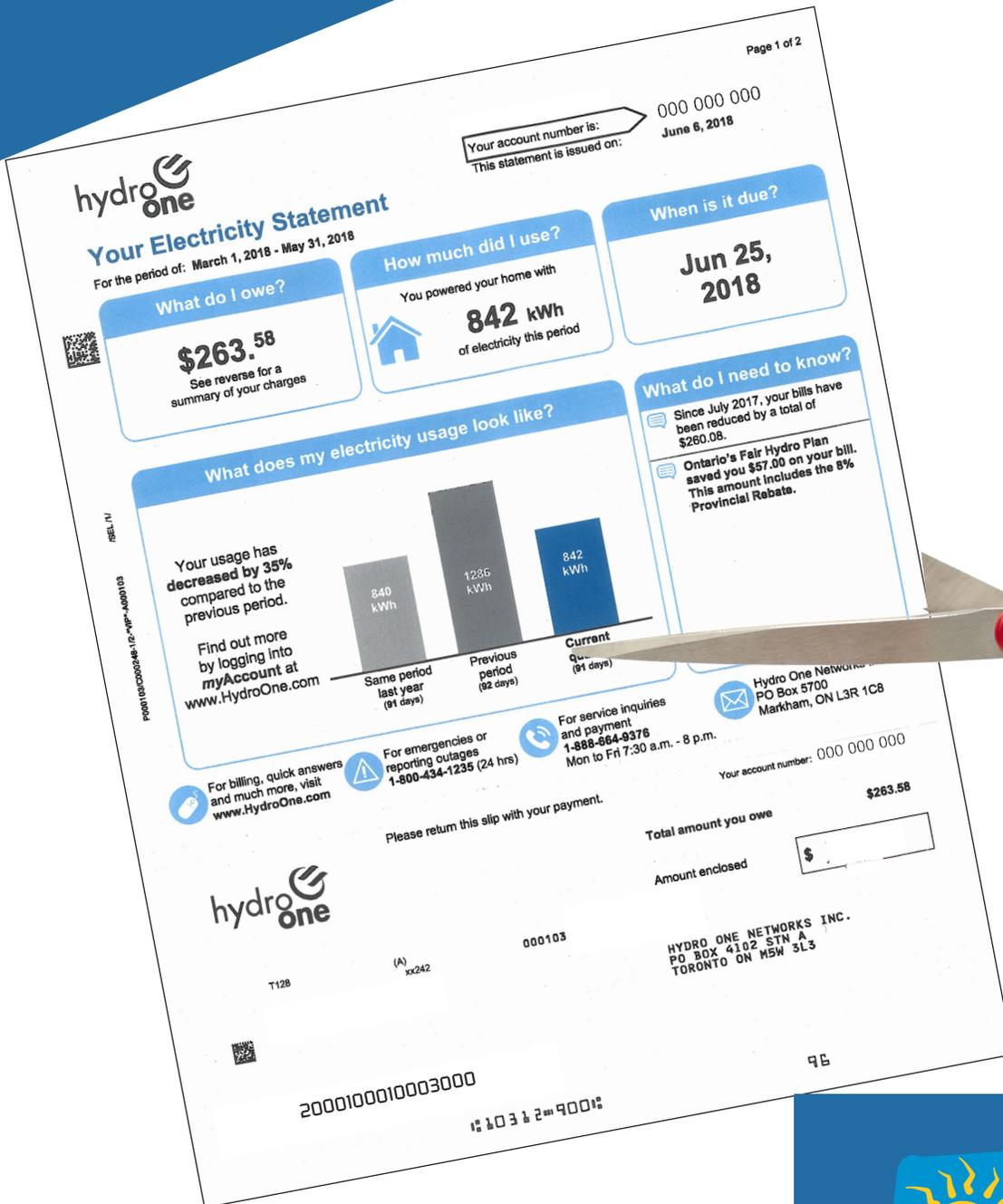


Three Options to Reduce Ontario's Electricity Costs



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A Preliminary Analysis

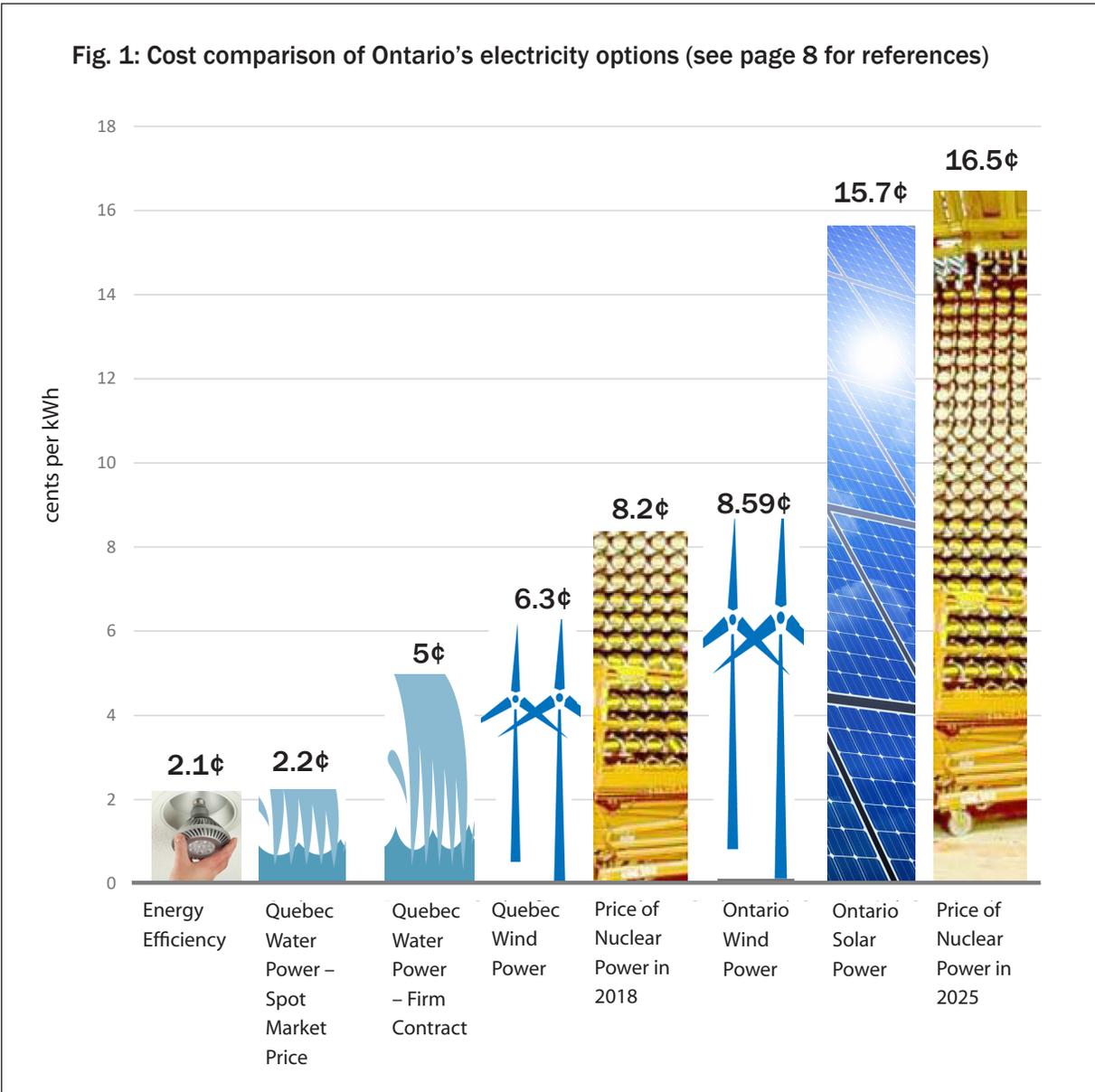
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THE MOST EFFECTIVE WAY TO REDUCE ELECTRICITY COSTS in Ontario is by continuing to invest in energy efficiency and importing low-cost water power from Quebec. Pursuing these options could result in real bill reductions given that they are 40 to 87% lower cost than the cost of continuing to run and rebuild aging nuclear reactors.



Despite the availability of lower-cost options, Ontario's former Liberal Government made three major commitments to high-cost nuclear power:

1. Extending the life of the 47-year-old Pickering Nuclear Station to 2024;
2. Re-building the Darlington Nuclear Station; and
3. Re-building the Bruce Nuclear Station.

This report analyses the potential for Premier Ford to lower our electricity costs by fully or partially rescinding one or more of the previous Government's costly nuclear commitments.

Option #1: Close the Pickering Nuclear Station, when its licence expires in August 2018

Option 1:
Save
\$1.1 - \$1.4
billion
per year



According to the Canadian Manufacturers & Exporters, the Pickering Nuclear Station’s performance is “persistently abysmal ...by any objective measure.”¹

As even Ontario Power Generation has admitted, Pickering’s operating costs are higher than those of any other nuclear station in North America.²

In 2019 Pickering’s operating costs will be 9.2 cents per kWh.³ In contrast, in 2017, Ontario imported water power from Quebec at an average price of 2.2 cents per kWh.⁴

Approximately half of Pickering’s output is surplus to Ontario’s needs and is exported⁵ to the U.S. at a financial loss.⁶ Specifically, during many hours of the year (e.g., at night and on weekends) Ontario’s nuclear reactors produce more electricity than is consumed in Ontario. Since the inflexible Pickering and Darlington nuclear reactors cannot lower their output during off-peak hours, we are required to export our surplus nuclear generation to the U.S. These exports are typically sold at prices that are below the cost of production. In fact, in 2016, during 23% of the hours of the year we “sold” our electricity to U.S. customers at a price equal to zero or less (i.e., we often paid our American neighbours to consume our surplus power).⁷

By closing Pickering, we can avoid the loss of \$737 million per year on money-losing electricity export sales.⁸

Obviously, if we close Pickering, we will have to find an alternative source of supply for electricity generated by the plant that is actually consumed in Ontario (approximately 10 billion kWh per year). As Figure 1 indicates, the cost of Quebec water power is approximately 50 to 75% lower than Pickering’s operating costs. **As a result, by importing Quebec water power, to displace Pickering’s output used in Ontario, we can save an additional \$407 million to \$679 million per year.⁹**

Therefore, our total annual savings from closing the Pickering Nuclear Station would be \$1.1 billion to \$1.4 billion per year.

Do we have enough transmission capacity?

The Independent Electricity System Operator (IESO) has stated that our existing transmission network allows us to import 16.5 to 18.5 billion kWh per year from Quebec.¹⁰ This is sufficient to completely replace all of Pickering’s generation that is actually consumed in Ontario (approximately 10 billion kWh per year).

Does Quebec have enough power to replace Pickering?

Hydro Quebec has a huge electricity surplus and is actively seeking new markets for its power.¹¹ In 2017, Hydro Quebec exported 34.9 billion kWh of electricity.¹² According to the Quebec Energy Commission, Hydro Quebec’s supply of surplus electricity available for export will rise to 41.1 billion kWh by 2022.¹³ This is equivalent to 30% of Ontario’s total annual electricity consumption.

Quebec’s electricity consumption per person is the highest in the world.¹⁴ As a consequence, Quebec could export even more low-cost water power 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 roughly an additional 30 billion kWh per year.¹⁵

Quebec's surplus power is available for export during at least 99% of the hours of the year.¹⁶ During some very cold hours of the year, when Quebec may not have surplus power available for export, Ontario can use its gas-fired power plants for back-up. And while water power may require gas back-up during 1% of the hours of the year, the Pickering Nuclear Station requires gas back-up during the 30% of the hours of the year when it is offline for maintenance.¹⁷

Option #2: Cancel the Darlington Re-Build

Currently, Ontario Power Generation (OPG) is re-building one of Darlington's four aging nuclear reactors.

OPG's price for nuclear electricity is currently 8.2 cents per kWh.¹⁸ But, according to OPG, its price of nuclear power must double to 16.5 cents per kWh by 2025 to pay for the re-building of all four of Darlington's reactors.¹⁹

In June 2017, Hydro Quebec offered to sell Ontario 8 billion kWh per year for 20 years at a price of 6.12 cents per kWh.²⁰ The Government of Ontario refused to accept this offer despite the fact that in August 2017 Hydro Quebec lowered its proposed price to 5 cents per kWh.²¹

By importing Quebec water power at a price of 5 to 6.12 cents per kWh and cancelling the re-building of three of Darlington's reactors, Ontario could reduce its electricity generation costs by up to \$2.1 billion to \$2.3 billion per year.^{21b}

The Cost of Additional Transmission Capacity with Quebec

If Ontario wishes to use Quebec power to displace the output of *both* the Pickering and Darlington reactors, our interconnection capacity with Quebec will need to be expanded.

Specifically, our transmission interconnection capacity with Quebec would need to be increased by 2,600 MW to permit the cancellation of 3 of the 4 Darlington reactor re-builds.²² This would increase Ontario's electricity *transmission* costs by approximately \$150 million per year.²³

Does Quebec have enough power to replace Pickering and three Darlington reactors?

We would need to import approximately 30 billion kWh of electricity from Quebec to replace the output of Pickering and three of the Darlington reactors. This would be equivalent to 86% of Hydro Quebec's total exports in 2017.²⁴ The good news is that Quebec has a huge untapped potential of low cost wind energy that could be developed to meet Ontario's electricity needs. Furthermore, Hydro Quebec can use its water reservoirs (like a giant battery) to convert

Option 2:
Save
\$2.1 - \$2.3
billion
per year



Option 3: Save \$2.3 billion per year



intermittent wind energy into a firm 24/7 baseload source of supply for Ontario. Specifically, Hydro Quebec has the potential to produce approximately 300 billion kWh of baseload wind power per year at a cost of approximately 6 cents per kWh or less.²⁵

Timing

By cancelling the re-build of three of Darlington's four reactors, the Government can avoid the need for OPG to double its price of nuclear power by 2025. These three non-re-built reactors, which are 25 to 26 years old, could continue to operate until the transmission links between Ontario and Quebec are upgraded to permit increased imports. According to the IESO, it could take up to 10 years to upgrade Hydro One's transmission links from Quebec to the GTA.²⁶

Option #3: Cancel the Bruce Re-Build

In December 2015, the Government of Ontario signed a 49-year contract with Bruce Power to finance the re-building of six of its eight nuclear reactors. These re-builds are scheduled to commence in 2020 and be completed by 2033.²⁷

Currently, Bruce Power's price for its nuclear electricity is 6.7 cents per kWh.²⁸ Both Bruce Power and the IESO have refused to publicly reveal the annual price increases that Bruce Power will receive to finance the re-building of six nuclear reactors. We believe it is reasonable to assume that, like OPG, Bruce's price of nuclear power will double during the next decade.

Off Ramps

The Bruce Re-Build Contract has the following "off-ramps" that can be triggered by the Government of Ontario to cancel the contract.

1. If Bruce Power's "Final Cost Estimate" for a reactor re-build is greater than the Government's "Cost Threshold," the Government can elect to not proceed with the re-build.²⁹ Bruce Power must submit its "Final Cost Estimate" for its first reactor re-build to the Government by Oct. 1, 2018.³⁰
2. Before the third reactor re-build commences, the Government can cancel the re-building of the 3rd, 4th, 5th and 6th reactors if there is no longer a need for the re-builds (e.g., due to falling electricity demand) or if there are more economic alternatives.³¹
3. The Province can trigger the off ramps for the 3rd, 4th, 5th and 6th reactor re-builds by investing in energy efficiency and buying renewable electricity from Quebec.

Increasing our Energy Efficiency to Lower our Electricity Bills by \$1 Billion

According to a report prepared for the IESO, Ontario has a huge untapped, but readily achievable energy efficiency potential. Specifically, by ramping up our energy efficiency programs we can cost-effectively reduce our electricity use by 29 billion kWh of electricity per year by 2035 and lower our electricity bills by \$1 billion.³² **These annual electricity savings could eliminate the need for 78% of the annual output of the six Bruce reactors that are scheduled to be re-built.**³³

Quebec Wind Power

As we have already noted, Hydro Quebec can supply firm baseload wind energy to Ontario at a cost of approximately 6 cents per kWh or less. Furthermore, the cost of the incremental transmission capacity to bring this power to the GTA would be only approximately 0.65 cents per kWh.^{33b} Clearly, Quebec wind power can meet Ontario's electricity needs at a lower cost than a nuclear option, the price of which will probably rise to 13 cents per kWh or more during the next 10 years. **Savings could exceed \$2.3 billion per year.**³⁴

Conclusions & Recommendations

Our analysis shows that the Government of Ontario can lower our electricity costs by billions of dollars per year by closing the Pickering Nuclear Station in August 2018 and cancelling the re-building of some or all of the proposed reactor re-builds at the Darlington and Bruce Nuclear Stations. Premier Ford has said that he wants to review all of Ontario's existing electricity contracts and wants to reduce electricity prices by an additional 12%. As part of its review, the Government should direct the Independent Electricity System Operator to:

1. Quantify the potential electricity cost savings between 2018 and 2024 that could be realized by buying Quebec water power and closing the Pickering Nuclear Station on August 31, 2018 or shortly thereafter.
2. Quantify the potential electricity cost savings between 2018 and 2050 that could be realized by cancelling the proposed re-building of three of Darlington's four aging nuclear reactors and replacing their power with Quebec water and/or wind power (while continuing to operate the reactors until the transmission upgrades have been completed).
3. Publish its forecast of the annual price of Bruce Power's electricity for each year until 2064 if Bruce is permitted to proceed with the re-building of six of its nuclear reactors between 2020 and 2033.
4. Quantify the potential electricity cost savings that could be realized between 2018 and 2064 by investing in energy efficiency and buying Quebec water and/or wind power to avoid the need for four to six of the proposed Bruce reactor re-builds.

Endnotes

- 1 Ontario Energy Board Docket No. EB-2016-0152, *Submissions of Canadian Manufacturers & Exporters*, (May 29, 2017), page 45.
- 2 Ontario Power Generation, *2015 Nuclear Benchmarking Report*, page 69.
- 3 Ontario Energy Board Docket No. EB-2016-0152, Exhibit L, Tab 6.5, Schedule 7 ED-018.
- 4 Financial Accountability Office of Ontario, *Electricity Trade Agreement: An Assessment of the Ontario-Quebec Electricity Trade Agreement*, (Spring 2018), page 7.
- 5 Ontario Energy Board Docket No. EB-2016-0152, Exhibit F2, Tab 2, Schedule 3, Attachment 1, page 12.
- 6 In 2017 Ontario's average electricity export price (Hourly Ontario Energy Price or HOEP) was 1.6 cents per kWh. <http://www.ieso.ca/en/power-data/data-directory>.
- 7 Financial Accountability Office of Ontario, *Electricity Trade Agreement: An Assessment of the Ontario-Quebec Electricity Trade Agreement*, (Spring 2018), page 8.
- 8 According to Ontario Power Generation, Pickering's total output in 2019 will be 19.4 billion kWh and its operating cost will be 9.2 cents per kWh. In 2017 Ontario's average electricity export price (Hourly Ontario Energy Price) was 1.6 cents per kWh. [19.4 billion kWh x 50% x (9.2 – 1.6 cents per kWh) = \$737 million.] Ontario Energy Board Docket No. EB-2016-0152, Exhibit E2, Tab 1, Schedule 1, Table 1 and Exhibit L, Tab 6.5, Schedule 7 ED-018; and <http://www.ieso.ca/en/power-data/data-directory>.
- 9 [19.4 billion kWh x 50% x (9.2 – 5 cents per kWh) = \$407 million] and [19.4 billion kWh x 50% x (9.2 – 2.2 cents per kWh) = \$679 million.] See also endnote 8 and Figure 1.
- 10 Independent Electricity System Operator (IESO), *IESO Response to Questions from the Ontario Clean Air Alliance*, (November 2014).
- 11 <http://nationalpost.com/pmn/news-pmn/canada-news-pmn/hydro-quebec-awarded-major-20-year-electricity-deal-from-massachusetts>
- 12 Hydro Quebec, *Annual Report 2017*, page 76.
- 13 Commission sur les enjeux energetiques du Quebec, *Maitriser Notre Avenir Energetique*, (2 fevrier 2014), page 183
- 14 Jean-Thomas Bernard & Jean-Yves Duclos, *Quebec's Green Future : The Lowest-Cost Route to Greenhouse Gas Reductions*, C.D. Howe Institute Backgrounder No. 118, (October 2009), page 2.
- 15 Chaire de gestion du secteur de l'energie, HEC Montreal, *2016 Etat De L'Energie Au Quebec*, page 28
- 16 Ontario Clean Air Alliance Research, *Can water power from Quebec avoid the need for the Darlington Re-Build?*, (April 7, 2015).
- 17 Ontario Energy Board Docket No. EB-2016-0152, Exhibit A1, Tab 4, Schedule 3, page 2; and Exhibit E2, Tab 1, Schedule 1, Table 1.
- 18 Ontario Power Generation, *Management's Discussion and Analysis: 2018 First Quarter Report*, page 7.
- 19 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.
- 20 Letter from Steve Demers, Vice President, Hydro Quebec to Peter Gregg, CEO, IESO, (June 22, 2017).
- 21 Pierre Couture, "Hydro Quebec l'Ontario en ligne de mire", *Journal de Montreal*, (August 16, 2017).
- 21b The Darlington Nuclear Station's four reactors have a total capacity of 3,512 MW and according to Ontario Power Generation, the re-built reactors will have an average annual capacity utilization rate of 88%. Therefore the forecast annual output of 3 of the 4 re-built reactors is 20.3 billion kWh [3512 MW x 0.75 x 8760 hours per year x 0.88]. If these re-builds are cancelled and the forecast output is replaced by Quebec water power the savings will be \$2.1 billion [20,300,000,000 kWh x (16.5 – 6.12 cents per kWh)] to \$2.3 billion per year [20,300,000,000 kWh x (16.5 – 5 cents per kWh)].
- 22 The net in-service capacity of Darlington's four reactors is 3,512 MW. Ontario Energy Board Docket No. EB-2016-0152, Exhibit A1, Tab 4, Schedule 3, page 2.
- 23 The IESO has identified three existing Hydro One transmission corridors which could be upgraded by 2,000 MW each to bring additional Quebec power to the GTA. Each of these upgrades would cost up to \$1.4 billion. Therefore the cost of upgrade our transmission capacity with Quebec by 2,600 MW would be approximately \$1.8 billion. Hydro One amortizes the costs of its transmission facilities over 55 years. Therefore assuming an 8% pre-tax cost of capital, the annual cost of a \$1.8 billion

transmission upgrade would be approximately \$150 million for Hydro One's ratepayers. IESO, *Ontario-Quebec Interconnection Capability: A Technical Review*, (May 2017), page 24; and Hydro One, *Annual Report 2017*, page 57.

- 24 In 2017 Hydro Quebec exported 34.9 billion kWh. Hydro Quebec, *Annual Report 2017*, page 76.
- 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 used a competitive procurement process to contract for wind power at an average generation cost of 6.3 cents per kWh. Since 2014, due to technological improvements, the cost of wind power has declined. For example, in 2017, the Government of Alberta used a competitive procurement process to obtain wind power at an average price of only 3.7 cents per kWh. Helimax Energie Inc., *Etude sur l'évaluation du potentiel éolien, de son prix de revient et des retombées économiques pouvant en découler au Québec*, (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 <http://www.cbc.ca/news/canada/calgary/wind-farm-rachel-notley-alberta-university-calgary-1.4448323>.
- 26 IESO, *Ontario-Quebec Interconnection Capability: A Technical Review*, (May 2017), page 24.
- 27 *Ontario's Long-Term Energy Plan 2017*, page 46.
- 28 TransCanada, *Quarterly Report to Shareholders*, (April 27, 2018), page 21.
- 29 *Amended and Restated Bruce Power Refurbishment Implementation Agreement Between Bruce Power L.P. and Independent Electricity System Operator*, (December 3, 2015), Section 9.1.
- 30 Email from Terry Young, Vice President, IESO to Jack Gibbons, Ontario Clean Air Alliance, (June 14, 2018).
- 31 *Amended and Restated Bruce Power Refurbishment Implementation Agreement Between Bruce Power L.P. and Independent Electricity System Operator*, (December 3, 2015), Section 9.2.
- 32 Nexant, *Achievable Potential Study: Long Term Analysis (Addendum 1 – Market Achievable Potential)*, Submitted to IESO, (November 25, 2016), pages 2 and 4.
- 33 The six Bruce reactors that are scheduled to be re-built have a total capacity of 4,800 MW. If they operate at an 88% capacity factor, they will produce 37 billion kWh per year.
- 33b Per endnote 23, the cost of upgrading the transmission capacity between Ontario and Quebec by 2,600 MW would be approximately \$150 million per year. This new capacity would permit Ontario to import an additional 22.8 billion kWh per year from Quebec at a cost of approximately 0.65 cents per kWh [\$150 million/22.8 billion kWh].
- 34 [37 billion kWh per year x (13 – 6.65 cents per kWh) = 2.35 billion per year.] See also endnote 33.

Notes for Figure 1

Energy efficiency: In 2016 the Independent Electricity System Operator's (IESO) average levelized unit energy cost (LUEC) of procuring a kWh of electricity savings was 2.1 cents. Independent Electricity System Operator, *2016 Conservation Results Report*, pages 2 & 11.

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).

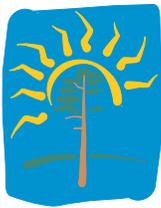
Price of Nuclear Power in 2018: Ontario Power Generation, *Management's Discussion and Analysis: 2018 First Quarter Report*, page 7.

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

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

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.

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