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Regional collaboration to unlock the power of hydro, wind and solar to decarbonize Canada's economy

Jan Gorski, Binnu Jeyakumar and Spencer Williams | September 2021

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In response to the growing climate emergency, countries around the world are setting targets for net-zero emissions.[1] Their efforts are buoyed by the rapidly decreasing cost of zero-carbon technologies. Decarbonizing the grid is an important component of supporting net-zero economies. In fact, the latest analysis by the International Energy Agency (IEA) concludes that developed countries need to achieve a net-zero grid by 2035 to keep global warming within safe limits.[2]

Canada has a legislated commitment to achieve net-zero greenhouse gas (GHG) emissions by 2050.[3] This will require pursuing several deep decarbonization pathways including electrification of end uses such as transportation and heating buildings. A study by the Canadian Institute for Climate Choices found that all paths to net-zero emissions required more electricity — anywhere from 38% to 70% more from 2018 levels.[4] Even though electricity currently produces only 12% of Canada's emissions, decarbonizing electricity grids is essential as more sectors make the switch from fossil fuels. Canada's current goal is to generate 90% of electricity from emissions-free sources by 2030[5] and net-zero before 2050.[6]

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[1] World Resources Institute, "Net Zero Targets: Which Countries Have Them and How They Stack Up." https://www.wri.org/events/2021/6/net-zero-targets-which-countries-have-them-and-how-they-stack

[2] International Energy Agency, *Net Zero by 2050: A Roadmap for the Global Energy Sector* (2021), 117. https://iea.blob.core.windows.net/assets/beceb956-0dcf-4d73-89fe-1310e3046d68/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

[3] Government of Canada, *Canadian Net-Zero Emissions Accountability Act*, August 13, 2021. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050/canadian-net-zero-emissions-accountability-act.html

[4] Canadian Institute for Climate Choices, *Canada's Net Zero Future: Finding Our Way in the Global Transition* (2021), 26. https://climatechoices.ca/wp-content/uploads/2021/02/Canadas-Net-Zero-Future_FINAL-2.pdf

[5] Government of Canada, "Powering our future with clean electricity." https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/powering-future-clean-energy.html

[6] Environment and Climate Change Canada, *A Healthy Environment and a Healthy Economy* (2020). https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy.html

Several Canadian provinces are at a planning crossroads right now as they phase out coal-fired generation. A total of 8,928 million watts (MW) of coal capacity will be retired from Alberta, Saskatchewan, Nova Scotia, and New Brunswick.[7] As provinces and utilities move to replace this capacity, they will make critical infrastructure investment decisions that will shape the electricity sector — and its greenhouse gas emissions — for decades to come.

Current government projections show that with the policies currently in place, Canada will not achieve its target of a 90% emissions-free grid by 2030 (Figure 1). Earnest efforts are needed at the provincial and federal levels if the country is to ensure decarbonization of its electricity grid. Connecting provincial grids is also essential to make the best use of the clean electricity resources available in each province.

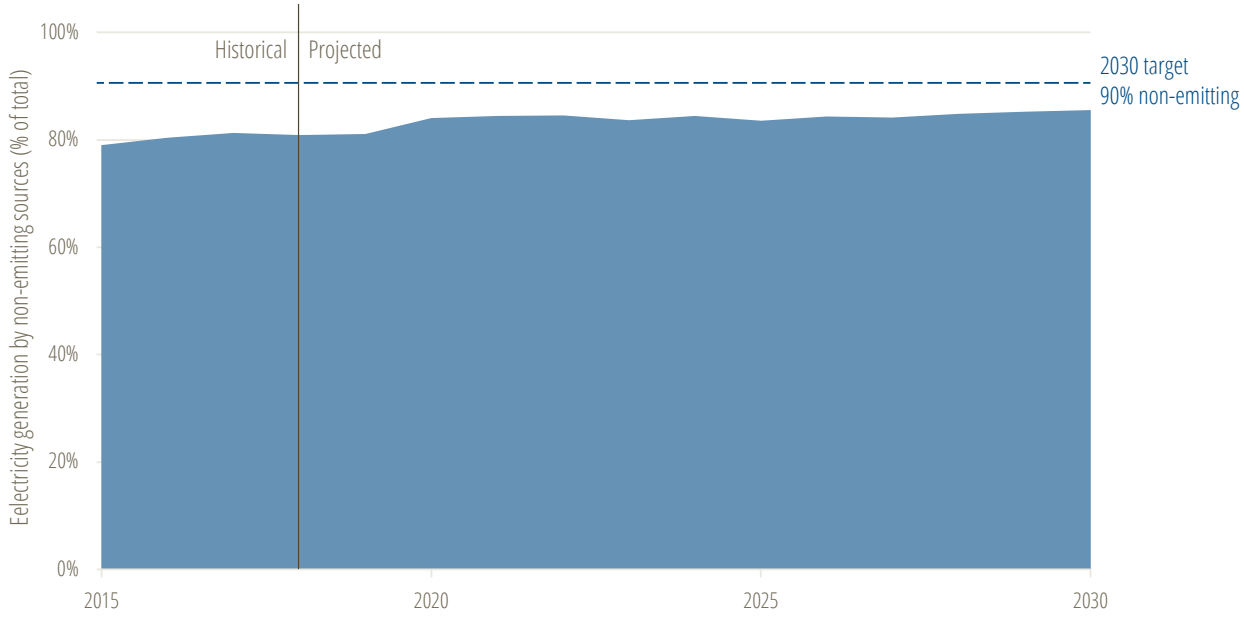

Figure 1. Historical and projected share of electricity generation from non-emitting sources

Data source: Environment and Climate Change Canada[8]

Current electricity supply mix and emissions intensity

Currently 81% of Canada's electricity is non-emitting. However, the supply mix and grid intensity of each province varies considerably. Figure 2 below shows that provinces that have abundant hydroelectricity have the lowest grid intensities. These provinces still need to

[7] While the federal government has promised to phase out coal power by 2030, Nova Scotia has signed an equivalency agreement with the federal government that allows its coal plants to operate past 2030 and New Brunswick is pursuing a similar agreement.

[8] Environment and Climate Change Canada, "Greenhouse gas emissions projections." https://data-donnees.ec.gc.ca/data/substances/monitor/canada-s-greenhouse-gas-emissions-projections/Current-Projections-Actuelles/Energy-Energie/Electricity-Electricite/?lang=en

contend with emissions from existing gas generation and from future gas plants being considered to support electrification, integration of variable renewables, and, in some cases, replacement of existing capacity. The provinces with grids with the highest carbon intensity still have considerable emissions from coal and gas that must be managed. The coal phase-out is proceeding at a different pace in different provinces.

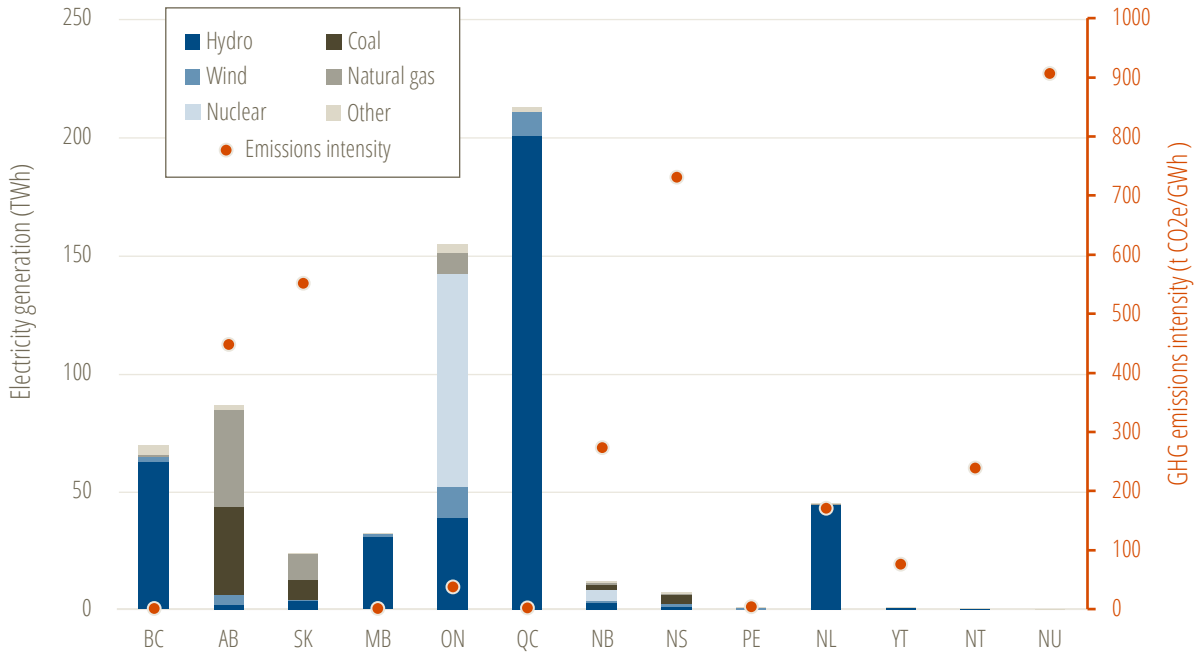

Figure 2. Electricity generation and GHG emissions intensity by province

Data source: Canada Energy Regulator[9], Environment and Climate Change Canada[10]

Components of a decarbonized grid

Canada needs a reliable, affordable, accessible, and emissions-free electricity grid that can support electrification of other sectors. A grid requires assets and technologies that can provide reliable energy services and ensure the stability and security of the grid. A portfolio of solutions needs to be deployed including:

- Renewable energy (hydro, wind, solar, etc.) to provide zero-carbon energy
- Energy efficiency to reduce how much electricity is needed
- Demand response to match when electricity is needed with when it is available
- More transmission lines to connect provincial grids in a way that allows clean energy sources such as hydro, wind, and solar to work together at a large scale

[9] Canada Energy Regulator, *Canada's Energy Future,* Data Appendices. https://doi.org/10.35002/zjr8-8x75

[10] "Greenhouse gas emissions projections."

- Storage including lithium ion batteries, pumped hydro, compressed air, along with technologies still in development such as flow batteries, supercapacitors, and clean hydrogen[11]

Other technologies like small modular nuclear reactors, natural gas with carbon capture, and geothermal may also have a role to play but are currently either too expensive or not yet mature.[12]

The role of transmission lines

To make the best use of the clean electricity resources available in each province, electricity grids between provinces should be connected. Interties make it easy to share electricity between regions with different strengths, allowing renewable energy to be developed in areas with the best conditions and distributed elsewhere. New transmission is also expected to lower the costs of "deep decarbonization."[13] This is particularly true in a country like Canada where some jurisdictions have plentiful hydroelectric resources while others have abundant wind and solar resources.

Wind and solar are among the cheapest sources of new electricity and are complemented by existing low-cost hydroelectricity. In particular, reservoir-based and pumped hydro systems can store energy for long periods of time and dispatch it when needed in a way that batteries cannot. This provides a valuable service to grids that want to integrate large amounts of wind, solar and electrification. Canada's best hydro resources are located in different provinces than those with the best wind and solar, and transmission lines can connect them in such a way that consumers in each province benefit.

The recent *North American Renewable Integration Study* concluded that a continent-wide transmission grid, along with storage and flexible operation of different generation technologies, in particular hydro power, could provide operational flexibility and deliver system-wide net benefits of $12.6-$38 billion (US$10-$30 billion).[14]

[11] Eli Angen and Binnu Jeyakumar, *Grid Modernization in Ontario* (Pembina Institute, 2016), 19. https://www.pembina.org/reports/on-grid-modernization.pdf

[12] IEA, "ETP Clean Energy Technology Guide." https://www.iea.org/articles/etp-clean-energy-technology-guide

[13] 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* (MIT Center for Energy and Environmental Policy Research, 2020), 1. http://ceepr.mit.edu/files/papers/2020-003-Brief.pdf

[14] Gregory Brinkman et al., *The North American Renewable Integration Study: A Canadian Perspective (*National Renewable Energy Laboratory, 2021). https://www.nrel.gov/docs/fy21osti/79225.pdf

Investment in transmission can deliver large benefits at low costs.[15] In particular, for those provinces retiring coal plants, significant opportunities have been identified to build new transmission in Canada and connect provinces with abundant hydro to those that have good wind and solar resources. Other opportunities may exist that haven't been identified here.

- Connecting hydro power in Manitoba with the coal-heavy grid in Saskatchewan (already underway)[16, 17]
- Connecting hydro power in British Columbia to the coal-heavy grid in Alberta[18, 19]
- Expanding connections between hydro resources in Quebec and Newfoundland and Labrador to the coal-heavy grids of New Brunswick and Nova Scotia[20, 21]

Current state of interconnections between provinces

As of 2014, there were 33 major (≥69 kV) interprovincial connections across Canada.[22] Canadian imports and exports are illustrated in Figure 3 below. Electricity trade between provinces is small with the largest interprovincial transfer being from the Churchill Falls plant in Newfoundland and Labrador, which sends hydroelectricity to Quebec.

Interestingly, more electricity flows between Canadian provinces and American states than between Canadian provinces. Trade in electricity between Canada and the U.S. is bidirectional, via 37 major transmission lines that transferred 82,400 GWh in 2016.[23] Canada is a net exporter

[15] Jeff St. John, "MIT Study: Transmission is Key to a Low-Cost, Decarbonized US Grid", *Green Tech Media*, January 8, 2021. https://www.greentechmedia.com/articles/read/study-transmission-is-the-key-to-a-low-cost-decarbonized-u.s-grid

[16] Manitoba Hydro, "Birtle Transmission Project." https://www.hydro.mb.ca/projects/expansion/birtle/

[17] Natural Resources Canada, *Western Regional Electricity Cooperation and Strategic Infrastructure (RECSI) Study*, prepared by GE Energy Consulting (2018). https://www.aeso.ca/assets/Uploads/RECSI-Western-Final-GE-Report.pdf

[18] Brett Dolter, G. Kent Fellows, and Nicholas Rivers, "The Economics of the Site C Hydroelectric Project in British Columbia," *SSRN,* (2020), 1. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3742136

[19] *ECSI Study.*

[20] Government of Canada, *Towards A Clean Power Roadmap For Atlantic Canada* (2020). https://www.canada.ca/content/dam/acoa-apeca/documents/Towards%20a%20Clean%20Power%20Roadmap%20for%20Atlantic%20Canada.pdf

[21] Natural Resources Canada, *Regional Electricity Cooperation and Strategic Infrastructure (RECSI) Summary for Policy Makers: Atlantic Region* (2018) https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/clean/RECSI_AR-SPM_eng.pdf

[22] Natural Resources Canada, "Canada's Electricity Reliability Framework", June 15, 2020. https://www.nrcan.gc.ca/energy/electricity-infrastructure/electricity-canada/canada-electric-reliability-framework/18792

[23] Doug Vine, *Interconnected: Canadian and U.S. Electricity,* (Center for Climate and Energy Solutions, 2017), 1. https://www.c2es.org/wp-content/uploads/2017/05/canada-interconnected.pdf

to the United States, with about 8% of the electricity it generates going to the U.S.[24] Net exports have increased over the past decade, and north-south transmission connections from Canada to the United States are greater than east-west connections between provinces.[25]

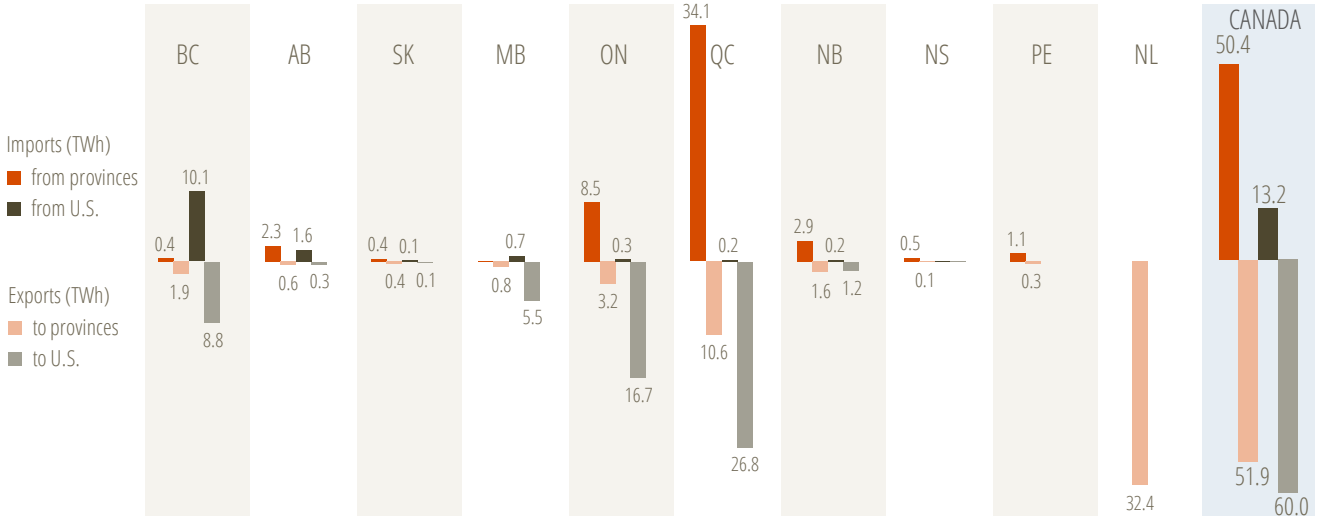

Figure 3. Electricity imports and exports between provinces and with U.S. in 2018

Source: CER[26]

Role of the federal government

The federal government has a role to play in both sides of the equation: driving decarbonization of electricity itself, and supporting supply of clean electricity to markets, including across provincial borders.

Driving electricity decarbonization: Existing policies and measures

To support the creation of clean electricity and decarbonized electricity grids, federal governments have successively set non-emitting targets and implemented different policies and programs to lower emissions from the electricity sector and provide financial support for transmission projects and research studies over the years. The most impactful actions include:

- Targets for non-emitting electricity: In 2006 the federal government committed to generating 90% of Canada's electricity from non-GHG-emitting sources by 2020. In 2016 this target was pushed back to 2030; however, there have recently been discussions on the target year to achieve a net-zero grid.

[24] Government of Canada, "Electricity Facts." https://www.nrcan.gc.ca/science-and-data/data-and-analysis/energy-data-and-analysis/energy-facts/electricity-facts/20068

[25] "The Economics of the Site C Hydroelectric Project," 5.

[26] *Canada's Energy Future,* Data Appendices.

- Emissions reduction policies: Canada's coal phase-out laws, carbon pricing systems, and performance standards for gas plants are all aimed at reducing emissions from the electricity system. These policies have contributed to the rapid phase-out of coal in Alberta and also create favourable conditions for investment in building transmission lines to help further reduce electricity emissions.
    - Coal phase-out legislation: In an effort to reduce emissions and address air quality impacts, the phase-out of coal power plants in Canada was initiated in 2012, through legislation to limit GHG emissions from coal plants,[27] which was updated in 2018[28] with an accelerated timeline of 2030.
    - Carbon pricing: The federal government introduced a carbon pricing system for large industrial emitters including electricity plants, and committed to increasing the carbon price to $170 by 2030.[29] This incorporates some of the climate costs of coal and gas plants, allowing renewables to compete on a more even playing field. In Alberta, carbon pricing has already been observed to have reduced generation from coal plants, and has contributed to the accelerated phase-out of coal by the generators.
    - Gas-fired electricity performance standard: In 2019 the federal government legislated emissions limits for gas-fired power plants, including units that are repowered coal plants. It helped accelerate conversions of coal plants to gas in Alberta; however, it does not send a signal for eliminating emissions from gas-fired electricity.

Accelerating transmission between provinces: Policy considerations and next steps

Decarbonizing Canada's economy by 2050 requires federal and provincial governments alike to move quickly to reduce emissions from the electricity sector. That starts with committing to achieve a net-zero grid by 2035 to align with the IEA.[30]

Broad policies and measures are all key to accelerating available supply of clean electricity to meet growing demand across Canada. One pivotal measure (but by no means the only measure required) to address the supply side of the clean electricity equation is interprovincial

[27] Environment and Climate Change Canada, *Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations,* SOR/2012-167 (2012). https://laws-lois.justice.gc.ca/eng/regulations/SOR-2012-167/FullText.html

[28] Government of Canada, *Regulations Amending the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations*, SOR/2018-263 (2018). http://gazette.gc.ca/rp-pr/p1/2018/2018-02-17/html/reg3-eng.html

[29] Nichole Dusyk et al., *All Hands on Deck: An assessment of provincial, territorial and federal readiness to deliver a safe climate* (Pembina Institute, 2021), 41. https://www.pembina.org/reports/all-hands-on-deck.pdf

[30] *All Hands on Deck,* 7.

connections between electricity grids. However, significant on-the-ground work is needed to secure strong environmental outcomes and community support for the large infrastructure projects needed to deliver the clean electricity that is the key to decarbonizing Canada's economy. Progress toward this goal requires consideration of the following:

1. The business case for transmission projects requires strong policies and regulations, including a coal phase-out that proceeds on or ahead of the original schedule, and a predictable, ambitious carbon pricing policy that provides the policy and investment certainty needed for projects to proceed.
2. Successful design of practical and economically beneficial ways to increase interconnections between jurisdictions depends on evidence-based analysis and then regional conversations about how to proceed. The federal government can play an important role continuing to support regional integration studies and convening regional dialogues.
3. Large infrastructure projects will face scrutiny, including those designed to significantly reduce emissions. Success depends on informing, engaging and securing participation of stakeholders to understand and then address their concerns. Governments should support meaningful engagement and participation by stakeholders to ensure interprovincial connections can contribute to meeting energy needs and achieving climate goals.
4. All new electricity plants and infrastructure projects should continue to be rigorously evaluated on their environmental impacts, including their life cycle carbon emissions.

Canada's federal governments have taken important steps toward decarbonizing electricity. Both federal and provincial governments should collaborate to build interties between provinces to accelerate the drive to quickly and fully decarbonize electricity grids and Canada's economy.