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Toward a National Energy Vision

Case Study: Electricity System Implications for Ontario and Quebec

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Council for Clean & Reliable Energy
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Marc Brouillette is the principal consultant at Strategic Policy Economics with over 20 years' experience in technology-based innovations impacting public-private initiatives in policy-driven regulated environments. His firm specializes in climate, energy and the science that supports them.

Marc has analyzed the strategic and economic implications of policies related to Ontario's electricity sector, including the role of renewables, nuclear generation and transmission interties. Marc has written about the challenges of cap and trade, the costs of Ontario's climate policies for emission reduction, the implications of renewables based distributed energy resources in Ontario and the role of interprovincial electricity transmission networks. His latest work addresses the Electrification Pathways for Ontario and the context for energy projects in Canada to help inform a principled approach for a National Energy Vision. These two recent reports have informed this Commentary.

All reports are available online at www.strapolec.ca

The Council for Clean & Reliable Energy

The CCRE is a non-profit organization that provides a platform for public dialogue and analysis on subjects related to energy policy and governance. It was established in 2005 by university academics, public and private sector executives, and labour leaders. Council members collaborate to broaden the public debate on energy issues.

The CCRE has invited energy leaders from around the world to facilitated conferences focused on sharing knowledge, experiences and expertise to create a better understanding of the challenges and potential solutions to common areas affecting energy policy in Canada and abroad. Over the years, it has hosted conferences on distributed generation, biomass, coal and nuclear, public sector governance in the electricity sector, and the future of local distribution companies. Annually, the CCRE hosts the Energy Leaders Roundtable. It encourages energy experts to provide reasoned opinions and points of view about significant issues relevant to the sector.

These CCRE Commentaries are distributed to opinion leaders and made available to the public as part of its mission to create a broader and more inclusive public discourse. During the last decade, its efforts have been recognized and appreciated by decision-makers in government and the energy sector as providing a neutral forum for the free exchange of ideas and opinions. The CCRE remains committed to continuing to facilitate debate on the generation, transmission and distribution of clean, affordable, and reliable energy with a clear focus on finding effective solutions for Canada and abroad.

For more information on the Council's recent initiatives, visit www.thinkingenergy.ca.

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Toward a National Energy Vision

Case Study: Electricity System Implications for Ontario and Quebec

Marc Brouillette

> *"Comprehensive and reliable data is critical for Ontario and Quebec in achieving federal climate goals"*

INTRODUCTION

In 2021, the Council for Clean & Reliable Energy (CCRE) launched a series of *Commentaries* that advocate for the development of a principle-based National Energy Vision for Canada. Such a collaboratively developed vision could help Canada develop a transformative plan for securing low-carbon national energy security, meet its climate commitments and stimulate economic growth.

The CCRE's first *Commentary*, "A National Energy Vision for Canada: A Principled Approach," posited core principles for developing such a vision to address Canada's enduring energy policy dilemma — creating a national energy strategy that aligns the economic and emissions conflicts between energy-producing and energy-consuming provinces. Canada's commitment to achieving a net-zero economy by 2050 has crystalized two of the vision's principles: clear goal; and a timeline.

The second *Commentary*, "Toward a National Energy Vision: Canada's Low-Carbon Energy Infrastructure Opportunity in a Global Net Zero Future," described the trifecta of low-carbon electricity, decarbonized fossil fuels and hydrogen that underpin the infrastructure prerequisites for achieving Canada's climate goals, given regionally diverse natural endowments for energy production. It informed two vision principles critical to addressing Canada's policy dilemma: enabling economic prosperity through thoughtful infrastructure decisions and the equitable development of that infrastructure.

This third *Commentary* provides a case study on the misalignment of electricity policies and climate objectives in Ontario, how that presents risks to national climate goals and how opportunities may be enabled through a collaboration between Ontario and Quebec on an overall regional energy vision. The case study focuses on illustrating the importance of three vision principles: fact and science-based discussions, the need for comprehensive and reliable data and ensuring affordability.

1. SIGNIFICANT EMISSION CONTRIBUTIONS OF ONTARIO AND QUEBEC

Ontario and Quebec are Canada's two most populous provinces and significant energy consumers.[1] Despite having the two lowest provincial per-capita emissions, these two provinces are the largest emitters outside the energy sector [Figure 1].

The federal government has set 2035 targets for net-zero electricity grids and 100-percent electric vehicle (EV) sales.[2] Electricity grids and light transportation emitted 160 metric tonnes (Mt) of greenhouse gases in 2019 or more than 20 percent of Canada's emissions.[3] While Ontario and Quebec represent only six percent of Canada's electricity sector's emissions, they together contribute 57 percent of Canada's light transportation emissions.

1 Strategic Policy Economics (Strapolec). "Towards a National Energy Vision - The Realm of the Possible for Canada: Hitting Above Its Weight to Reduce Global Emissions", December 2020.

2 Transport Canada. "Building a green economy." June 2021.

3 Environment and Climate Change Canada. Data on GHG emissions by province. 2019. Strapolec analysis.

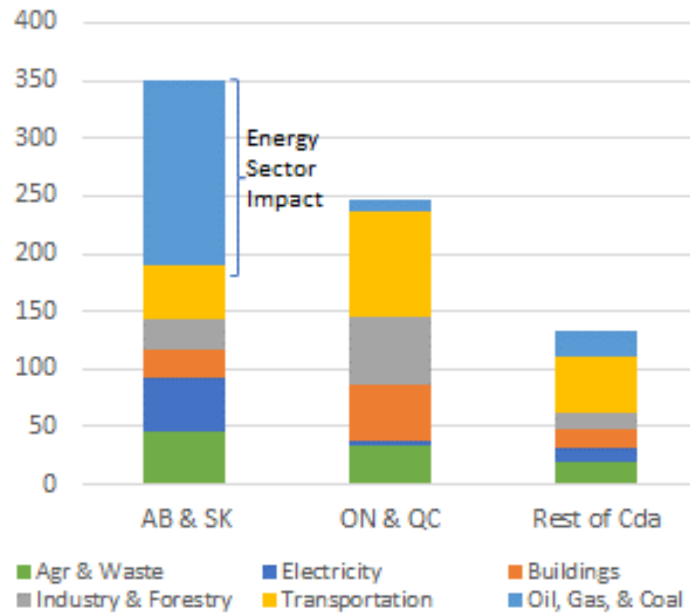

Figure 1: Total Emissions by Sector for Provincial Groups
(Mt CO_2e, 2019)

Source: Environment and Climate Change Canada, data on GHG emissions by province, 2021.

"Resolving uncertainty in carbon capture viability impacts electricity demand for hydrogen"

2. THE ENERGY TRANSITION IN ONTARIO AND QUEBEC UNIQUELY RELIES ON LOW-CARBON ELECTRICITY

The trifecta of energy options — low-carbon electricity, decarbonized fossil fuels and hydrogen — will unfold differently across Canada, influenced by regional climate and energy policy alignment.[4] Low-carbon electricity will figure prominently in the clean-energy transition for Ontario and Quebec due to their existing energy infrastructure and the composition of their economies. Moderate electricity demand growth has been forecast for Quebec since it has significantly electrified the building (heating) and industry sectors. In Ontario, however, electricity demand growth is forecast to be more than double that of most other provinces. Drivers include Ontario's transportation and industrial sectors and the need to decarbonize building heating [Figure 2]. However, meeting Ontario's demand for electricity depends on whether hydrogen that is produced from electricity or natural gas. The approach to hydrogen production and the options available for a low-carbon-electricity-system supply mix will, in turn, depend on the viability of carbon capture utilization and storage (CCUS).

Hydrogen is forecast to supply some 30 percent of Canada's energy by 2050.[5] This could include deploying electrolyzers in Ontario and Quebec, especially to decarbonize heavy-duty transportation such as trains and trucks.[6] The Windsor-Montreal "trade corridor" is such an opportunity, representing 60 percent of all U.S.-Canada trade.[7] Furthermore, urban centres depend on delivery vehicles, buses and garbage trucks, while the northern forestry, mining and transportation sectors also deploy multiple heavy-duty vehicles. The economics of distributed electrolytic hydrogen production at end-use locations can benefit from using existing electricity transmission and distribution infrastructure.[8] The alternative is to pipe hydrogen from centralized production locations equipped with CCUS.

4 M. Brouillette. "Toward a National Energy Vision." CCRE *Commentary*. December 2021.
5 Natural Resources Canada. "Canada's Hydrogen Strategy." 2021.
6 Government of Ontario. "Ontario's Low Carbon Hydrogen Strategy." April 2022; Government of Quebec. "2030 Plan for a Green Economy." 2020; Nuclear Innovation Institute. "Why Hydrogen Needs Nuclear." September 2021.
7 Green Ribbon Panel. "Clean Air, Climate Change and Practical, Innovative Solutions." 2020
8 Nuclear Innovation Institute. "The Hydrogen Unity Project." November 2020; Strapolec. "Advancing Ontario's Energy Transition: Part 1." 2021.

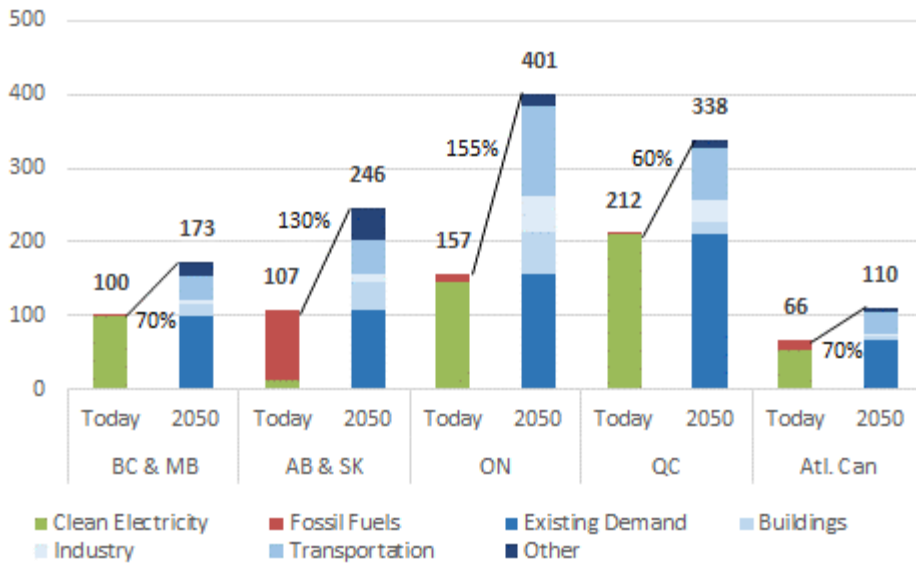

Figure 2: Forecast Provincial Electricity Demand by Sector
(TWh, Today by supply type, 2050 by demand source)

Forecast energy demand based on economic sector-specific TWh/Mt forecasts. Excludes electrolytic hydrogen in BC, AB, SK and MB, assuming these provinces will rely on steam methane reforming from natural gas coupled with carbon capture. Assumes 75-percent reduction in AB/SK oil sector activity by 2050.

Source: Canada Energy Regulator, Canada's Renewable Power, 2021; Environment and Climate Change Canada Data, 2021; Strapolec Analysis.

"Ontario is ill-prepared for electricity demand growth of over double that of other provinces"

While CCUS technologies are receiving federal financial support,[9] the viability of CO_2 storage in Ontario and Quebec has no established fact base, including for southwestern Ontario's favourable geologic formations.[10] Additionally, CCUS economics are not yet established in three areas: using natural gas imported from the U.S.; enhancing pipeline infrastructure to reduce the region's dependence on imported natural gas; and natural-gas-based hydrogen production within the region.

The presence or absence of comprehensive and reliable data on CCUS options may shape how the trifecta-driven infrastructure unfolds in Ontario and Quebec and impacts infrastructure decisions in the rest of Canada.

3. ONTARIO'S CURRENT ELECTRICITY PLANNING WILL UNDERMINE CANADA'S NET-ZERO TARGETS

Ontario is facing a recently identified need to procure 25 percent, or six gigawatts (GW), more generation capacity by 2030 – a challenge equivalent to more than doubling the capacity of its existing hydro fleet in seven years. This need is driven by population and economic growth, the imminent retirement of the 3.1 GW Pickering Nuclear Generation Station, modest EV uptake and only select industrial electrification.[11]

Currently, net-zero is gaining public profile.[12] Independent analyses forecast Ontario generation capacity requirements of 70 GW by 2050, including 26 GW of new baseload supply [Figure 3].[13] The baseload increase is equivalent to doubling that provided by Ontario's existing nuclear and hydro fleets.

9 Canadian Federal Budget. Apr 2022.

10 Ontario Ministry of Natural Resources. "A Review of Sequestration Opportunities for CO2 in Ontario." 2007. Referenced in "Ontario's Low-Carbon Hydrogen Strategy." 2022.

11 Independent Electricity System Operator (IESO). 2021 Annual Planning Outlook (APO) materials. January 2022.

12 The IESO's 2021 APO includes a high-demand scenario and Ontario-commissioned studies, to be completed in late 2022, assessing the impacts of the electrification of the economy and a moratorium on new gas supply. Ref: Ministerial Directive to IESO, Nov. 10, 2021; IESO. "Pathways to Decarbonization." February 2022.

13 Strapolec. "Advancing Ontario's Energy Transition: Part 1." 2021.

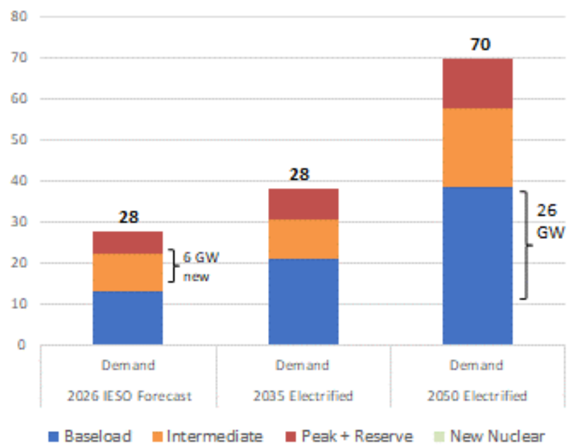

Figure 3: Ontario's Forecast Capacity Needs
(GW, derated capacity at peak)

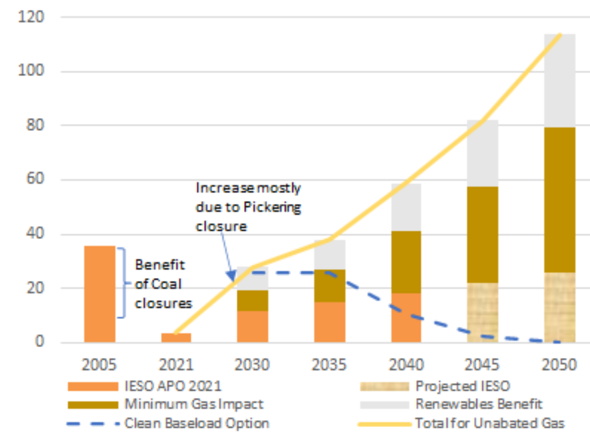

Figure 4: Forecast Emissions Scenarios for Ontario's Electricity System
(Mt CO_2e)

Baseload supplies full output for at least 98 percent of the hours in a year. Intermediate supplies tend toward zero output at night and address most of the daily demand except for peaking needs, which occur in only two percent of the hours in a year.
Source: Strapolec. "Electrification Pathways for Ontario to Reduce Emissions: Procuring Ontario's Energy Future." 2021.

"Lack of data on clean electricity options is driving Ontario to high emission future"

Unfortunately, Ontario's procurement policies favour new natural-gas-fired generation rather than low-carbon facilities.[14,15] Consequently, the emissions forecast for Ontario's electricity sector grows from four Mt in 2021 to between 30 Mt and 40 Mt by 2035, depending on how Ontario renews its wind and solar fleet [Figure 4].[16] This growth in emissions will erase the reductions achieved by Ontario's coal station closures a decade ago, set back Canada's 2030 national emission targets and make it impossible to achieve Canada's proposed 2035 Clean Electricity Standard objectives.[17]

Absent an urgent shift to non-emitting supplies, Ontario's electricity emissions could become as high as 60 Mt by 2040 and 110 Mt by 2050 – double the total achievable emission reductions from decarbonizing electricity in coal-burning provinces.

Given the 10-to-15-year time span required to develop alternative non-emitting resources, Ontario's current procurement of new gas-fired generation will make it impossible to avoid the 2035 emission impacts [Figure 4]. Furthermore, achieving reductions for 2040 necessitates the urgent procurement of new, large-scale, low-carbon options such as hydroelectric, CCUS and nuclear. Regrettably, Ontario's decisionmakers have not been provided with the transparent, comprehensive and reliable fact-based data regarding the emerging demand, options for addressing it and the associated affordability implications so critical to the energy transition.

4. AFFORDABLE OUTCOMES ARE LINKED TO INTEGRATING ONTARIO'S AND QUEBEC'S LOW-CARBON RESOURCES

Ontario's transmission constraints are limiting its electricity supply options. By 2040, Ontario requires new supply in different locations across the province – with eight to 13 GW required for the Greater Toronto Area alone from the east by 2035 [Figure 5].[18] This need could approach 19 GW by 2041, equivalent to more than doubling the province's existing capacity from nuclear, hydroelectric and imports from Quebec.

14 IESO's April 2022 "Annual Acquisition Report" and "Long-Term Request For Proposal Design Webinar Materials" favour flexible capacity to operate for more than four consecutive peak hours with no criteria related to emissions.

15 The bias toward gas-fired generation has been a long-standing characteristic of the electricity markets model in Ontario as described in the 2020 Strapolec report "Electricity Markets in Ontario."

16 Strapolec. "Advancing Ontario's Energy Transition: Part 1." 2021.

17 Environment and Climate Change Canada. "Clean Electricity Standard Discussion Paper." 2022.

18 IESO 2021 APO. Strapolec analysis.

While these are evident opportunities for additional electricity trade between Ontario and Quebec, Quebec is facing its own supply challenges. It anticipates 100 terra-watt hours (TWh) of new demand resulting from its net-zero ambitions.[19] It has forecast a near-term need for four GW of new peak-winter supply, increasing its current capacity requirement from 42 GW to 46 GW in 2029. Quebec plans to secure two GW by enhancing the capacity of its existing assets and procuring three GW of wind to address energy growth.[20]

The growing demand for a low-carbon energy transition is stimulating innovation in integrative approaches and technologies such as: demand-side management; distributed storage; hydrogen electrolyzer operations; natural-gas distribution infrastructure for winter peaking; and low-carbon baseload generation from hydroelectric, CCUS-equipped gas-fired generation and nuclear.[21,22]

Based on industry-benchmark generation-cost forecasts, detailed simulations of these integrated approaches indicate that solutions based on a nuclear platform could cost 25-percent less than future CCUS-enabled gas-fired options integrated with renewables [Figure 6].[23] Broad validation and consensus on the fact base behind this generally unrecognized finding would greatly aid decisionmakers.[24]

"Understanding innovations will shape low-cost options for Ontario and Quebec"

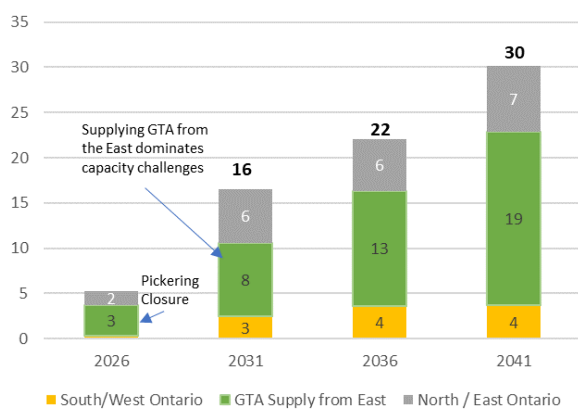

Figure 5: Ontario Incremental Capacity Needs
(GW by Region, path to net-zero)

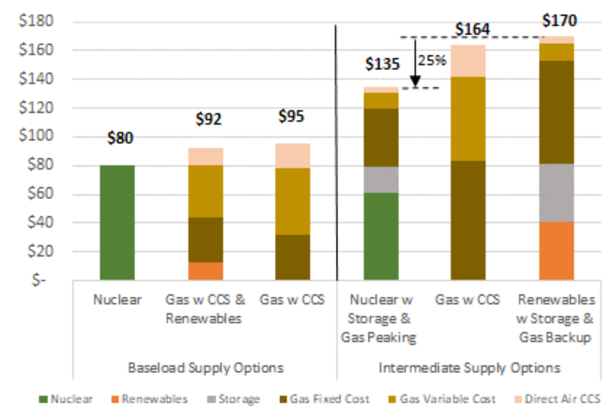

Figure 6: Future Non-emitting Electricity Costs
Nuclear vs. Gas & Renewables-based alternatives
($/MWh 2018, 2035 Installations)

Costs from U.S. National Renewable Energy Laboratory (NREL) 2020 Advanced Technology Baseline generation costs for 2035 adjusted for Ontario weather, local costs and exchange rates. Modelling shows renewables with storage scenarios for baseload supply exceed costs shown for intermediate supply scenario. Note: Canadian hydroelectric cost using NREL model = $143/MWh (not shown and extrapolated from capital costs of Muskrat Falls, Site C, Keeyask).
Source: Strapolec. "Electrification Pathways for Ontario." 2021. Strapolec Analysis.

These innovations are also driving a trend to localized peak-demand management that will reduce the variability of demand presented to the bulk system and hence transition the bulk electricity system more toward supplying baseload needs. This trend has significant implications for the operation of Quebec's electricity system and its interoperability with neighbouring jurisdictions.

19 Hydro Quebec. "Strategic Plan 2022-2026." 2022.
20 Renewables work effectively with Quebec's reservoirs to maintain levels without losing energy. In Ontario, when demand is low, surplus energy is curtailed and lost without economic benefit.
21 Strapolec. "Electrification Pathways for Ontario to Reduce Emissions." 2021. Note: Renewables options are most cost effective when paired with natural-gas-fired solutions since the output from renewables can displace gas, thereby minimizing storage costs and avoiding the curtailment of other low-carbon supplies.
22 Hydro Quebec. "Strategic Plan 2022-2026." 2022.
23 Strapolec. "Electrification Pathways for Ontario to Reduce Emissions." 2021.
24 M. Brouillette. "Distributed Energy Resources in Ontario: A Series of Unfortunate Truths." CCRE *Commentary*. 2019.

Quebec's hydro reservoirs capture the spring runoff for use throughout the year. Quebec's generation capacity has been sized for winter demand, which is 50-percent greater than in summer [Figure 7]. However, Quebec is now short of winter generation capacity and its net surplus reservoir energy in the summer will be eroded quickly by the anticipated 60-percent increase in demand. With innovations moderating winter-peaking demand growth, Quebec would benefit from access to new baseload supply that can free up Quebec's hydroelectric capacity for year-round, higher-value variable-demand export. With Quebec's non-heritage supply costs of $110/MWh, Ontario and Quebec collaboration on the above-noted low-cost, low-carbon electricity development could provide multiple benefits. Freeing up Quebec's peak hydro capacity could facilitate greater exports to Ontario and the U.S. as their winter demands increase. Aligning the respective hydrogen strategies of the two provinces could also improve the economics of the electricity system; i.e., via integrated regional power system optimization, use of blended natural gas, decarbonization of the Windsor-Montreal transportation corridor and the potential for hydrogen exports to the U.S. Better data and analyses would help confirm the viability for Ontario and Quebec of these critical elements of their respective pathways to decarbonization.

"Decarbonizing Ontario and Quebec is an opportunity for advancing a National Energy Vision"

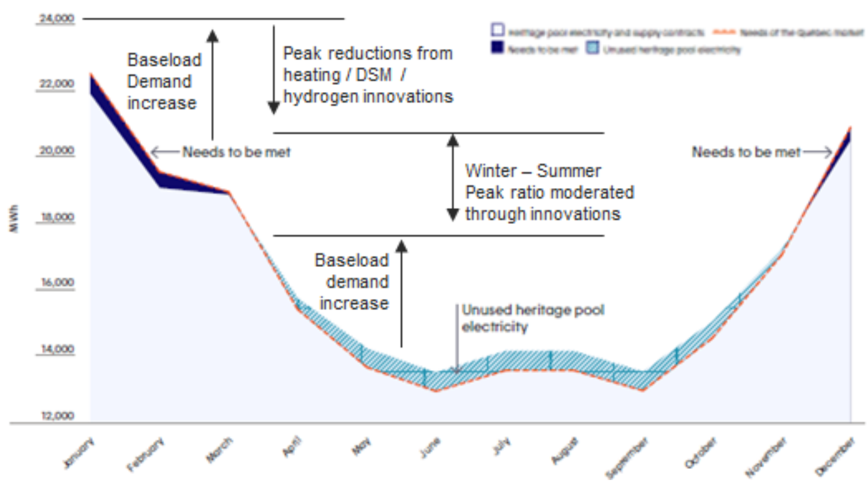

Figure 7: Hydro Quebec Distribution Supply Needs from Quebec Heritage Resources
(Illustrative trends, MW)

Source: Hydro Quebec. "Electricity Supply Plan 2020-2029." 2019; Strapolec annotations and analysis.
Decarbonizing Ontario and Quebec is an opportunity for advancing a National Energy Vision

Developing energy infrastructure of this complexity and scale represents a significant opportunity to incentivize innovation across the energy spectrum. Ontario and Quebec need low-cost, low-carbon electricity, hydrogen and natural gas to sustain and enhance their economic competitiveness and long-term, low-carbon energy security. Solutions represent opportunities across the country: enhanced energy security for Manitoba and the Atlantic provinces from infrastructure links with Ontario and Quebec; nuclear solutions for decarbonizing the oil and gas sector; and supply of low-carbon hydrogen and natural gas from western Canada, including for export from eastern Canada.

Aligning federal, provincial and territorial climate policies with fact-based decision-making on energy opportunities and their transition implications could facilitate a National Energy Vision to ensure an affordable, low-carbon energy future for all Canadians.

CONCLUSION

The success of Canada's net-zero transition is inextricably linked to the decarbonization policies in all provinces, including Ontario and Quebec. The required principles for creating a National Energy Vision are clear, and the low-carbon resources that Canada brings to the table are well understood. Analyses clearly indicate an important role for hydrogen, carbon capture and storage, and nuclear across Canada, but comprehensive facts are not yet ubiquitous. Collaboration and transparent discussions using scientific facts and reliable data are the necessary prerequisites for an affordable transition.