-term electricity supply and storage (load balancing) contracts with Hydro Quebec to help phase-out our gas plants and to meet our electricity needs at a lower cost than re-building up to 10 nuclear reactors.**
6. **Put a moratorium on the re-building of our aging nuclear reactors while the IESO seeks to negotiate long-term electricity supply and storage contracts with Hydro Quebec.**
7. **Direct the IESO to purchase Made-in-Ontario wind and solar power that can keep our lights on at a cost that is less than the price of nuclear electricity (e.g., 9.5 cents per kWh in 2020).**



Endnotes

- 1 IESO, *Annual Planning Outlook*, (January 2020), page 32.
- 2 *Annual Planning Outlook*, page 2.
- 3 *Annual Planning Outlook*, page 10.
- 4 *Annual Planning Outlook*, page 21.
- 5 *Annual Planning Outlook*, page 21.
- 6 *Annual Planning Outlook*, page 11; and *Ontario's Long-Term Energy Plan 2017*, pages 45 & 46.
- 7 Government of Ontario, Newsroom, "Premier Ford, Premier Higgs and Premier Moe Sign Agreement on the Development of Small Modular Reactors", (December 1, 2019).
- 8 Hydro One's forecast cost of this upgrade is \$23.4 million. Email to Jack Gibbons from Leonard Kula, Chief Operating Officer, IESO, (February 14, 2019); and Ontario Energy Board Docket No. EB-2019-0082, ISD SS-06, pages 1 – 4.
- 9 *Annual Planning Outlook*, pages 2 and 8.
- 10 Ontario Clean Air Alliance Research, *Enbridge's Hamilton Pipeline: More Greenhouse Gas Pollution and Higher Gas Rates*, (February 4, 2020).
- 11 Bloomberg New Energy Finance, *New Energy Outlook 2019: Executive Summary*.
- 12 Navigant Consulting Ltd., *2019 Integrated Ontario Electricity and Natural Gas Achievable Potential Study*, (September 13, 2019), page v.
- 13 Financial Accountability Office of Ontario, *Electricity Trade Agreement: An Assessment of the Ontario-Quebec Electricity Trade Agreement*, (Spring 2018), page 4.
- 14 IESO, *IESO Response to Questions from the Ontario Clean Air Alliance*, (November 2014).
- 15 In 2019 Ontario's total imports from Quebec were 5.9 billion kWh, however 0.5 billion kWh were re-exported to the U.S. Email to Jack Gibbons from David Barrett, Supervisor, Customer Relations, Independent Electricity System Operator, (February 12, 2020).
- 16 The IESO is forecasting that Ontario's total gas-fired electricity generation in 2030 will be 28.6 billion kWh. Email to Jack Gibbons from David Barrett, Supervisor, Customer Relations, Independent Electricity System Operator, (February 6, 2020).
- 17 According to the IESO report, the 350 km transmission line option could cost up to \$1.4 billion, we have estimated the cost of the other two transmission options by assuming that their costs per km would be the same as the 350 km option. IESO, *Ontario-Quebec Interconnection Capability: A Technical Review*, (May 2017), pages 24 to 27.
- 18 IESO, *Ontario-Quebec Interconnection Capability: A Technical Review*, (May 2017), pages 25 to 27.
- 19 The IESO is forecasting that Ontario's total gas-fired electricity generation in 2030 will be 28.6 billion kWh. Email to Jack Gibbons from David Barrett, Supervisor, Customer Relations, Independent Electricity System Operator, (February 6, 2020).
- 20 IESO, *Ontario-Quebec Interconnection Capability: A Technical Review*, (May 2017), page 10.
- 21 Hydro Quebec, *Annual Report 2019*, page 97.
- 22 Jean-Thomas Bernard & Jean-Yves Duclos, *Quebec's Green Future: The Lowest-Cost Route to Greenhouse Gas Reductions*, C.D. Howe Institute Background No. 118, (October 2009), page 2.
- 23 Chaire de gestion du secteur de l'énergie, HEC Montreal, *2016 Etat De L'Energie Au Quebec*, page 28.
- 24 Equiterre and Ontario Clean Air Alliance Research, *Higher Profits and Lower Bills: A New Electricity Strategy for Hydro Quebec*, (July 14, 2010), pages 2 and 3; and Hydro Quebec, *Press Release*, "Calls for tenders for the purchase of 450 MW of wind power: Hydro-Quebec Distribution accepts 3 bids totaling 446.4 MW", (December 16, 2014).
- 25 Quebec has the potential to produce 299 billion kWh of wind energy per year from sites that are within 25 km of Hydro Quebec's existing transmission lines. In 2014 Hydro Quebec contracted for wind energy at an average cost of 6.3 cents per kWh. Since 2014, due to technological improvements, the cost of wind energy has fallen significantly and in 2019 Bloomberg New Energy Finance forecast that the cost of wind power will fall by an additional 48% by 2050. See: Helimax Energie Inc., *Etude Sur L'Evaluation Du Potential Eolien, De Son Prix De Revient Et Des Retombees Economiques Pouvant En Decouler Au Quebec*, (2004), page vi; Hydro Quebec, *Press Release*, "Calls for tenders for the purchase of 450 MW of wind power: Hydro Quebec Distribution accepts 3 bids totalling 446.4 MW", (December 16, 2014); and Bloomberg New Energy Finance, *New Energy Outlook 2019: Executive Summary*.
- 26 Taylor McKenna, "Don't overlook Ontario's nuclear advantage", *Hamilton Spectator*, (February 6, 2020).
- 27 Pierre-Olivier Pineau, Professor, HEC Montreal, "Can Ontario and Quebec benefit from more electricity market integration? A long-term perspective", Power Point Presentation for York University Conference, January 9, 2015.
- 28 Hydro Quebec, *Annual Report 2019*, page 11.
- 29 Ontario Energy Board Docket No. EB-2013-0321, Undertaking J14.3.

- 30 Cornwall Electric's residential rate schedule is posted on the CornwallElectric.com web site. We used the OEB.ca bill calculator to calculate the typical residential bills in Hamilton and Toronto.
- 31 The August 2003 blackout began on August 14th at 4:11 p.m. Ontario's power emergency did not end until 8 p.m. on August 22nd. Independent Electricity Market Operator, *Participant News*, "IMO Says Ontario Residents Deserve Special Thanks", (August 22, 2003); and Ontario Ministry of Energy, *August 14, 2003 Outage Report*.
- 32 Ontario Power Authority, *Integrated Power System Plan*, Exhibit D, Tab 5, Schedule 2, Attachment 1, pages 4, 23 & 25.
- 33 In 2019 Ontario consumed 135.1 billion kWh. See IESO, *News Release*, "2019 Year in Review", (January 30, 2020).
- 34 Emil Dimanchev, Joshua Hodge and John Parsons, *Two-Way Trade in Green Electrons: Deep Decarbonization of the Northeastern U.S. and the Role of Canadian Hydropower*, Massachusetts Institute of Technology Center for Energy and Environmental Policy Research, (February 2020), page 53.
- 35 *Two-Way Trade in Green Electrons: Deep Decarbonization of the Northeastern U.S. and the Role of Canadian Hydropower*, page 1.
- 36 Paul Burke, *Post-Pickering Technical Discussion Paper*, Pollution Probe, (January 2020), pages 17 and 18.
- 37 Hydro Quebec, *Annual Report 2019*, page 31.
- 38 <https://www.cleanairalliance.org/wp-content/uploads/2020/04/OCAA-2019-GFG-Export-Est-Apr-2020-v4.pdf>
- 39 Auditor General of Ontario, *Climate Change: Ontario's Plan to Reduce Greenhouse Gas Emissions*, (2019), page 123.
- 40 *Annual Planning Outlook*, page 32; IESO, *News Release*, "2019 Year in Review", (January 30, 2020) and email to Jack Gibbons from David Barrett, Supervisor, Customer Relations, IESO, (February 6, 2020).

Figure 2 notes

Energy efficiency: In 2017 the Independent Electricity System Operator's (IESO) average levelized unit energy cost (LUEC) of procuring a kWh of electricity savings was 1.69 cents. Independent Electricity System Operator, *2017 Report on Energy-Efficiency Activities*, page 8.

Quebec water power – spot market price: In 2017 the average price of Ontario's spot market electricity purchases from Quebec was 2.2 cents per kWh. Financial Accountability Office of Ontario, *Electricity Trade Agreement: An Assessment of the Ontario-Quebec Electricity Trade Agreement*, (Spring 2018), page 7.

Quebec water power – firm contract: On June 22, 2017 Hydro Quebec offered to sell Ontario 8 billion kWh per year, for 20 years, at a price of 6.12 cents per kWh. In August 2017 Hydro Quebec lowered its proposed price to 5 cents per kWh, but the Government of Ontario still refused to accept the offer. Letter from Steve Demers, Vice President, Hydro Quebec to Peter Gregg, CEO, Independent Electricity System Operator, (June 22, 2017); and Pierre Couture, "Hydro Quebec l'Ontario en ligne de mire", *Journal de Montreal*, (August 16, 2017). In 2017 the average price of Hydro Quebec's short and long-term electricity exports was 4.7 cents per kWh. Hydro Quebec, *Annual Report 2017*, page 76.

Quebec wind power: In 2014 Hydro Quebec used a competitive procurement process to contract for wind power at an average generation cost of 6.3 cents per kWh. Hydro Quebec, *Press Release*, "Calls for tenders for the purchase of 450 MW of wind power: Hydro-Quebec Distribution accepts 3 bids totalling 446.4 MW", (December 16, 2014).

Ontario wind power: IESO, *News Release*, "IESO Announces Results of Competitive Bids for Large Renewable Projects," (March 10, 2016).

Price of Nuclear Power in 2020: Ontario Power Generation, *Management's Discussion and Analysis: 2019 Third Quarter Report*, page 15.

Ontario solar power: IESO, *News Release*, "IESO Announces Results of Competitive Bids for Large Renewable Projects," (March 10, 2016).

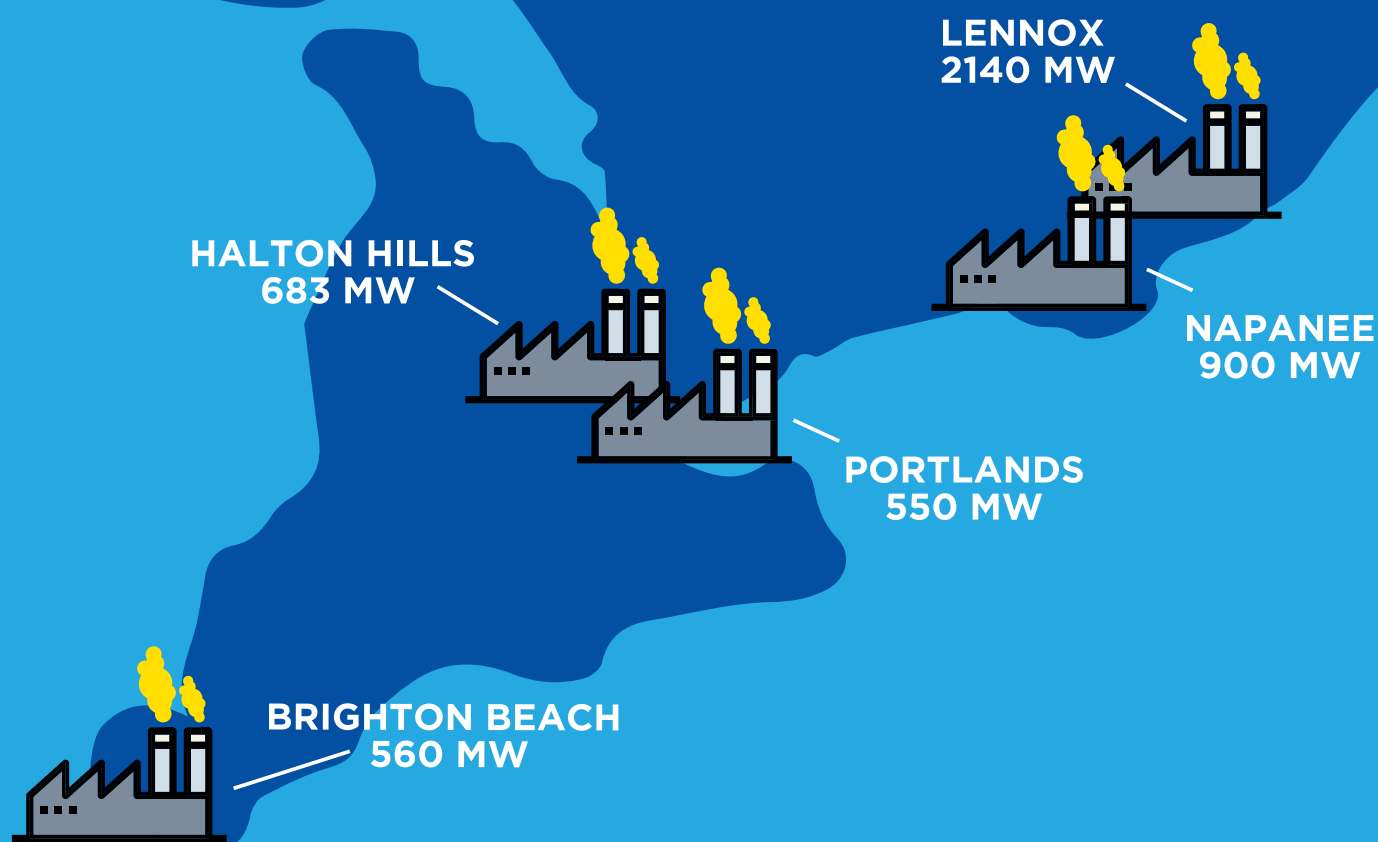
Small Modular Reactor: The Canadian nuclear industry is forecasting that the cost of electricity from a small modular reactor (SMR) will be 16.3 cents per kWh; however they note that if there is a 3% capital cost overrun the cost will rise to 21.5 cents per kWh. They are hoping that the first commercial SMR will be in-service by 2030. Canadian Small Modular Reactor Roadmap Steering Committee (2018), *A Call to Action: A Canadian Roadmap for Small Modular Reactors*, pages 35 and 54.

Price of Nuclear Power in 2025: Ontario Power Generation has told the Ontario Energy Board that it will need to raise its price of nuclear power to 16.5 cents per kWh in 2025 to pay for the re-building of the Darlington Nuclear Station. Ontario Energy Board Docket No. EB-2016-0152, Exhibit N3, Tab 1, Schedule 1, Attachment 2, Table 14.

Alberta wind power: In 2018, the Government of Alberta used a competitive bidding process to obtain 763 megawatts (MW) of wind power at an average price of 3.9 cents per kWh. Government of Alberta, *News Release*, "Wind projects create jobs, Indigenous partnerships", (December 17, 2018).

Alberta solar power: In 2019, the Government of Alberta used a competitive bidding process to obtain up to 146,000 megawatt-hours of solar electricity per year at an average price of 4.8 cents per kWh. Government of Alberta, *News Release*, "Alberta-based solar power on the rise", (February 15, 2019).

Ontario Power Generation's Gas Plants



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