Case Study in Informing a National Energy Vision

Ontario decarbonization and implications for Quebec and Canada

June, 2022

STRATEGIC POLICY ECONOMICS

Canada's aspirational NZ 2050 objectives have varied implications

Highlights the enduring dilemma of energy producing vs consuming provinces

Government of Canada multiple climate objectives

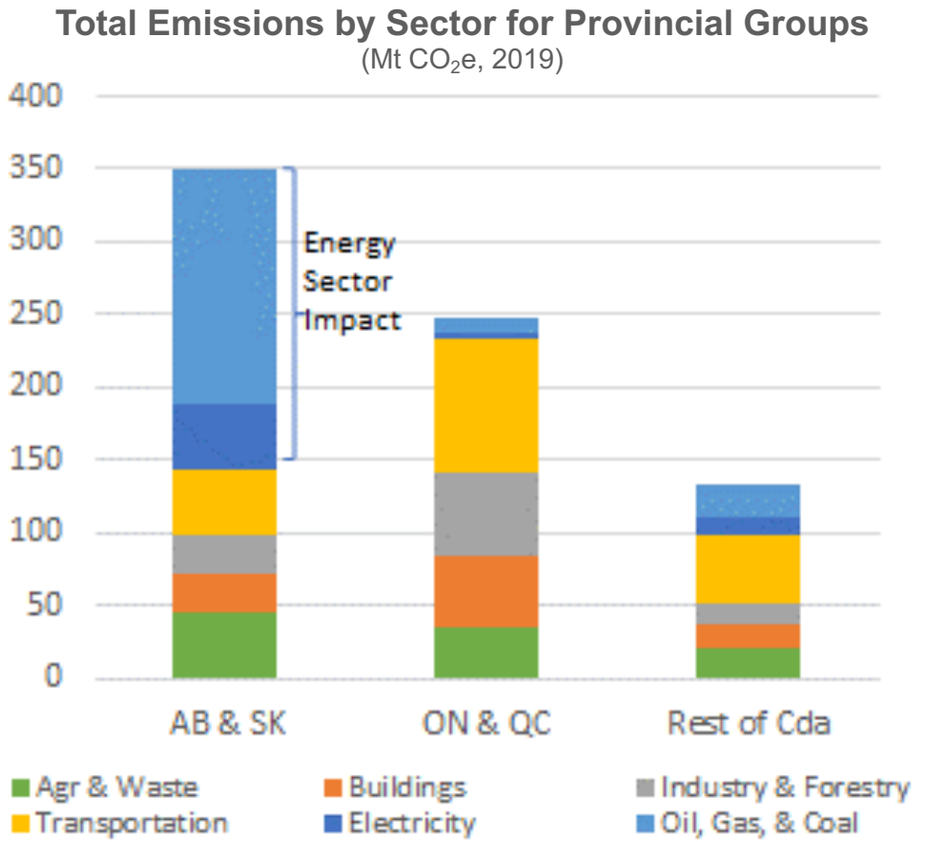
- Net Zero 2050 targets
- 100% of light vehicle sales to be EV by 2035
- Clean Electricity Standards requiring Net Zero emissions by 2035
- Clean Fuel Standard to incent fuel switching

Government of Canada clean energy strategies

- Carbon pricing and Output Based Pricing System for industry
- National Hydrogen Strategy
- Small Modular Reactor (SMR) Action Plan
- Carbon Capture and Storage investments

Decarbonization pathways differ substantially across the country

- Alberta and Saskatchewan must address the Oil and Gas sector and Electricity
- Ontario & Quebec must face Transportation, Industry and Buildings

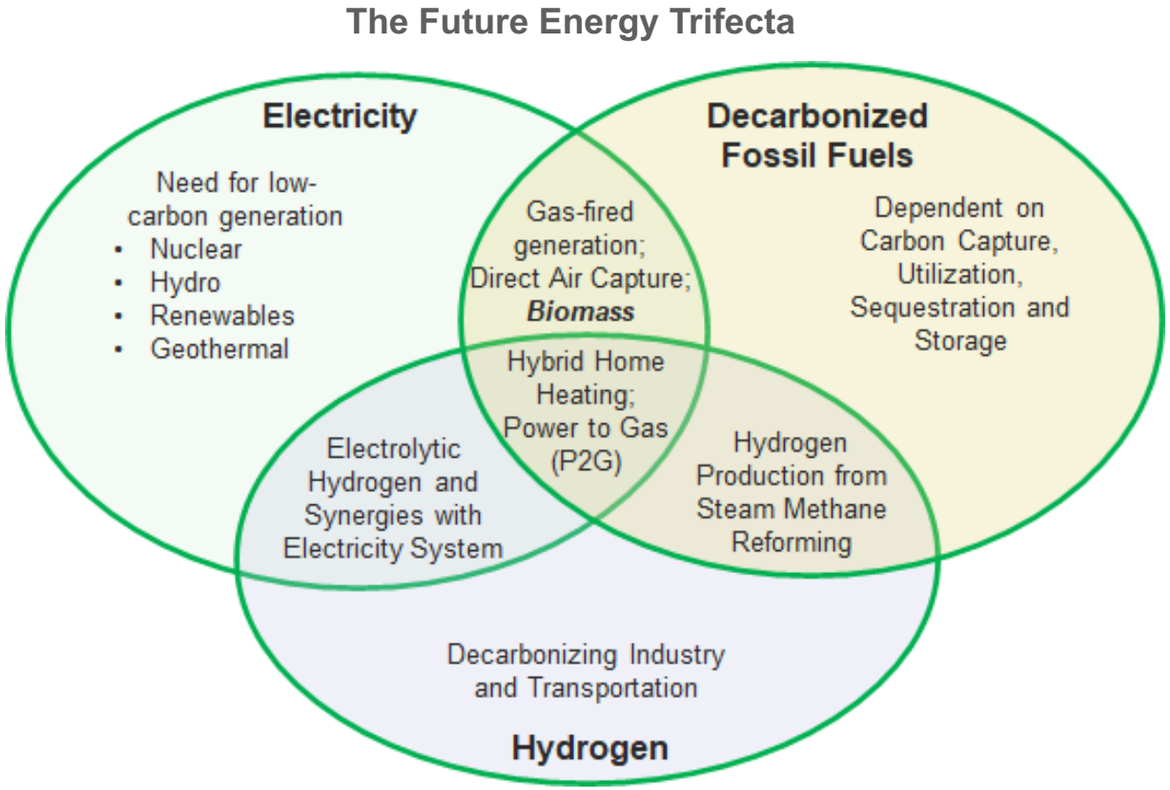


Source: Environment and Climate Change Canada, data on GHG emissions by province, 2021; Strapolec analysis

The future is resolving around a trifecta of energy solutions

Low Carbon Electricity, Decarbonized Fossil Fuels, Hydrogen → Pathways differ regionally

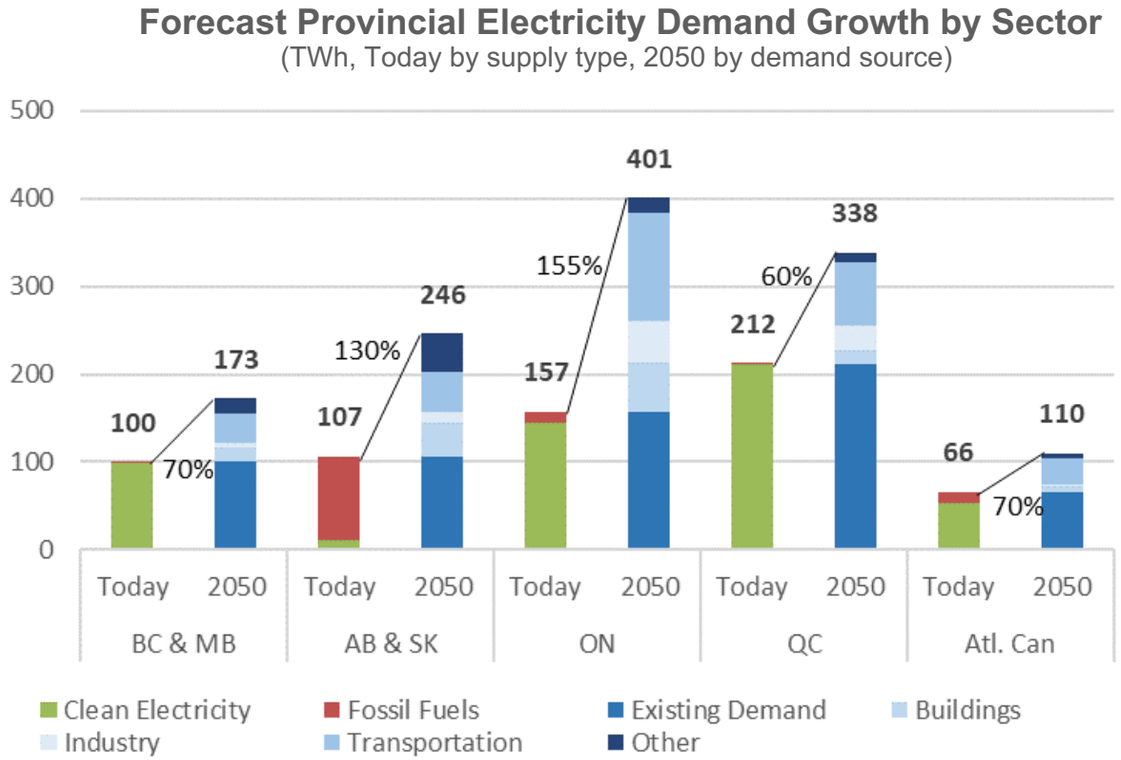
West focusing on decarbonizing fossil fuels & carbon capture



- Hydrogen is depended on the regional cost and viability of carbon capture vs other low carbon electricity options

Need for electricity transformation is greatest in Ontario

- Although need for new low carbon electricity is as great in AB/SK



Note: Forecast energy demand based on economic sector-specific TWh/Mt forecasts. Excludes electrolytic hydrogen in BC, AB, SK, & 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.

Sources: M.Brouillette, "Towards a National Energy Vision", CCRE Commentary, 2021; note decarbonized fossil fuels includes synthetic fuels and biofuels; Canada Energy Regulator, Canada's Renewable Power, 2021; Environment and Climate Change Canada Data, 2021; Strapolec Analysis.

Ontario's electricity infrastructure challenge → emissions or brownouts?

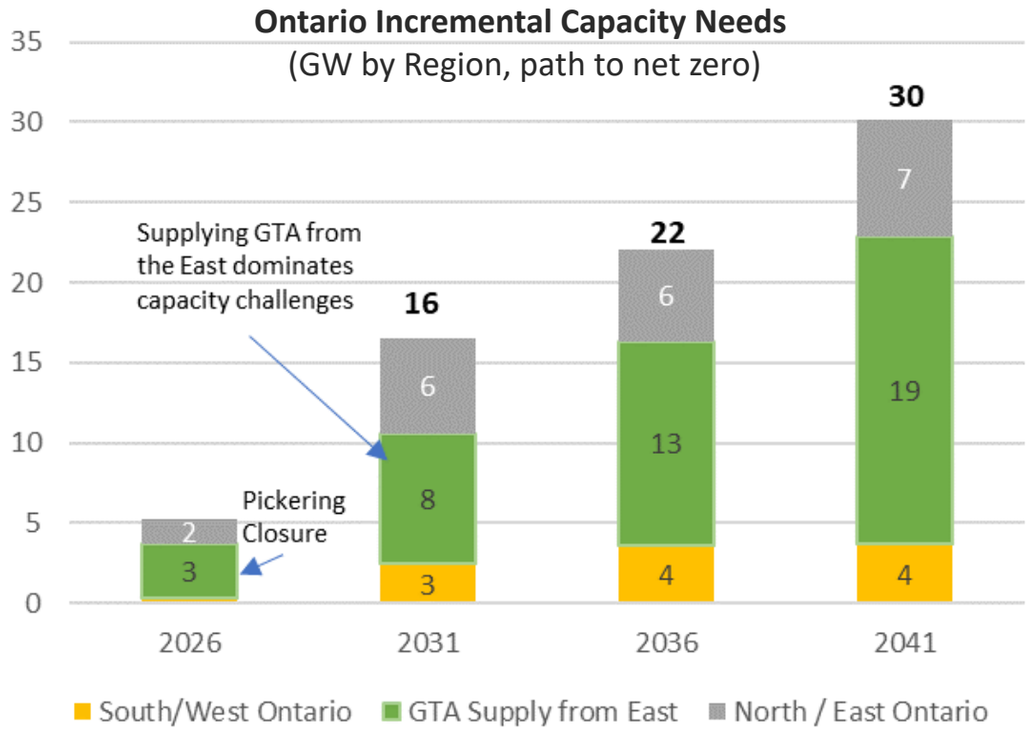
Equivalent to tripling the combined capacity of its hydro / nuclear fleet & interties with Quebec in 15 years

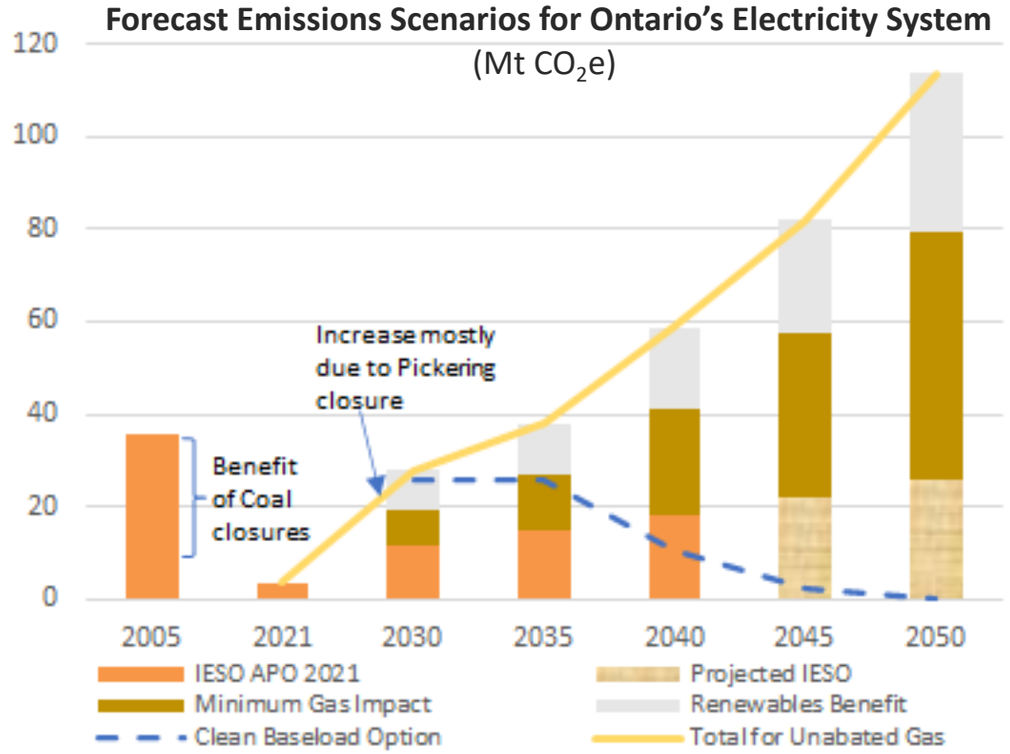
New capacity needs dominated by eastern portion of the GTA

- Underpinned by Pickering Nuclear retirement
- IESO recently expediting procurements favouring natural gas

Current gas-based procurements and development timelines for low-carbon electricity alternative will increase emissions

- Undermining Federal climate objectives





Source: IESO, 2021 Annual Planning Outlook; Strategic Policy Economics, "Electrification Pathways for Ontario", 2021; Strapolec analysis

Electricity demand in decarbonized Ontario will resemble Quebec's

Winter demand 50-60% higher than summer demand – but collaboration could free up hydro capacity

Ontario will need both baseload and peaking supplies

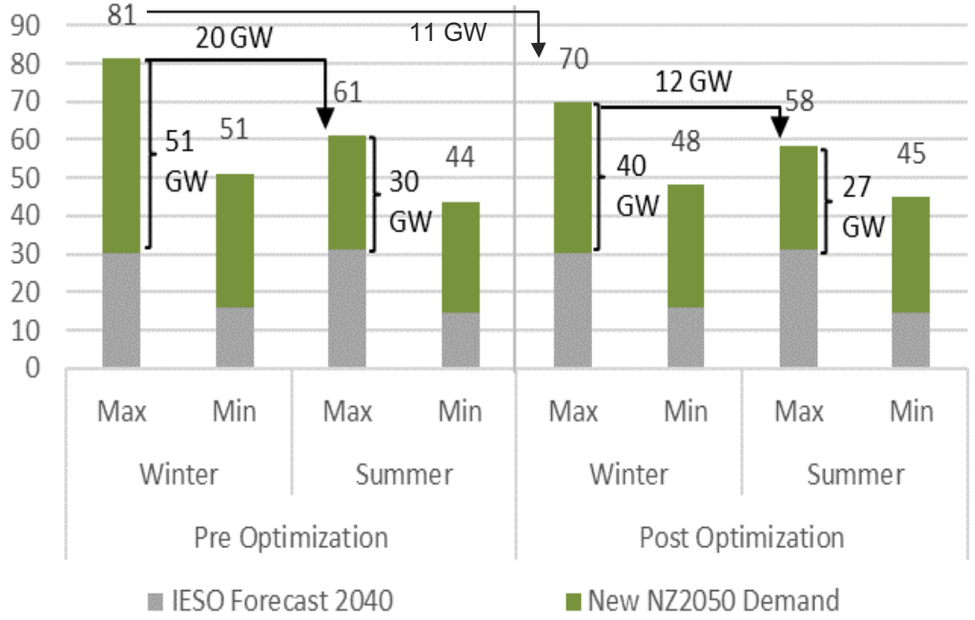
- Innovations may allowing energy system optimization, moderating the peak supply needs

Quebec's forecast growth of 60% will require new baseload

- Quebec has already built all the peaking supply they need
- Wind can contribute energy, but doesn't help with winter peak

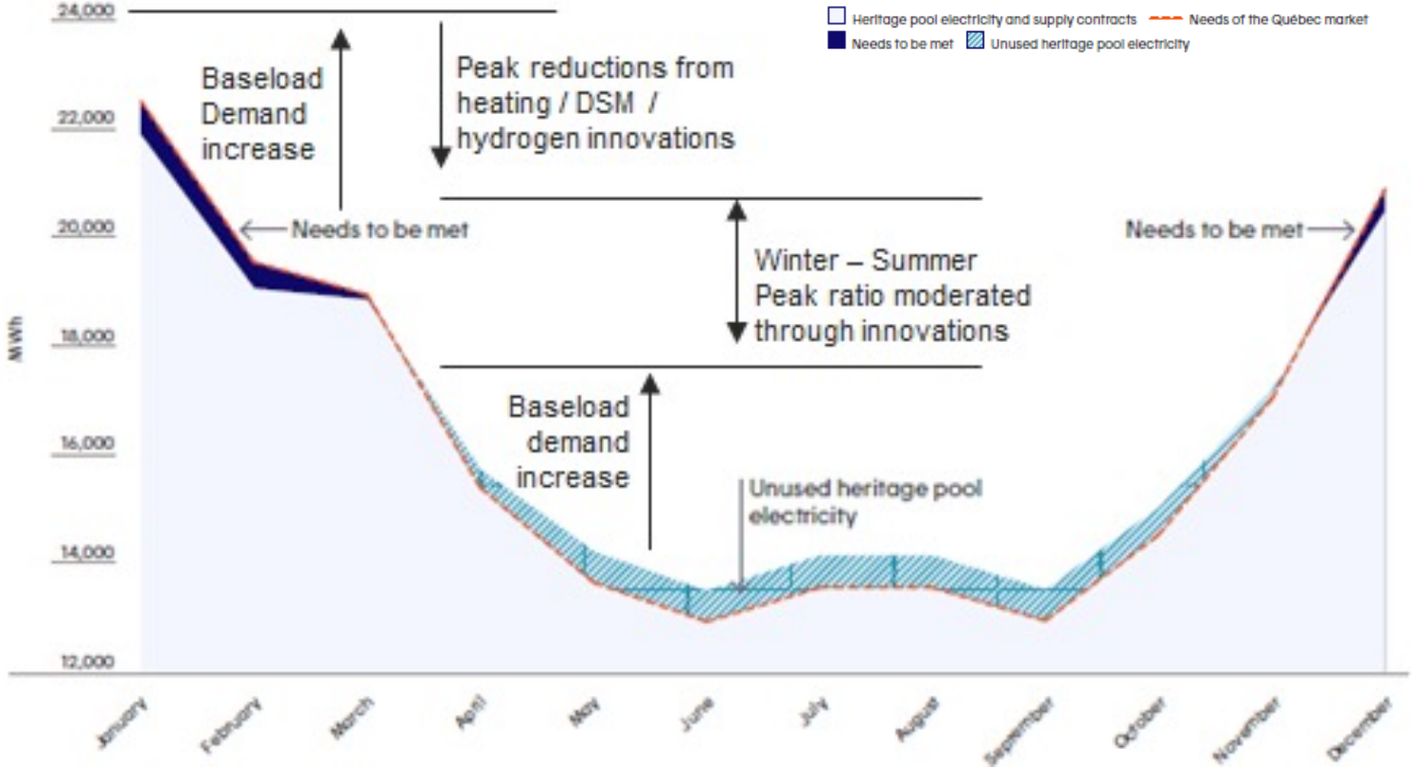
Ontario Forecast Seasonal Capacity Needs

(GW by Season, NZ2050, Pre vs. Post Optimization)



Hydro Quebec Distribution Supply Needs from Quebec Heritage Resources

(Illustrative trends, MWh)

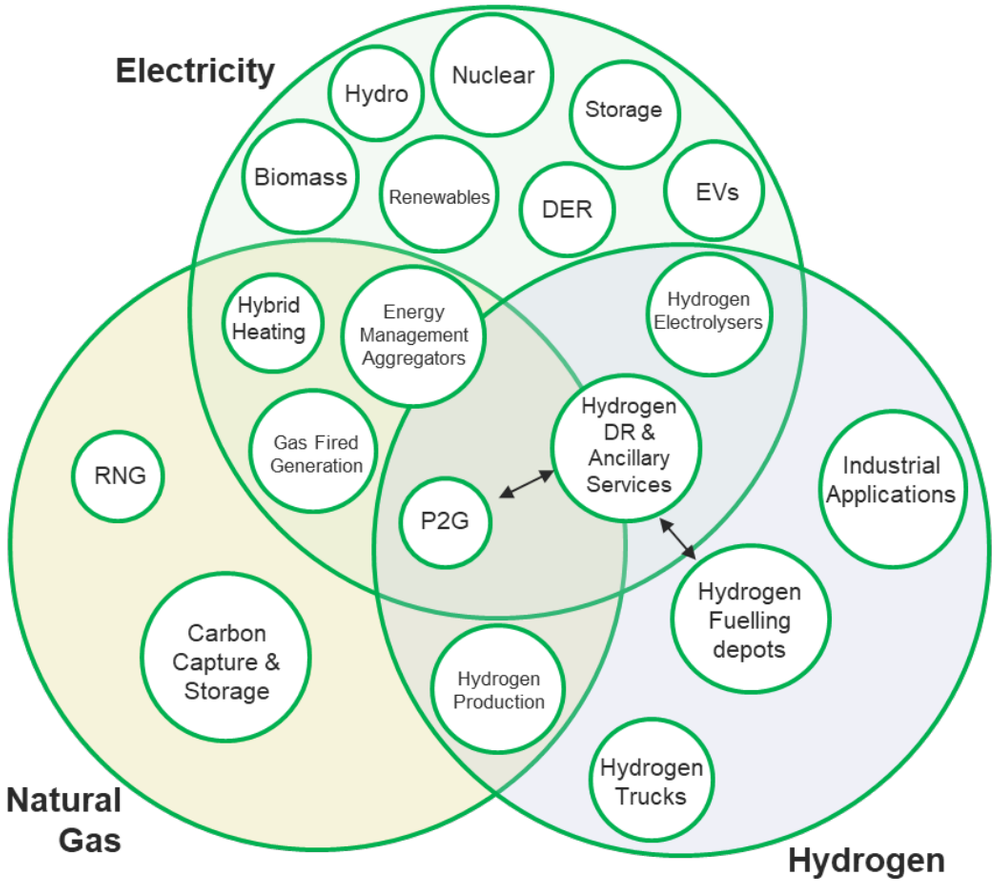


Source: Strategic Policy Economics, "Electrification Pathways for Ontario", 2021; Hydro Quebec, "Strategic Plan 2022-2026", 2022; Hydro Quebec, "Electricity Supply Plan 2020-2029", 2019; Strapolec annotations and analysis

Energy system innovations mitigate needs for peak energy

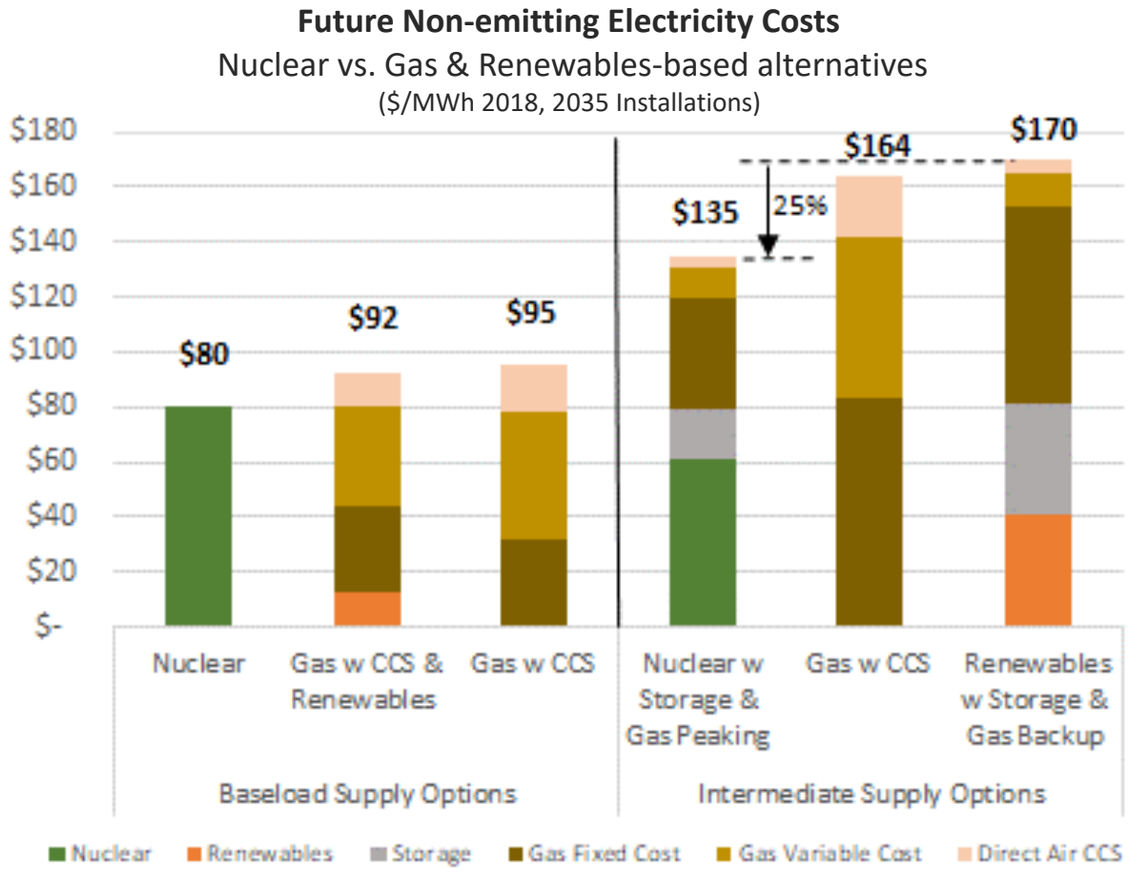
Integrated approach to trifecta can enable affordable electricity system outcomes

Synergies of electricity, natural gas and hydrogen create efficiencies by reducing peak demand in favor of baseload



Source: Strategic Policy Economics, "Electrification Pathways for Ontario," 2021; Strapolec Analysis

Baseload electricity supply options are significantly less costly than renewables in Ontario



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.

A national energy vision offers opportunities in both West and East

By optimizing regional trifecta advantages, Canada may hit above its weight on emissions reduction

Innovations in Western Canada can help the East

- Carbon capture technology development
  - Potentially lower cost hydrogen
- Improved national energy security
  - Domestic supply of natural gas and oil

Eastern Canada can help the West

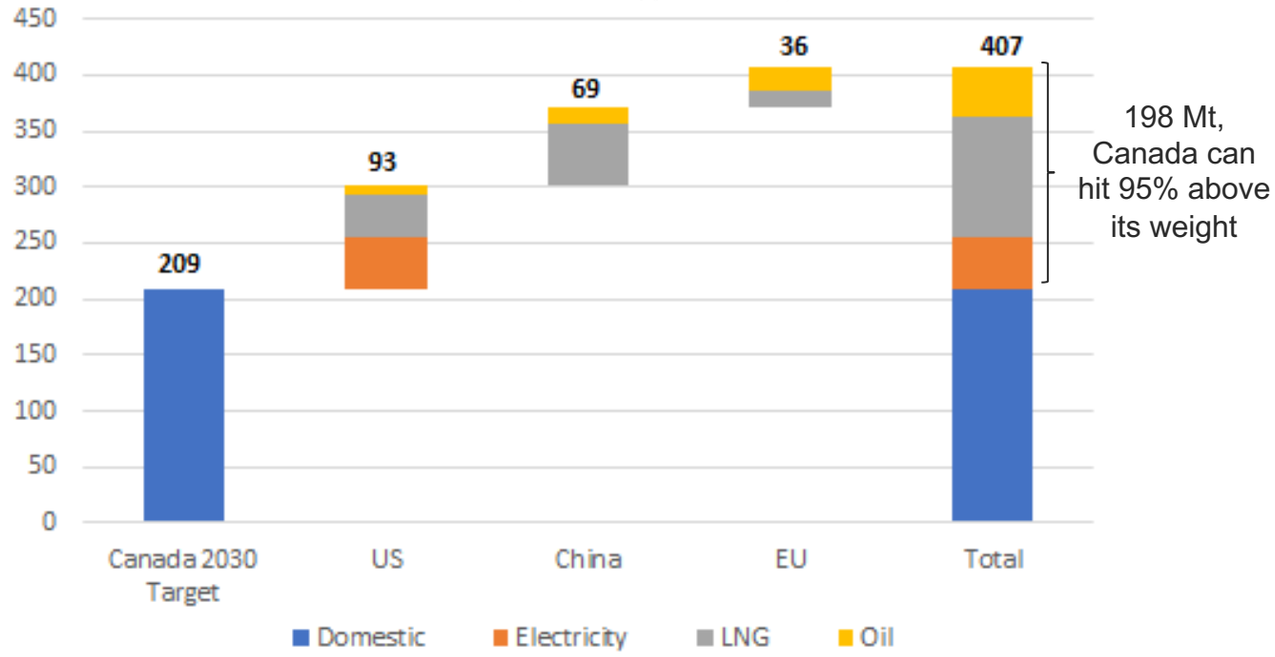
- Development of nuclear technologies to decarbonize Oil & Gas
  - E.g. collaboration on small modular reactor development by Alberta, Saskatchewan, Ontario, and New Brunswick
- Supporting pipeline development to enable export opportunities for LNG and oil to Europe

Collaborating on comprehensive and reliable data that underpins cost and economic implications of Canada's energy advantages is important

- It may enable low-cost infrastructure and greater exports of all energy types from all regions of Canada
- Canada may be able to offer lower carbon energy resources to Canada’s biggest trading partners

2030 Emissions Reduction Potential from Canadian Electrification and Energy Exports

(Mt CO_2eq/year, 2030)



Source: Strategic Policy Economics, “Towards a National Energy Vision - The Realm of the Possible for Canada: Hitting Above Its Weight to Reduce Global Emissions”, December 2020.

U.S. Northeast faces similar decarbonization challenges

Potentially at a 20% higher cost than in Ontario and Quebec

U.S. states neighboring on Ontario and Quebec are pursuing similar climate objectives requiring development of:

- Low-carbon electricity
- Low-carbon hydrogen

Ontario/Quebec electricity system infrastructure collaboration may support improved economics for greater exports to the U.S.

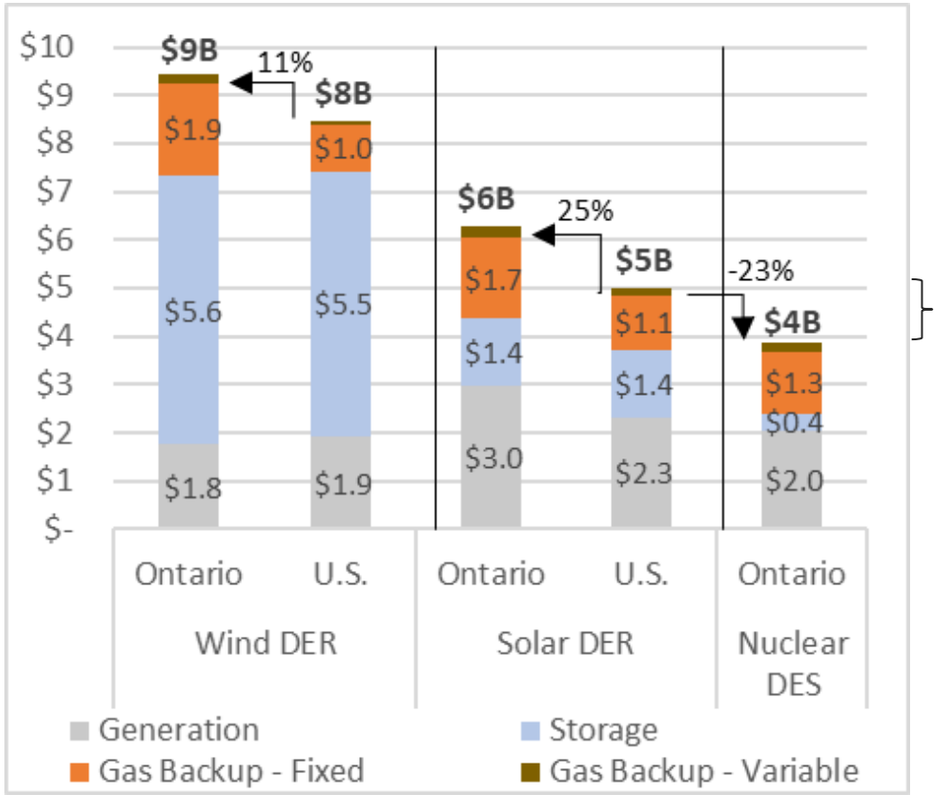
- Comprehensive, reliable, evidence-based data will set these facts straight

Opportunity for Ontario and Quebec is about first mover advantage

- Ideas presented here may not be the solutions, but do warrant collaborative discussions to find the answer
- Which is about a Canadian National Energy Vision

Distributed Energy Resource System Annual Cost Implications, 2030

(Ontario vs. U.S.; $B Ontario Market equivalent)



Ontario's potential electricity cost advantage over the U.S.

Source: M.Brouillette, "Distributed Energy Resources (DER) in Ontario: A Series of Unfortunate Truths", CCRE Commentary, 2019; U.S. costs shown in Canadian dollars.

Appendix

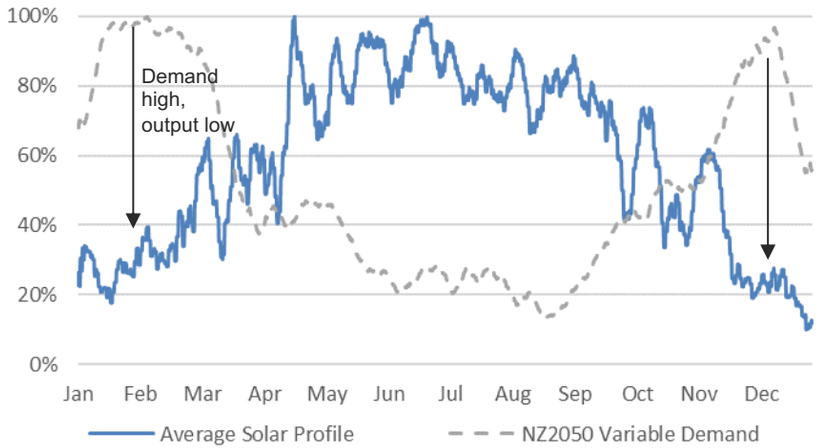
Seasonal demand typically not well matched by renewable generation

Renewables generally not aligned with mother nature; Nuclear output can be managed

Although wind may be better aligned with the future of electricity heating

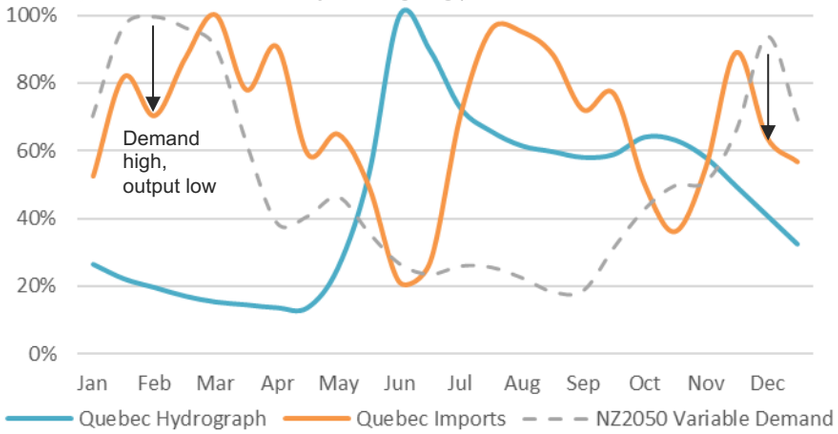
Solar output is seasonally asynchronous to new demand profile

(% of annual max, NZ2050 Demand vs. 2016 Solar Production, 7-day running avg.)



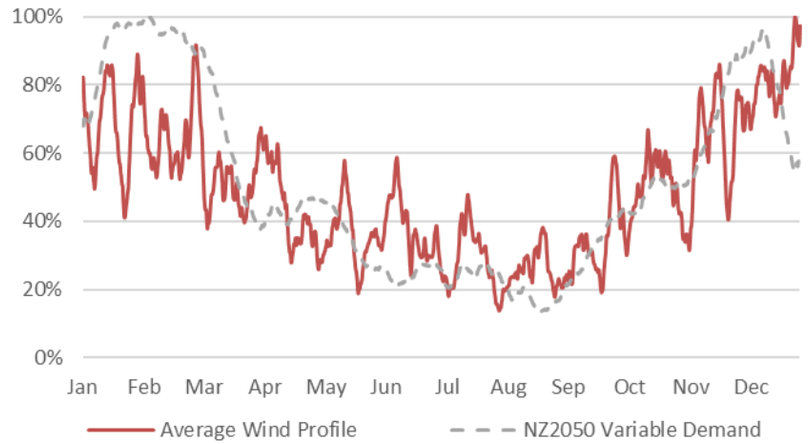
Quebec currently ramps down exports to Ontario in winter

(% of annual max, Projected Quebec Hydrograph, 2020 Quebec Exports to Ontario, NZ2050 Demand 7-day running avg.)



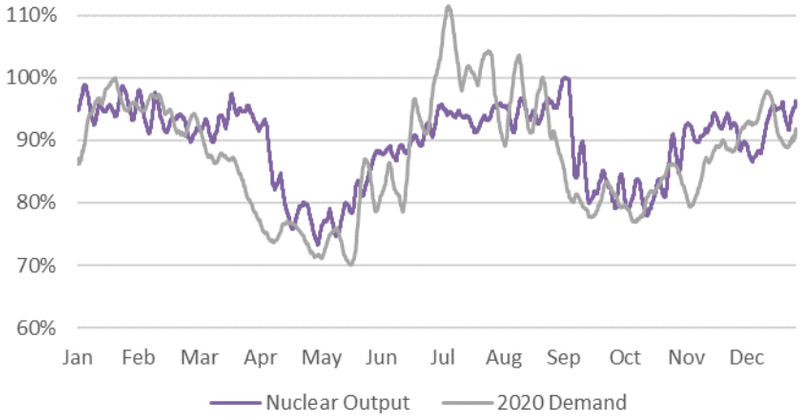
Ontario wind energy may track winter demand, but is volatile

(% of max, NZ2050 Demand vs. 2016 Wind Production, 7-day running avg.)



Nuclear can be managed to mirror seasonal demand

(% of winter max, Ontario 2020 Demand vs. 3-year avg. nuclear fleet generation 2014-2016, 7-day running avg.)



Sources: UN World Water Assessment Program: Water and Climate Change in Quebec, 2009; IESO, Power Data, Generator Output and Ontario Demand, 2014-2020; Strapolec Analysis