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The Case for Stronger Grid Interconnections in Canada

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SUMMARY

Building better transmission interconnections between Canada's provinces and with the country's northern territories has the potential to deliver many benefits. Balancing the country's largely emission-free generation sources, enhancing export capacity and supporting additional resource development in the north are among the promising possibilities.

The Canadian electrical grid is better interconnected with the American states south of the border than it is east-west between the provinces and north-south with the territories. The Canadian government is undertaking a feasibility study to determine the merits of strengthening regional interconnections across the country as part of its efforts to "green the grid" by reducing emissions from electricity generation. Building transmission to interconnect the provinces and territories will be a major effort, but are there benefits that justify the buildup? What are some of the advantages that our current electrical grid does not offer that stronger interties could untap? What are the regional business cases, and who would benefit from them?

Ways we explore this begin with exploring Canada's advantages: 82 percent of its generation capacity being free from greenhouse gas emissions, and much of it's coal generation is schedule to retire over the next decade. Canada can produce goods at a lower carbon intensity than other major economies, including the United States. To make this delicate balance work, grid engineers must back up the intermittent renewables with dispatchable baseload generation to maintain a reliable grid. This backup capacity could come in the form of hydro, gas, nuclear or storage. While there is some potential for hydro in the U.S. states, the scope for major developments is limited. The only opportunity to likely to be deployed is natural gas.

Over time, there's a real possibility that countries with greener grids could have a strategic advantage in attracting companies providing everything from manufacturing and resource extraction to retail, thanks to the reduced carbon pricing burden. This represents a major opportunity for Canada, which can be a competitive source of dispatchable green electricity to the United States and help the country integrate more renewable generation. Canada has long

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been a major energy exporter to the U.S. Canadian exports of oil and gas are well known, but there is also significant export of clean and emission-free electrical power from several provinces.

In addition to the export potential, a better interconnected grid also provides the added benefits of greater overall grid reliability, price stability, improved load factor and increased load diversity. This positions Canada for long-term competitiveness and energy supply. Strengthening the interconnections between the provinces and with the northern territories could be a win-win for Canada by increasing the nation's non-GHG-emitting electricity export potential. Interconnections also will help reduce the northern Canadian communities' dependence on diesel and enable new resource development potential in northern Canada, creating job opportunities. The benefits should outweigh the costs incurred to build and strengthen the grid interconnections.

KEYWORDS

Power, grid, grid interconnections, renewables, renewable energy, Canada

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Building transmission to interconnect the provinces and territories will be a major effort, but are there benefits that justify the buildup? What are some of the advantages that our current electrical grid does not offer that stronger interties could untap? What are the regional business cases, and who would benefit from them? This paper explores these questions.

CANADA'S CLEAN ADVANTAGE

Canada is in an enviable position, with nearly 82 percent of its generation capacity being free of greenhouse gas (GHG) emissions. In comparison to other countries, the Canadian electricity sector is very clean. As much of the nation's remaining coal generation is retired over the next decade, the GHG emissions intensity should further decrease, giving Canada over 90 percent GHG-emission-free generation.

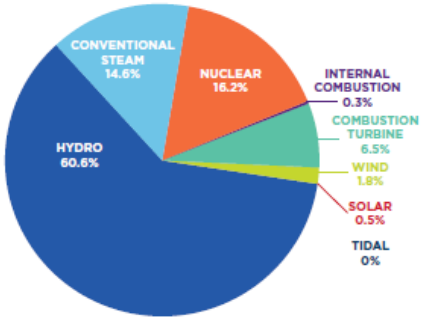
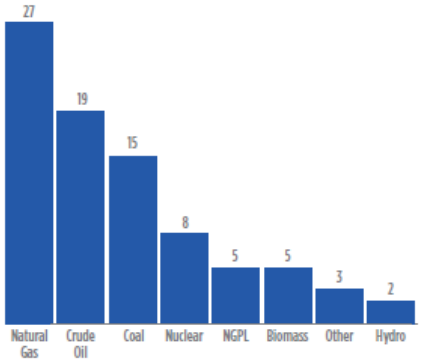


FIGURE 1: *Canadian Generation Fleet by Fuel Type as of 2014. Source: Statistics Canada, Electric power generation, by class of electricity producer, annual (CANSIM Table 127-0007), 2014*



Note: "Natural Gas" is dry gas. "NGPL" is natural gas plant liquids. "Other" includes geothermal, solar and wind. "Hydro" is conventional hydroelectric.

FIGURE 2: *U.S. Primary Energy Production By Major Sources, 2016. (data in quadrillion British thermal units) Source: U.S. Energy Information Administration (EIA)*

Canadian industries have a major advantage in being able to produce goods at a lower carbon intensity than other major economies. For instance, U.S. electricity generation is almost 65 percent from thermal sources of generation.

To improve on this percentage, many U.S. states are pushing to increase the share of non-GHG-emitting sources of generation. In fact, there has been significant investment in renewable generation installation. This trend is expected to continue, with wind and solar as the primary sources of renewable generation being deployed. However, as wind and solar increase their share of the grid, their intermittent nature poses a challenge for engineers, who must balance the grid and maintain system reliability with a steady supply despite the varying weather conditions.

To make this delicate balance work, grid engineers must back up the intermittent renewables with dispatchable baseload generation to maintain a reliable grid. This backup capacity could

come in the form of hydro, gas, nuclear or storage. While there is some potential for hydro in a few U.S. states — namely Washington, Oregon, California and New York — the scope for major developments is limited, and it is not an option for all regions. The scope for nuclear power also is not promising, as the upfront costs to install a nuclear facility are steep and the perceived risks too great. Battery storage still can be expensive, and its limited capacity inhibits wider applications. This leaves natural gas as the primary option being deployed, even though it still has some GHG emissions (albeit at a much lower rate than coal or oil).

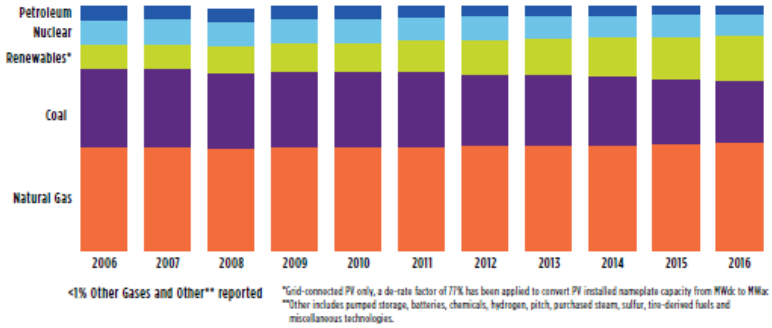


FIGURE 3: *U.S. Electricity Generating Capacity by Source 2006-2016. Source: EIA, LBNL, SEIA/GTM*

IMPROVING INTERNAL INTERCONNECTIONS

As the desire for carbon reduction plays a greater role in the new economy, the attraction of non-GHG-emitting power for factories and technology firms continues to get stronger. Companies like Google, Apple, Tesla and Ikea are opting to reduce their environmental footprints by investing heavily in renewable energy supply to their facilities. Over time, there's a real possibility that countries with greener grids could have a strategic advantage in attracting companies providing everything from manufacturing and resource extraction to retail, thanks to the reduced carbon pricing burden.

This represents a major opportunity for Canada, which can be a competitive source of dispatchable green electricity to the United States and help the country integrate more renewable generation. Canada has long been a major energy exporter to the U.S. Canadian exports of oil and gas are well known, but there is also significant export of clean and emission-free electrical power from several provinces to neighboring states. In 2015, the latest year for which statistics are available, the combined value of net electricity exports to the United States from British Columbia, Manitoba, Ontario and Quebec amounted to CA$2.5 billion.

In fact, Canada already has strong grid interconnections with the United States. All the provinces bordering the U.S. have grid connections with export capability to their neighboring states, as shown in Figure 5.

These interconnections have long been used for hydroelectricity exports from British Columbia, Manitoba, Quebec and New Brunswick — or, for grid stability, in Alberta and Saskatchewan. However, as the coal fleet in Alberta, Saskatchewan and New Brunswick retires and renewable generation expands, there is huge potential to export even more emission-free electricity to the U.S. This potential would be amplified if the provinces develop strong interties between the hydro provinces and those with wind and/or solar farms. By strengthening Canada-to-U.S. interconnections, intermittent renewable sources in the U.S.

can be backed with quickly dispatchable Canadian hydro. If the Alberta-British Columbia, Saskatchewan- Manitoba, Quebec-Ontario and Quebec-New Brunswick interconnections are further strengthened, the combined export potential of green and cheaper electricity could increase significantly from current levels.

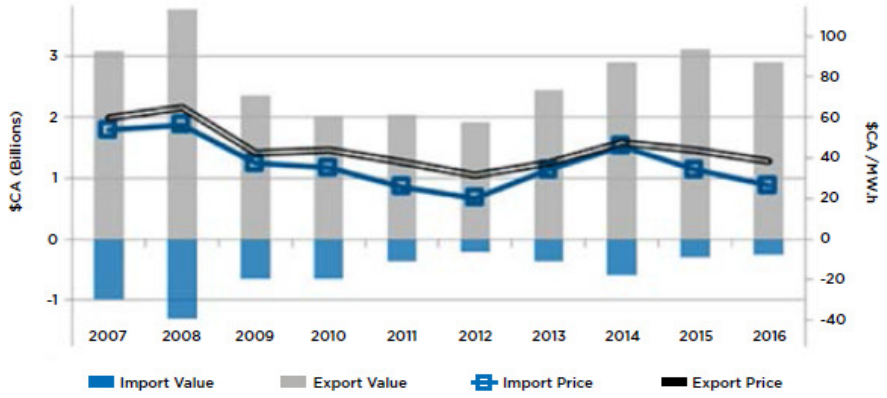


FIGURE 4: *Historical Electricity Trade Values and Prices. Source: NEB Commodity Tracking System Statistics.*

POTENTIAL PROVINCIAL PARTNERSHIPS This is especially true in the west, where Alberta and Saskatchewan have the best wind and solar resources in Canada, and British Columbia and Manitoba have strong hydro resources. Both Alberta and Saskatchewan have set aggressive renewable energy targets for their electricity sectors: Alberta is targeting 30 percent renewable energy by 2030, while Saskatchewan is aiming for 50 percent. This is expected to attract up to $20 billion in investment to build 5,000 megawatts (MW) of renewable capacity in Alberta and 2,000 MW in Saskatchewan over the next 13 years. The Alberta Electric System Operator (AESO) is responsible for competitively procuring the capacity in Alberta. At its first round of competition, the AESO awarded contracts for 600 MW procured at a weighted average price of 3.7 Canadian cents per kilowatt-hour, a historic low in Canada. The next two rounds of competition are underway, with awards expected in December 2018. In Saskatchewan, SaskPower is currently conducting competitive bidding to procure 200 MW of wind, expected to be awarded in the fourth quarter of 2018, and 60 MW of solar, expected to be awarded in 2018.

There may be a real opportunity for greater synergy by tying Alberta's and Saskatchewan's intermittent wind and solar with British Columbia's and Manitoba's firm hydro. With stronger interconnections, the abundant and cheap wind and solar resources in Alberta and Saskatchewan — complemented with British Columbia's and Manitoba's fast-ramping hydro — can be harvested to lucratively export a steady, 100 percent renewable supply of electricity into the growing western and midwestern U.S. Whereas hydroelectric dams can take more than a decade to develop for a high upfront cost, both wind and solar can be developed as quickly as within two years. This would help diversify the provincial economies that export large amounts of thermal oil and gas energy by helping them export renewable energy. That could potentially pay for the costs incurred to strengthen provincial interconnections and increase capacity of the U.S. interties for additional exports.

Another potential opportunity is building north-south interconnections between the Canadian provinces and territories. This would increase the northern resource development potential while bringing reliable utility infrastructure and jobs to the northern First Nations communities. Currently, no electric grid interconnections exist between the provinces and

Yukon, Northwest Territory and Nunavut. The territories must rely on expensive, less reliable and polluting diesel generation to meet their needs. This could be offset with a reliable supply from the electricity-rich southern provinces. There is also tremendous hydro potential in the north that has not been developed because of the lack of transmission lines connecting to the southern markets. If large-scale hydro dams could be developed, it would not only facilitate the resource extraction but also further increase the export potential to the U.S.

FIGURE 5: *Major Canada-U.S. Transmission Interconnections. Source: Canadian Electricity Association*

In addition to the export potential, a better interconnected grid also provides the added benefits of greater overall grid reliability, price stability, improved load factor and increased load diversity. This positions Canada for long-term competitiveness and energy supply.

CONCLUSION

Strengthening the interconnections between the provinces and with the northern territories could be a win-win for Canada by increasing the nation's non-GHG-emitting electricity export potential. Interconnections also will help reduce the northern Canadian communities' dependence on diesel and enable new resource development potential in northern Canada, creating job opportunities. The benefits should outweigh the costs incurred to build and strengthen the grid interconnections.

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[1] Source: Statistics Canada, Electric power generation, by class of electricity producer, annual (CANSIM Table 127-0007), 2014

[2] US Energy Information Administration (EIA). US primary energy production by major source, 2016

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[4] Major Transmission Interconnections Between Canada and the U.S., National Energy Board