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Buying Electricity from Quebec: The Case Against New Intertie Capacity

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Declaration of Interest

The views expressed in this CCRE publication are based on the comprehensive analyses undertaken for *Renewables and Ontario/Quebec Transmission System Interties: An Implications Assessment*, June 2016, commissioned by the Power Workers' Union.

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Buying Electricity from Quebec: The Case Against New Intertie Capacity

Marc Brouillette

Ontario's 2013 Long-Term Energy Plan (LTEP) suggested importing electricity from Quebec as an option for supplying Ontario's electricity demand (Ontario Ministry of Energy, 2013). Now, with preparation for the 2017 LTEP underway, this commentary re-examines the idea and finds that enhancing the capacity to import Quebec electricity involves substantial costs that exceed the anticipated benefits under the two provinces' demand-and-supply forecasts.

"Infrastructure costs for Quebec imports outweigh the benefits."

While the costs are not detailed in the 2013 LTEP, the posited benefits of importing Quebec electricity included:

- Exchanging peak-capacity reserves to balance the seasonal needs of the two provinces;
- Smoothing the intermittency of Ontario's wind generation by leveraging the storage capacity of Hydro-Quebec's large reservoirs; and
- Sourcing low-carbon firm hydroelectric imports while lessening Ontario's dependence upon higher-emitting, natural-gas-fired generation.

These potential benefits can be assessed by answering several questions:

- What are the characteristics and capacity of the transmission system interties[1] as they relate to demand and supply in Quebec and Ontario?
- How is Ontario's integration of renewable generation impacting its electricity system?
- How do Ontario's baseload options for the future compare; i.e., how does the chosen refurbished nuclear generation option compare to wind generation plus imports?

This commentary discusses the transmission system, the Quebec-Ontario interties and the challenges related to upgrading their capacity. Future papers will consider the roles the interties play in integrating Ontario's renewable generating resources in the supply mix and in supporting arrangements for a firm baseload supply.

QUEBEC AND ONTARIO: DIFFERENT DEMANDS

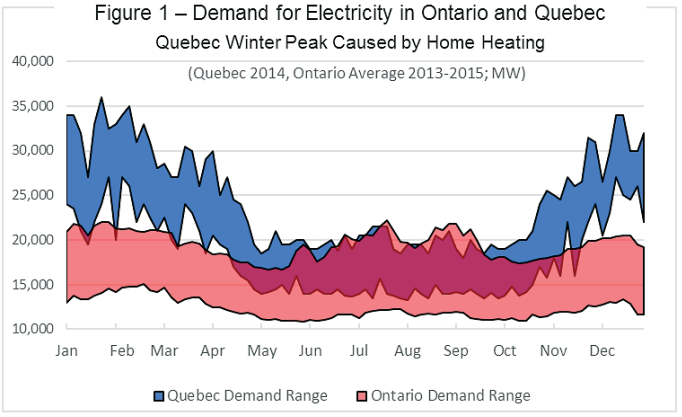
Quebec and Ontario have different energy demand and supply characteristics (Figure 1). While the two provinces have offsetting seasonal peaks, Quebec's seasonal demand variation is more amplified than Ontario's.

Historically, Ontario has exported and imported significant amounts of electricity to and from Quebec. These arrangements help Ontario ensure sufficient reliable energy and capacity to meet provincial demands.[2]

Ontario's total annual energy requirement, including for exports, is ~160 Terawatt-hours (TWh) with peaks in the summer. However, the average difference between Ontario's summer and winter peak demand is only ~1.5

[1] An intertie is a transmission facility that connects two separately operated transmission systems.

[2] There is a distinction between "energy" and "capacity". Energy is the cumulative amount of electricity over a period of time and, at the provincial scale, is measured in Gigawatt-hours (GWh) or Terawatt-hours (TWh). Capacity is the rate at which energy can be generated, delivered or used, and is measured in Gigawatts (GW) or Terrawatts (TW).



Source: Pineau, 2015; IESO, 2016

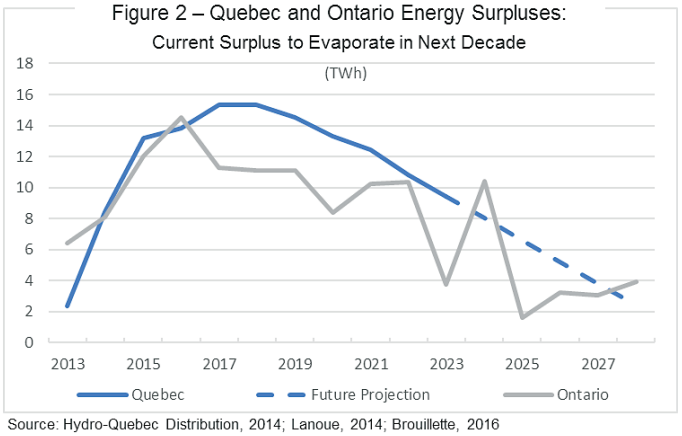
Gigawatt (GW).[3] In some years, such as 2014 when the province experienced a cold winter and mild summer, peak summer demand can be less than in winter.

"Adequate firm supply for electricity exchange evaporates by 2028."

Summer electricity demand is very similar in the two provinces. However, due to the extensive use of electrical heating in Quebec, its winter peak can be ~15 GW or 65-per-cent higher than its summer peak – a seasonal variation tenfold greater than in Ontario.

Quebec's vast developed hydro reservoirs provide it with a globally unique and flexible hydroelectric capability that helps Hydro-Quebec meet the 222 TWh annual provincial demand. Reservoirs such as the James Bay La Grande complex provide a provincial grid-level seasonal storage that is essential for meeting winter demand. In contrast, Ontario has only limited and short-term daily storage.

Currently, Quebec has an energy surplus (Hydro-Quebec Distribution, 2014). However, this surplus is expected to evaporate by 2028 as demand increases (Figure 2[4]) (Brouillette, 2016; Hydro-Quebec Distribution, 2014; Lanoue, 2014). Notwithstanding this current energy surplus, Quebec's winter generating capacity is insufficient to meet demand and the province must import electricity from Ontario. Similarly, Ontario has a surplus of low-carbon electricity supply that will disappear with the retirement of the Pickering Nuclear Generating Station in 2024 (IESO, 2016).



Source: Hydro-Quebec Distribution, 2014; Lanoue, 2014; Brouillette, 2016

[3] Based on 2013 LTEP data tables.

[4] Forecast to 2028 extrapolated from Hydro-Quebec projected trends to 2023.

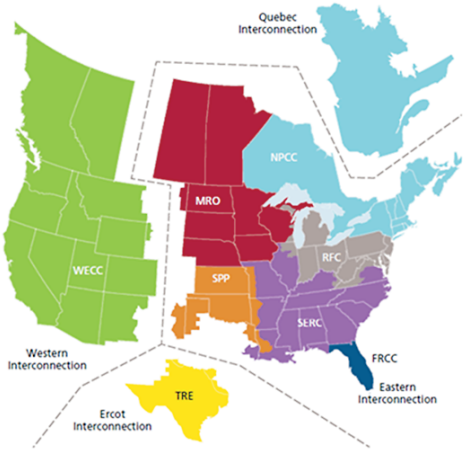
These emerging supply-and-demand dynamics suggest that when Ontario needs sustained energy from Quebec in the future, Quebec's hydroelectric resources won't be able to meet the demand. Conversely, when Quebec needs winter supply from Ontario in less than a decade, Ontario won't have low-carbon generation available. The recent agreements between Ontario and Quebec (Office of the Premier, 2016) are near term only, potentially reflecting these realities.

QUEBEC'S TRANSMISSION SYSTEM AND INTERTIES WITH ONTARIO

Quebec's transmission network operates asynchronously and is physically distinct from those in Ontario and the United States. Quebec is one of four "interconnections" that supply North American electricity needs. They are: (1) the Eastern Interconnection; (2) the Western Interconnection; (3) the Electric Reliability Council of Texas Interconnection (Ercot); and (4) the Quebec Interconnection (Figure 3). The four interconnections are independent in that they are not synchronized with each other, but are linked through limited direct current (DC) interties.[5] The Eastern and Western interconnections extend into Canada. The Eastern Interconnection has six different Regional Coordinating Councils.

"Quebec has a distinct electricity network with limited cross-border connections."

Figure 3 – North American Electricity Networks
(4 Interconnections, 8 Regional Reliability Councils)



Source: Canadian Academy of Engineering, 2014; Hydro-Quebec, 2017

The northeastern states, Atlantic provinces along with Ontario and Quebec—despite Quebec's asynchronous system—operate within the context of the Northeast Power Coordinating Council (NPCC). The Quebec Interconnection is connected to New York and New England by DC interties.

Quebec and Ontario are connected by nine interties grouped operationally into three regions with a combined capacity of 2,775 Megawatts (MW) (Figure 4) (IESO, 2015):

1. Quebec North connections have modest capability, generally less than 100 MW.
2. Quebec South (Ottawa) has two classes of connections: (a) Bi-directional 1,250 MW high-voltage, direct-current (HVDC) line that came into service in 2009 and (b) Three interties in the Ottawa region with a total of 660 MW into Ontario and 220 to 240 MW from Ontario to Quebec.

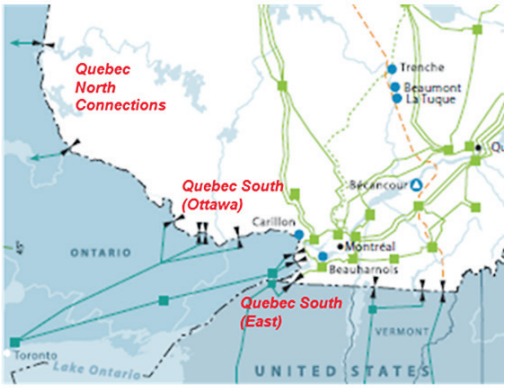
[5] Within each interconnection, all generators are "synchronized" so that the entire system appears to be a single large alternating current (AC) generator. A direct current link between two AC systems allows them to operate separately without synchronizing (i.e., asynchronously).

3. Quebec South (East) connections support up to 800 MW into Ontario and 470 MW to Quebec.

Other than the HVDC interface, the interties are associated with specific generating stations located either in Ontario or Quebec. To enable flows across the interties, these generators are connected (segregated) by physically switching them onto one system or the other, depending on system and market conditions.

The HVDC is thus the primary intertie for real-time energy flow between the provinces and was the focus of the IESO 2014 assessment of firm imports to Ontario, discussed below.

Figure 4 – Ontario - Quebec Intertie Locations



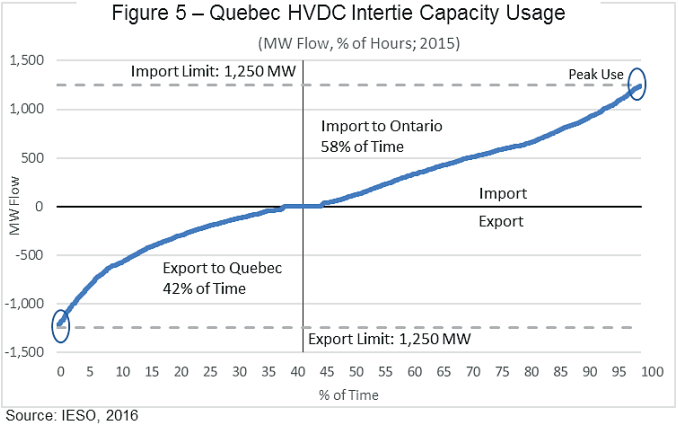
Source: IESO, 2015

"Ontario exports to Quebec 42% of the time and imports 58%."

TAPPING INTERTIE CAPACITY

In 2015, the HVDC intertie was used 42 per cent of the time to export off-peak surplus energy from Ontario to Quebec, generally at night, and 58 per cent of the time to import energy from Quebec to Ontario during the day (Figure 5) (IESO, 2016). Imports from Quebec during daytime hours supplement Ontario's use of natural-gas-fired generation to meet peak needs.

Figure 5 – Quebec HVDC Intertie Capacity Usage



Source: IESO, 2016

The intertie peak usage in 2015 exceeded 90 per cent of capacity only four per cent of the time. The average capacity usage was ~33 per cent. This operating profile suggests that if Quebec wanted more Ontario energy at different times, the interties would allow for it, and vice versa. However, exchange profiles of higher and more constant flow in one direction or the other would reflect a baseload power exchange rather than the peaking-exchange service the interties currently provide. Indeed, the IESO's 2014 intertie assessment states that the interties were not designed to be used to replace significant amounts of baseload power (IESO, 2014).

INTERTIE UPGRADING COSTS

The 2013 LTEP identified a need for imported energy after the retirement of the Pickering Nuclear Generating Station. In 2014, the IESO assessed the alternative viability of expanding the capacity of the interties to meet this need (IESO, 2014). The IESO's analysis reflected existing plans to address the anticipated transmission constraints in the Ottawa area by 2020 and enable a 1,000-MW firm import flow from Quebec within the capacity of the existing interties. It found that providing an additional 2,300 MW of firm import capacity across the HVDC intertie and enabling onward delivery of the resulting 3,300 MW to the Greater Toronto Area would cost approximately $1.9 billion. The IESO analysis also suggested that related investments in Quebec could be similar. Quebec's cost for the existing HVDC intertie project validated this suggestion to yield a combined total estimated investment of approximately $3.3B (Hydro-Quebec, 2009; Brouillette, 2016) A further analysis of Quebec's cost for the existing HVDC intertie project confirmed a combined total estimated investment of approximately $3.3 billion (Hydro-Quebec, 2009; Brouillette, 2016).

"Increased Quebec import capacity would be 50% more expensive than in-province alternatives."

IS IT WORTH IT?

The cost implications of intertie upgrades can be viewed from two perspectives: (1) as they relate to providing peak reserve capacity and (2) how they would accrue under a firm import arrangement.

For peak reserve capacity purposes, investing in a 2,300-MW intertie upgrade represents a financed cost of ~$450 million/year.[6] The IESO found that for peak reserve supply a Simple Cycle Gas Turbine (SCGT) capacity is more cost effective than upgrading the interties (IESO, 2015). An SCGT has a capacity charge of approximately $130,000 per MW per year, which is about $300 million annually for 2,300 MW. Upgrading the interties is thus approximately 50 per cent more expensive than solving peak reserve capacity challenges with SCGT plants.

For firm imports, the incremental consumer cost is a function of the energy that the interties transport: the higher the usage, the lower the per-megawatt-hour (MWh) cost and vice versa. For a fully utilized line, the IESO estimated the intertie upgrade would add between $20/MWh and $30/MWh to the cost of electricity. As an independent check, U.S. Energy Information Administration financing assumptions (U.S. Energy Information Administration, 2015) were used to estimate the per-MWh cost[7] at about $25/MWh. This figure is consistent with the IESO's estimate.

The IESO's analysis concluded that upgrading the interties would not be cost effective for the purpose of addressing the firm import needs projected in the 2013 LTEP.

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[6] The U.S. Energy Information Administration suggested a pre-tax weighted average capital cost of 14 per cent with a 30-year life. $3.3 billion equates to $456 million annually.

[7] 2,300 MW could support up to 20 TWh of energy transfer. Based on the derived $456 million per year, the yield is $25/MWh at a 90-per-cent-capacity factor.

SUMMARY

The electricity systems of Quebec and Ontario balance very different energy needs and constraints. The interties are rarely used to maximum capacity and that use is highly correlated with Ontario's demand profile – higher demand during the day and lower demand at night.

Costs for upgrading the intertie capability have been assessed to be around $3.3 billion for 2,300 MW of additional intertie capability. For peak reserve capacity purposes, upgrading the intertie costs 50 per cent more than the SCGT option recommended by the IESO. The current low utilization of the intertie, the planned capacity upgrades in the Ottawa area to enable 1,000 MW of firm imports and the available capacity in the two provinces over the next 15 years makes new investment in enhanced intertie capacity unwarranted under the 2013 LTEP flat demand forecast.

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