PWU Submission to NRCan on Electricity Grid Modernization

March 23, 2023

Natural Resources Canada (NRCan) is seeking input regarding the regulatory, policy and market barriers and opportunities for accelerating the pace of electrification and electricity grid modernization to meet Canada's net zero goals. NRCan aims to enhance federal programming to address stakeholder needs in the complex regulatory environment related to grid modernization and electrification.

An NRCan report that suggests Canada's electricity grid must innovate to accommodate more variable renewable energy resources and a greater volume of flexible electricity loads across the entire electricity system is the premise for this consultation.[1] In fact, NRCan states that to meet Canada's targets, disruptive *changes via electrification and grid modernization are necessary*. NRCan suggests that there are barriers to the timely adoption of new emerging grid modernization technologies at the scale required. NRCan suggests that the existing regulatory and market framework may not be well suited to address and finance the needed transformation.[2] These factors raise additional concerns about the significant costs of the transformation and questions about the role of taxpayers, rate payers, and private investment. NRCan raises a particular concern about the burden that may be placed on vulnerable populations.

NRCan is seeking feedback on: the opportunities to accelerate the pace of electrification and modernization; regulatory constructs that may require changing; the barriers and opportunities for innovations in electric grid modernization, distributed energy resources, and behind-the-meter (BTM) resources; and, the impacts of cost allocation to different customer groups. This advice is intended to be used by NRCan to develop new federal programming in these areas.

The PWU believes that NRCan's underlying premise is flawed and is therefore focused on the "edges" of the challenge. The real barrier facing Canada is the timely creation of new low-carbon baseload generation. Additionally, the existing regulatory framework is workable for the foreseeable future, however, the market focused procurement framework existent in Ontario and Alberta is ill-suited to meet these needs.

The PWU makes the following recommendations:

1) Electrification planning should be based on established analyses and facts associated with Canada's Net Zero challenge, particularly with respect to the country's bulk electricity system;
2) Clearly identify the competing timelines between encouraging electrification and building the electricity system infrastructure required to meet it;
3) Focus federal programming on financing low-carbon bulk system infrastructure and encouraging consumer adoption of BTM demand side management technologies, such as bi-directional EV charging; and,
4) Minimize the cost of transitioning the electricity system and allow existing practices to protect vulnerable populations.

[1] 2021 Smart Grid in Canada,
[2] 2022 report by Gattinger and Associates; 2020 report by Guidehouse.

Recommendation #1 - Electrification planning should be based on established analyses and facts associated with Canada's Net Zero challenge, particularly with respect to the country's bulk electricity system.

NRCan's current initiative was informed by the recommendations of the Smart Grid in Canada Report. The report correctly notes that the amount of electricity generated from renewable and non-emitting sources must expand to reach decarbonization and electrification goals. However, the report also indicates that new intermittent renewable energy sources and increasingly flexible loads must be integrated to uphold the integrity and stability of electricity grids. These conclusions are based only on a qualitative narrative that does not cite actual demand nor the requisite supply performance of technologies required to address it. Developing a reliable electricity system is an engineering problem and requires robust technical due diligence to ensure viable and cost-effective solutions are chosen to achieve this fundamental outcome and Canada's NZ goals.

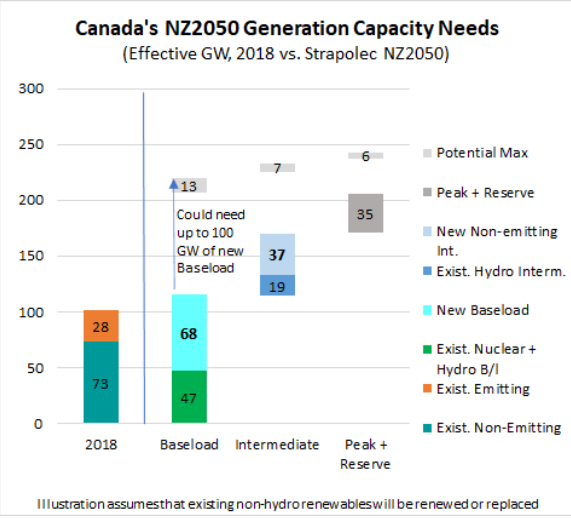
Two factors suggest that there is minimal need to dramatically reform the country's grid management practices:

- The nature of new demand growth has limited need for grid management innovation; and,
- Renewables must be integrated into dispatchable hybrid solutions to reliably supply emerging demand.

The nature of new demand growth and limited need for grid management innovation

To ensure reliability, electricity system operators require dependable supplies that can be dispatched to match supply to demand. More specifically there are three types of demand that the system must meet as illustrated by Figure 1. Growth is apparent in each category and Canada needs new non-emitting sources to meet it: [3]

- Approximately 70 GW of new baseload demand-- 24x7, 365 days per year;
- About 38 GW of variable demand that rises during the day and decreases at night and also seasonally. Most of this new variable demand will be in Ontario and Alberta (27 GW) to replace existing fossil assets; and,
- 35 GW of peaking demand (including reserve capacity) that occurs rarely, less than 2% of the time.



This doubling of the capacity of Canada's electricity system is a significant challenge. A closer examination of each demand type indicates that most of it can be achieved with no changes to grid

[3] Council for Clean and Reliable Energy, Commentary, Towards a National Energy Vision Case Study: Ontario and Quebec, 2022; Strapolec analysis

operations. Only about 7 GW being unlocked by adopting new grid management technologies. Optimizing these 7 GW is addressed in recommendation #3.

From a grid modernization perspective, there are no challenges inhibiting the development of new baseload supplies. Historically, large-scale, transmission connected baseload facilities have connected the electricity system to the load centers in Canada's cities and form the backbone of ensuring the entire grid is stable. Canada's publicly run system operators are experienced at managing these baseload needs. Each provincial operator can decide when and how to procure it.

Currently, peak demand in most provinces is driven by air-conditioning to cool buildings on extreme hot summer days and in future, like Quebec today, peak demand is forecast to shift to extremely cold winter days due to electrification of heating systems in buildings. Demand response for managing peak demand is an effective grid management practice. In addition to the Demand Response, competitive capacity market auctions and rate programs such as Ontario's Industrial Conservation Initiative (ICI) provide additional capabilities. When electrolytic hydrogen becomes available it could also offer Demand Response services at a substantially lower cost.[4] In fact, Ontario is already piloting an interruptible rate program for hydrogen producers that will facilitate their provision of demand response services.[5] Analysis has shown that hydrogen electrolysis demand response may enable the elimination of natural gas-fired generation in Ontario.[6]

Meeting variable demand is more complex. Studies show that consumer behaviors are the most significant drivers of variable daily and seasonal demand. However, analysis shows that the ability of these new grid technologies to influence those behaviors is modest. Studies show that demand side management capabilities may be able to mitigate 10% of the combined variable and peak supplies (excluding demand response), or about 7 GW nationally as mentioned above. That represents only 3 to 4% of the demand that the new electricity system is required to manage. The 80-20 rule suggests that this is not low-hanging fruit.

Renewables must be integrated into dispatchable hybrid solutions to reliably supply emerging demand.

Procurement of new supplies through RFPs should be straightforward if the requirements are specified by demand type. For example, an RFP for baseload that will be available 24x7, 365 days per year supply and that is dispatchable by the grid operator is easily defined. The challenge for decision makers is to remain focused on the procurement specifications not proponent hyperbole. The promise of renewables is a prime example even though wind and solar cannot deliver baseload supply without significant flexible back up generation.

With respect to solar, all major studies have concluded that only modest supplies of solar can be cost effectively integrated into the grid due to the general misalignment of solar output with demand, particularly in winter.[7]

[4] Strategic Policy Economics, Electrification Pathways for Ontario, 2021.
[5] https://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Interruptible-Rate-Pilot
[6] Strategic Policy Economics, Electrification Pathways for Ontario, 2021.
[7] EPRI 2021, CER 2021, Trottier 2021, Suzuki 2022, Strapolec 2021.

For wind, the most recent report by the Suzuki Foundation claims that it is possible to economically achieve a net zero electricity system in Ontario with significant amounts of wind energy and extensive interconnections between provinces, such as between Ontario and Quebec. However, the Ontario analysis is based on two egregiously flawed assumptions: 1) the lack of resolution and fidelity in the modelling simulations underrepresents the impacts of wind intermittency and the need for backup; and, 2) even with those optimistic simulation outcomes, the analysis unrealistically assumes that hydroelectricity from Quebec can compensate for the wind intermittency in Ontario. Quebec is already struggling to address its own need for almost 60% more generation and has limited options for new hydro to meet its own 10+ GW need for new baseload supply .[8] In fact, Quebec has signaled that it is not interested in developing electricity to manufacture hydrogen for export given that its first priority is domestic needs.[9] Therefore, it is extremely unlikely that Quebec will develop the additional 10 GW of new hydro identified in the Suzuki Report that will only be used to two months of the year to meet Ontario's sporadic winter peaking needs.

In spite of these aforenoted shortcomings, renewables can play a role. For example, given the extensive flexible generation that Quebec's hydro reservoirs provide, there is significant room for new integrated wind generation that will help extend the useable capacity of these vast reservoirs to help meet Quebec's growing demand. Quebec's reservoirs can provide the extensive flexible back up generation needed to support intermittent wind generation output without materially reforming its grid management practices.

Procurement and grid management becomes simple when decision makers recognize that renewables require backup flexible generation, even when supplemented by extensive amounts of storage.[10] If wind advocates wish to bid those technology options, efficient system operations require their integration into co-located dispatchable hybrid solutions that can reliably and cost-effectively meet the operational profile for baseload or variable demand. This approach obviates the need for advanced grid management innovations.

The federal government's role should ensure that independently verified and peer-reviewed facts regarding cost-effective options are transparently provided to all Canadians. The first priority should be to underscore the need to develop a non-emitting electricity system by 2035, including new, reliable, low-carbon baseload generation resources.

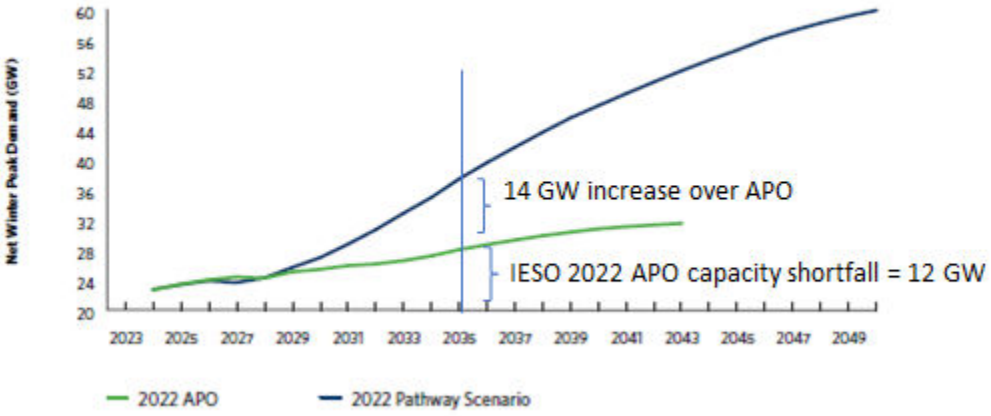
Recommendation #2 - Clearly identify the competing timelines between encouraging electrification and building the electricity system infrastructure required to meet it.

Huge amounts of new, cost-effective, low-carbon baseload supply must be developed rapidly. Public awareness about the urgency to address NZ is increasing electricity demand. The accelerating adoption of electric vehicles (EVs) provides an example. Analyses show that the demand for applications such as EVs and home heating will outpace the ability to develop the necessary infrastructure.[11] According to

[8] Hydro Quebec 2022-2026 Strategic Plan, 2022; Globe and Mail, March 2023, Quebec needs Newfoundland and Labrador's power.
[9] Presentation at the Hydrogen Business Council Conference, Nov 2022.
[10] Strategic Policy Economics, Distributed Energy Resources in Ontario, 2018.
[11] Strategic Policy Economics, Electrification Pathways for Ontario

the IESO's 2022 Annual Planning Outlook (APO), Ontario needs 12 GW of new non-emitting supply by 2035 to comply with the pending federal Clean Electricity Regulation (CER) and avoid brownouts.[12] On the path to NZ, Ontario has the greatest need for rapid development of new infrastructure given its forecast need to develop 14 GW of new supply in the next 15 years over and above the 12 GW identified in the IESO's 2022 APO. This is illustrated in Figure 9, which was extracted from the IESO's Pathways to Decarbonization (P2D) study.

Figure 9 | Annual Winter Peak Demand



For most provinces, and Ontario and Alberta in particular, the optimum strategy will be to build new clean baseload as rapidly as possible and transition away from using fossil-fired generation to provide baseload power and use it instead for variable power and then ultimately for peak and reserve supply. The latter two phases of the transition will make emissions negligible and ultimately zero.

For baseload power, Canada has three options – nuclear, hydro and gas-fired generation with carbon capture. Additionally, the viability of these options is affected by regional factors. For example, the federal government is only supporting carbon capture in Alberta and Saskatchewan.[13] Ontario's IESO ruled out the viability of carbon capture in its P2D study. While there is available hydro development potential, studies in Ontario and Quebec show it to be insufficient to meet the full baseload demand.[14] The IESO's P2D study also suggests it will be very expensive at over $200/MWh. In light of these facts, new, large-scale nuclear generation is essential to meet the amounts of electricity required in the forecast timeframe and all viable infrastructure opportunities should be pursued as soon as possible given the long lead times required for their development.

Integrating renewables backstopped by fossil-fueled generation provides a near-term opportunity to reduce emissions during the energy transition until the non-emitting baseload resources are available. However, decision-makers need to recognize the risks of curtailment and ultimate stranding of any investments in the accelerated deployment of renewable generation, including decommissioning and waste management before non-emitting baseload options come online. Analysis indicates that the most

[12] IESO, Pathways to Decarbonization, 2022
[13] Federal Carbon Capture and Sequestration Tax Credit eligibility
[14] OPG, Hydropower options for Ontario, 2023.

cost-effective approach is to ensure that the baseload supplies are developed as rapidly as possible to mitigate these risks.

The federal government should work with the provinces to address these transition impacts and their respective contribution to achieving national Net Zero goals and incent the urgent, rapid development of low-carbon baseload resources. Delays expose Canadians to the unnecessary risks of brownouts associated with the accelerated electrification that is emerging across Canada.

Recommendation #3 - Focus federal programming on financing low-carbon, bulk system infrastructure and encourage consumer adoption of BTM demand side management technologies, such as bi-directional EV charging.

There are two key steps that the federal government could take to help accelerate the capacity of the electricity system to accommodate the ongoing electrification of the economy:

1) Provide financial support for investments in new low-carbon baseload supplies; and,
2) Incent the adoption of BTM demand management systems.

Supporting new low-carbon baseload supplies

The federal government's 2023 budget has considered the implications of the US Inflation Reduction Act (IRA) on Canada's climate policies. As a result, there has been significant discussion among energy sector stakeholders on the role of clean energy tax credits. The PWU believes it is critical that these credits should be applied to Canada's situation so as to create a level playing field for investment in non-emitting energy resources. This would facilitate investment in large-scale, non-emitting resources, help de-risk the projects for investors and support provinces that are investing in such projects.

The federal government acts should also consider:

1) Clearly, communicating the challenges Canada is facing and the roles that new nuclear, hydro and carbon capture can play to help achieve Net Zero;
2) Partnering with the provinces on low-carbon infrastructure projects, including leveraging Canada's Infrastructure Bank (CIB)—both financing and equity positions. In some instances, equity participation may be more favorable than tax credits; and,
3) Invest in a balanced manner in the development of the science and technology infrastructure in all three of these technologies: nuclear, hydro, and carbon capture.

Incent the adoption of BTM demand management systems

As mentioned earlier, studies have shown that BTM demand management systems can help mitigate system peaks. The most cost-effective mechanism for addressing peak demand is at the end user's location. This avoids the need for peak generation and increases the efficiency of the existing grid which can help avoid the need for upgrades. There are two key technology areas that NRCan could help promote more effectively: dual source heat pumps; and, bidirectional EV charging.

1) *Dual source heat pumps.* Studies have shown that this technology can help mitigate demand on the electricity system and reduce winter peaks by over 10% while still achieving a 90% emission

reduction.[15] Blending renewable natural gas and hydrogen increases the benefits. While heat pumps are expensive, their adoption could be accelerated with subsidies. NRCan currently provides heat pump subsidies which could be prioritized to dual fuel heat pumps that would use natural gas only on very cold days. Accelerating the adoption of dual fuel heat pumps versus other heat pump technologies could help manage the transition while a non-emitting electricity system is being developed.

2) *Bidirectional EV charging.* Studies have shown that on its own, bidirectional EV charging can provide much of the needed demand side management required to help smooth demand at the end user. In fact, for Ontario, given the recent push to develop 2500 MW of grid-based storage, if even 30% of EV owners become equipped with bidirectional chargers, Ontario's need for additional storage beyond the 2500 being procured may be obviated.[16] It is recommended that the bidirectional EV charger supported are vehicle-to-building (V2B) power supply, not vehicle to grid (V2G). Connecting to the grid is complex and of negligible, if not negative, value. However, using a homeowners EV to supplement electricity needs within the home and reduce its own demand from the grid provides the benefits required. [17] While NRCan currently supports the installation of EV chargers today, it should migrate its supports to bidirectional chargers and reduce support for other devices.

While these challenges have received significant attention, solutions can be effectively implemented without the need for developing sophisticated grid management capabilities. Time of Use (TOU) rate programs that incent consumers to shift their power consumption from times of daily peaks to times of lower demand have been shown to provide up to 70% of the benefits.[18] These solutions are more effective than hourly electricity market pricing as they are: deterministic, predictable, of known value, and simple to implement. Studies have shown that trying to use market-based mechanism along with grid management technologies to control non-emitting technology supplies is not viable due to the lack of a true variable cost signal.[19]

With TOU regimes, it is easy to program EV charging and heat pump operations to avoid using electricity at peak times. Furthermore, bidirectional EV chargers can supply power to the home at peak times. The result could achieve a 15% reduction in peak demand, or, more importantly, defer the need to construct 15% more new capacity.[20] Ontario has recently implemented an Ultra-Low TOU program, specifically aimed at encouraging EV owners to charge their vehicles at night. That same program offers significant value to EV owners that use their vehicles to offset their power consumption during peak hours. The gap is bi-directional EV chargers.

Recommendation #4 – Minimize the cost of transitioning the electricity system and allow existing practices to protect vulnerable populations.

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[15] Strategic Policy Economics, Electrification Pathways for Ontario, 2021; Guidehouse Report to Enbridge, Pathways to Net Zero Emissions for Ontario; 2022.
[16] Strategic Policy Economics, Electrification Pathways for Ontario, 2021.
[17] Strategic Policy Economics, EV Batteries Value Proposition for Ontario's Electricity Grid and EV owners, 2020.
[18] MIT, Electricity Retail Rate Design in a Decarbonizing Economy: An Analysis of Time-of-Use and Critical Peak Pricing 2022.
[19] Strategic Policy Economics, Electricity Markets in Ontario, 2020.
[20] Strategic Policy Economics, Electrification Pathways for Ontario, 2021.

NRCan has raised concerns about the cost of the transition to rate payers, taxpayers, and vulnerable populations. The federal government's strategy should focus on communicating the best options and provide financial support for infrastructure investments to help minimize the cost of the transition.

Studies have shown that optimizing the electricity system by using the most cost-effective options, specifically nuclear, hydrogen, demand-side management with dual fuel heat pumps and bidirectional EV charging will decrease the unit cost of electricity by as much as 25%.[21]

The federal government can help balance the costs between rate payers and taxpayers by backing up their climate policies with investment tax credits (ITCs) such as those being offered in the US as previously noted. Analysis provided to the government shows that tax credits could be designed that will not impact taxpayers in the long run while reducing the cost to rate payers by almost 30%.

If the development of the required infrastructure and the pace of electrification is properly managed (i.e., fact/analyses-driven, transparent, cost-effective) and employs a suite of existing tax and rate programs, costs to vulnerable populations can be reduced. As new challenges emerge, these tactics may be tweaked as required.

First and foremost, NRCan should focus on clarifying the needs, options and associated cost implications, and a going forward process. This in turn should be shared transparently with all Canadians. This should better inform the need for additional programming for vulnerable populations.

Closing

In summary, NRCan should not be investing resources in grid modernization. NRCan's priorities should be to: create a common understanding of what are the viable options to achieve Net Zero; rapidly develop baseload supplies, like new large-scale nuclear generation; and invest in behind the meter technologies, e.g., dual fuel heat pumps and bidirectional chargers that consumers can use to mitigate the cost impacts of electrification of Canada's economy.

The PWU has a successful track record of working with others in collaborative partnerships. We look forward to working with the federal government and other stakeholders to strengthen and modernize the electricity system of Canada and Ontario. The PWU is committed to the following principles: Create opportunities for sustainable, high-pay, high-skill jobs; ensure reliable, affordable, environmentally responsible electricity; build economic growth for Ontario's communities; and promote intelligent reform of Ontario's energy policy.

We believe these recommendations are consistent with and supportive of the government's objectives to transition to a Net-Zero economy and supply low-cost and reliable electricity for all Canadians. The PWU looks forward to discussing these comments in greater detail and participating in the ongoing stakeholder engagements.

[21] Strategic Policy Economics, Electrification Pathways for Ontario, 2021.