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Toward a National Energy Vision:

Canada's Low-Carbon Energy Infrastructure Opportunity in a Global Net Zero Future

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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 has addressed 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.

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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.

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Toward a National Energy Vision: Canada's Low-Carbon Energy Infrastructure Opportunity in a Global Net Zero Future

Marc Brouillette

INTRODUCTION – VISIONING CANADA'S STRATEGY IN THE GLOBAL ENERGY TRANSITION

In early 2021, the Council for Clean and Reliable Energy (CCRE) released the first in a series of Commentaries advocating for the development of a long-overdue, principles-based National Energy Vision. Our vision's dual objective: to reconcile Canada's energy and climate needs and to facilitate a transformation plan to a low-carbon, secure energy future.[1] Meanwhile, tumultuous forces related to climate change have continued to batter the global energy sector. As a result, governments, businesses, and institutions around the world accelerated approaches for achieving Net-Zero emission targets by 2050. To date, more than 130 countries have made such commitments.[2]

"Canada's enduring policy dilemma faces greater complexity with Net Zero ambitions"

Furthermore, this year's landmark report from the International Energy Agency (IEA) declared that new fossil resource expansion must stop.[3] Carbon capture is now considered a prerequisite for the ongoing use of fossil fuels, and new low-carbon energy vehicles like hydrogen are being considered for large-scale deployment. These trends underscore the critical need for a principles-based process to guide the evolution of Canada's energy demand and supply policies.

This complex energy transformation shines a light on an enduring Canadian policy dilemma: how to craft a national energy strategy that balances the conflicting demands between energy producing and consuming provinces that arise from our vast geography and unequal distribution of energy resources.

To build upon the principles-based process identified in the first *Commentary*, this follow-up *Commentary* first profiles Canada's energy resources and their importance to our national economy and then explores how global trends in the demand and supply for energy have different implications across the country. Finally, it lays out the infrastructure pre-requisites to enable an energy transformation that works hand-in-glove with Canada's climate policies – supporting the fundamental objective of a National Energy Vision to ensure energy is cost effectively available where it is needed both within Canada and for our export markets.

CANADA'S ENERGY RESOURCES PLAY A SUBSTANTIAL ECONOMIC ROLE

Canada's energy sector, comprising electricity generation and transmission along with oil and natural gas extraction and pipelines accounts for 9.5 per cent of our GDP and 1.5 per cent of the labor force.[4] In 2018, the sector contributed $14.9 billion to government revenues or 7.1 per cent of all corporate and indirect taxes paid.

Canada is home to some of the world's largest energy reserves – third largest of crude oil and fourth largest of uranium [See Figure 1]. Canada is also a major energy producer – fourth in extracting natural gas and crude oil and in generating zero-emission electricity. The volume of our uranium production is second only to Kazakhstan.[5] Much of this energy production is intended for export [See Figure 2]. Indeed, in 2018 Canada was the world's third largest electricity exporter and the fourth largest exporter of crude oil. Energy products have been Canada's largest export product in nearly every year since 2010.[6]

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1 K. Taylor. CCRE *Commentary*. "A National Energy Vision for Canada: A Principled Approach." April 2021.
2 United Nations, Net-Zero Coalition, 2021.
3 IEA. "Net Zero by 2050." 2021
4 R.Alahdad, J.Hai, G.Holburn and B.Rivard. "Energy in Canada: A Statistical Overview." Ivey Business School. 2020.
5 Strategic Policy Economics. "Towards a National Energy Vision." 2021.
6 R.Alahdad, J.Hai, G.Holburn and B.Rivard. "Energy in Canada: A Statistical Overview." Ivey Business School. 2020.

Figure 1: Canada's Share of Global Energy Resources (2018)
(% share of global production and reserves; with global rankings)

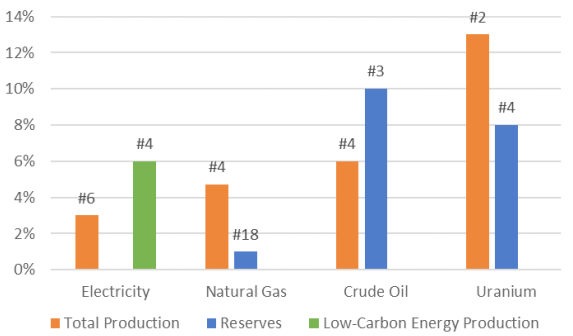
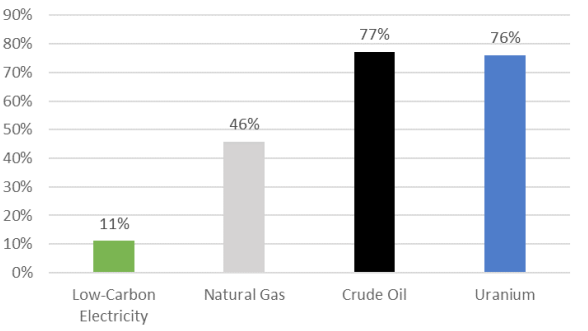


Figure 2: Percentage of Canada's Energy Production Exported (2018)
(Exports as % of production)



Sources: Strategic Policy Economics. "Towards a National Energy Vision." 2021.

"Net Zero ambitions raise new questions with different implications across Canada"

While these contributions are significant, they obscure a fundamental reality — the variable and unequal distribution of these energy resources across Canada. Natural gas production is concentrated in British Columbia and Alberta, while oil is concentrated in the Prairie provinces. Ontario and Quebec are major low-carbon electricity exporters of hydroelectric and nuclear generation, while they and Atlantic Canada rely on foreign sources for 45 per cent of their natural gas and oil needs. This historically distributed endowment of resources favours entrenched special and regional interests over a shared national energy vision.

THE NEW ENERGY TRIFECTA

The global transition to Net Zero is calling into question future energy demands as well as the role of conventional higher carbon-emitting energy resources. New, complicated policy questions about Canada's future energy mix are emerging [Table 1].

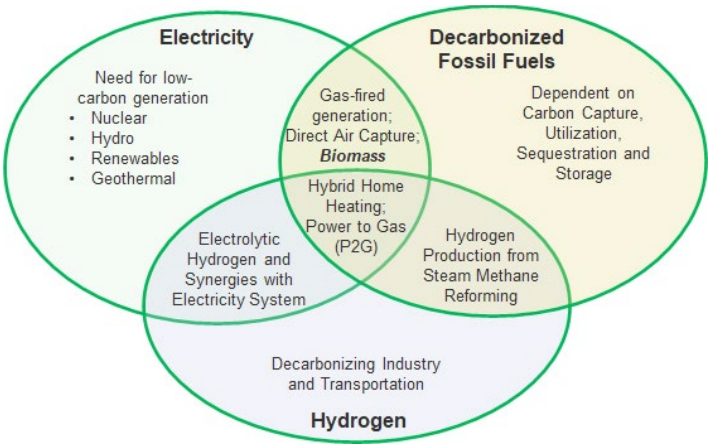
Table 1: Emerging Energy Questions

In early 2020, we asked...	Today, we are asking...
What kind of energy is needed?	**How much might efficiency improvements reduce energy demand?**
How can Canada get its oil and gas resources to market?	**Will global demand for oil and gas persist beyond the medium term? What impact might clean fuel standards have?[7]**
How can natural gas act as a bridge fuel to help achieve the Paris Targets?	**Does natural gas have a future for space heating or electricity?[8] How can carbon capture become a reality?[9]**
What are the energy options that help address climate change?	**How can Canada develop its own hydrogen economy?[10] Are there better nuclear options?[11] Can renewables be integrated? What about renewable forestry waste biomass resources?[12]**
When will consumers find electric vehicles to be a viable choice?	**How soon will electric vehicles become 100% of all vehicles on the road?[13]**

The emerging global demand for lower-carbon energy is shaping three potential paths to Net Zero: electrification; decarbonizing fossil fuels; and hydrogen. This trifecta offers a range of opportunities to balance Canada's demand for and supply of energy resources [See Figure 3].

7 Environment and Climate Change Canada. "Clean Fuel Standard." 2021.
8 Independent Electricity Systems Operator. "Decarbonization and Ontario's Electricity Sector." 2021.
9 Government of Canada. "Federal Carbon Capture Utilization and Storage Tax Credit Proposal." 2021.
10 Natural Resources Canada (NRCan). "Hydrogen Strategy for Canada." 2020.
11 NRCan. "Canada's Small Modular Reactor Action Plan." 2020.
12 Government of Ontario. "Sustainable Growth: Ontario's Forest Sector Strategy." 2021.
13 Greentech Media. "General Motors Pledges a Zero-Emissions Light-Duty Vehicle Fleet by 2035." 2021; and Government of Canada. "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada." 2021.

Figure 3: The Future Energy Trifecta



"An energy trifecta will guide the path to Net Zero"

Electrification through switching from fossil fuels is a pathway to achieve significant reductions in carbon emissions in buildings, transportation and industry.[14] Electric heat pumps can efficiently heat buildings and hot water. The global paradigm shift toward battery-powered electric vehicles has some major auto companies abandoning gasoline-powered vehicles.[15] Meanwhile, industrial applications are being electrified and/or or shifting to hydrogen use.[16,17] This places electricity sources at the centre of the energy debate. However, hydroelectric, nuclear and biomass potential varies across the country, as does the economic ability to incorporate renewables into the infrastructure.

Decarbonizing fossil fuels involves the capture or elimination of emissions as well as the use of bio-based or other synthetic fuels. Indeed, two carbon-abatement approaches may enable the continuing use of fossil fuels in a net-zero world. The first, carbon capture, utilization and storage (CCUS) captures carbon at the point it is emitted from large-scale facilities such as gas-fired generation and then either incorporates it into a static product (utilization) or else sequesters it (storage), often in geological formations. Such suitable geological formations have been assessed only in Western Canada, leaving the approach's feasibility in the remainder of the country unknown.[18]

The second carbon-abatement approach, direct air capture, absorbs carbon dioxide from ambient air to address small emitters such as home heating. Direct air capture technologies are in early development, have not yet been demonstrated at scale, and rely on the same utilization and storage capabilities.[19] Given the regional diversity of these energy resources and storage capacity, the potential role of CCUS can be expected to vary across Canada.

Meanwhile, renewable biomass from forestry, agriculture and waste streams can be used to generate electricity and in combined heat and power applications. Canada's vast boreal forest that spans the country [See Figure 4] could spur such use. As well, sustainable forest harvest management is also an effective carbon sink.[20] While harvesting trees specifically to produce electricity does not effectively reduce emissions, converting waste forestry biomass into wood pellets does.[21] Such use can reduce imports of natural gas in forestry-rich regions that depend on imported energy supplies. Equipped with CCUS, a biomass-fuelled plant could act as a carbon sink.

14 The largest sources of emissions in Canada are in buildings, transportation and industry as described in Canadian Institute for Climate Choices. "Canada's Net Zero Future: Finding our way in the global transition." 2021.

15 *Car and Driver*. "Here Are All the Promises Automakers Have Made about Electric Cars." 2021; Daimler. "Ambition 2039: Our path to CO-neutrality." 2021; *Driving*. "Motor Mouth: Toyota's master plan for a low-carbon future." 2020; Greentech Media: "General Motors Pledges a Zero-Emissions Light-Duty Vehicle Fleet by 2035." 2021; Hyundai. "Hyundai Motor to further extend lead in zero-emission mobility." 2021.

16 Algoma Steel. "Government of Canada Endorses Algoma Steel's Transformation Plan for Green Steel. Commitment of up to $420 Million." 2021; ArcelorMittal. "ArcelorMittal and the Government of Canada announce investment of CAD$1.765 billion in decarbonisation technologies in Canada." 2021.

17 Friedman, Fan and Tang. "Low-Carbon Heat Solutions for Heavy Industry: Sources, Options, and Costs Today." Columbia Center on Global Energy Policy. 2019.

18 Navius Research. "Achieving net zero emissions by 2050 in Canada." 2021.

19 IEA. "Direct Air Capture." 2020.

20 NRCan. "Indicator: Forest carbon emissions and removals." 2021.

21 World Resources Institute. "INSIDER: Why Burning Trees for Energy Harms the Climate." December 2017.

"The potential for trifecta elements differs across the country"

Figure 4: Canada's Boreal Forest

Source: NRCan. "Boreal Forest." 2021.

Hydrogen can be used for many power applications in buildings, transportation and industry.[22] Hydrogen is generally produced by water electrolysis or through the steam methane reforming of natural gas. Canada is rich in both feedstocks. However, for hydrogen to help reduce emissions it must be produced from low-emitting sources.

Low-carbon hydroelectric, nuclear and biomass generated electricity can efficiently and reliably provide electricity to produce carbon-free hydrogen. Indeed, the existing electricity infrastructure can distribute such low-carbon energy to wherever the production of hydrogen is warranted, in either large or small scale.

Alternatively, Canada's current hydrogen strategy could make centralized fossil-fuel-based production, coupled with CCUS, a viable pathway to supply low-carbon hydrogen nationwide.[23] As such, hydrogen represents a transformative opportunity for Canada's oil and gas sector to leverage natural gas reserves, CCUS and existing infrastructure.[24]

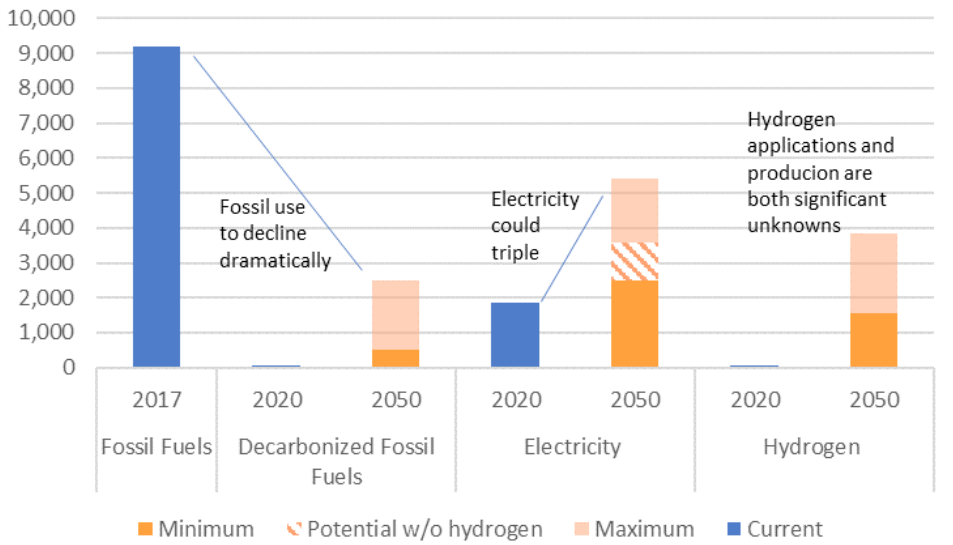
An optimal Canadian hydrogen strategy would reflect regional realities of hydrogen feedstocks: concentration of hydroelectric and nuclear resources in Ontario; hydroelectric assets in British Columbia, Quebec and the Atlantic Provinces; and natural gas production in Western Canada.

Trifecta Outlook: The future energy potential of each trifecta element would vary, influenced by regional choices, local cost competitiveness and export potential [See Figure 5].[25] Analyses suggest that while overall future energy demand may drop, more fossil fuel use will need to be transitioned than can be mitigated by carbon capture.[26,27]

22 Green Ribbon Panel. *Clean Air, Climate Change and Practical, Innovative Solutions*. 2020.
23 NRCan. *Hydrogen Strategy for Canada*. 2020.
24 BNN Bloomberg. "Home of the oil sands eyes cleaner future as hydrogen superpower." 2020.
25 Navius Research. "Achieving net zero emissions by 2050 in Canada." 2021; Environment and Climate Change Canada. "Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy." 2016; SNC Lavalin. *Engineering Net Zero*. 2021; NRCan. "Hydrogen Strategy for Canada." 2020; Nuclear Innovation Institute. "Why Hydrogen Needs Nuclear." 2021; NRCan. "*Energy Fact Book 2019-2020*." 2021.
26 Canadian Institute for Climate Choices. "Canada's Net Zero Future: Finding our way in the global transition." 2021.
27 IEA. "Net Zero by 2050." 2021.

Figure 5: Forecast Contribution of Energy Type to Energy Consumption, 2020 vs. 2050

(Energy Demand in Petajoules)



"Infrastructure implications are an opportunity to address Canada's infrastructure deficit"

Sources: Current fossil fuel use from *NRCan. "Energy fact book 2019-2020." 2020;* Decarbonized fuel potential range and minimum electricity from *Navius Research. "Achieving net zero emissions by 2050 in Canada." 2021;* Maximum electricity from *Environment and Climate Change Canada. "Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy." 2016; SNC Lavalin. "Engineering Net Zero." 2021; Strapolec Analysis;* Low hydrogen range from *NRCan. "Hydrogen Strategy for Canada." 2020.* Electricity contribution for hydrogen based on *Nuclear Innovation Institute. "Why Hydrogen Needs Nuclear." 2021; Strapolec Analysis.*

INFRASTRUCTURE PREREQUISITES

Public awareness of the emission reduction potential in powering buildings, transportation and industry continues to grow, especially as technological innovations make alternatives more cost-effective. Analyses show that while many consumer choices to transform energy use are beyond the control of Canada's policymakers, three-quarters of the emission reductions achievable via voluntary behavioural changes require significant investments in large infrastructure, such as low-carbon emission electricity generation.[28] Canada's low-carbon energy future depends on optimally enabling large-scale infrastructure buildout to satisfy consumers' needs.

The federal government is working to quantify Canada's "infrastructure deficit," currently unknown even under a business-as-usual scenario and completely unquantified when net-zero climate ambitions are considered.[29] The significant lead time required for exploring the infrastructure implications associated with the "energy trifecta" and their planning and regulatory approval help illustrate this challenge and the need for a National Energy Vision.

• **Electrification of the economy** will require significantly more low-carbon electricity than planners are currently forecasting.[30] Analyses show that meeting this demand implies a substantial build-out of bulk electricity system generation and transmission assets. Such projects may involve multiple jurisdictions and will require collaboration among provinces and affected communities, including Indigenous communities.[31]

28 Ibid.

29 Government of Canada. "Building the Canada We Want in 2050." 2021.

30 Strapolec. "Advancing Ontario's Energy Transition Part 1: Electrification Pathways." 2021; Navius Research. "Achieving net zero emissions by 2050 in Canada." 2021; Environment and Climate Change Canada. "Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy." 2016; SNC Lavalin. "Engineering Net Zero."2021.

31 Strategic Policy Economics. "Towards a National Energy Vision." 2021.

• **Decarbonization of Fossil Fuels** to achieve Net Zero will involve investments in new infrastructure such as CCUS. The captured CO2 must be transported from the source to a site that has the geology to suitably sequester it, making "pipeline infrastructure critical for development of a CCUS industry."[32] Furthermore, the economic viability of CCUS requires the concurrent emergence of capture, transport and storage technologies, a policy challenge given the diverse stakeholders involved in each element. Such an approach will require coordination between carbon-producing and carbon-storing jurisdictions and a connecting transport infrastructure.

• **Hydrogen's** role and the scale of the infrastructure investments required by Canada's hydrogen strategy are still being developed. The infrastructure choices will impact the balance between low-carbon electrolysis vs. natural-gas-based production. The future of electrolytic hydrogen will be impacted by the availability of low-carbon electricity and by the transmission between the generation and the electrolyser loads. Indeed, natural-gas-based pathways require transportation of natural gas to hydrogen production centres and additional infrastructure to transport the hydrogen and waste carbon dioxide to end-use or storage/sequestration sites.

THE STAKES ARE HIGH: RISKS AND OPPORTUNITIES

The infrastructure build-out at the necessary scale will require billions of dollars of new investment. Still, investments to realize such a national energy vision would increase GDP, support domestic industries and provide jobs across Canada. Meanwhile, failure to provide for an increased demand for low-carbon electricity could result in brownouts – Ontario's potential scenario in the next decade.[33] Failure to decarbonize the fossil fuels that will still be needed during the transition will jeopardize emission-reduction objectives.

"The climate imperative and energy trifecta challenge warrant collaboration amongst Canada's decision-makers"

Canada is not alone in facing these dilemmas. The same energy trifecta investments are being considered globally, and Canada's status as an ongoing energy superpower may hinge on its timely development of the supporting infrastructure. We would be well served by quickly making the strategic investments to sustain Canada's future prosperity: economic competitiveness; growth of domestic technological and manufacturing capabilities; continued energy exports to other jurisdictions; energy security; and, positive trade balances.

CONCLUSION

Our first Commentary set out the principles for the collaborative creation of a Canadian National Energy Vision. This second Commentary identifies the trifecta of energy transformation opportunities available to achieve net-zero ambitions and the pan-Canadian challenges to energy infrastructure decision-making. As the CCRE advocates for a principles-based collaborative National Energy Vision development, these considerations will become important discussion points on the quest to reasonably transform the country's energy infrastructure and support Canada's future prosperity.

32 Navius Research. "If you build a CO2 pipeline, capture and storage will come." 2021.

33 Strategic Policy Economics. "Electrification Pathways for Ontario." 2021.