Feedback Form

Pathways to Decarbonization – February 24, 2022

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Following the February 24 engagement webinar, the Independent Electricity System Operator (IESO) is seeking feedback from stakeholders on the items discussed during the webinar. The webinar presentation and recording can be accessed from the engagement web page.

Please submit feedback to engagement@ieso.ca by **March 16**. Please attach research studies or other materials for consideration by the IESO to support your submission.

If you wish to provide confidential feedback, please submit as a separate document, marked "Confidential". Otherwise, to promote transparency, feedback that is not marked "Confidential" will be posted on the engagement webpage.

Policy

Topic	Feedback
Are the assumptions indicated reasonable and comprehensive in terms of scale and timing?	**Uncertainties in the range of emerging CO2 policies and regulations should be evaluated, as the electricity system will need to respond to this uncertainty.** Currently, there are various carbon policies being considered by the federal government that may constrain natural gas generation in the future, including carbon pricing and emissions performance standards. The IESO should consider factoring in the potential range of emerging policies in the analysis. Ontario's CCGTs currently pay a nominal cost on their CO2 emissions under Ontario's Emissions Performance Standard. However, there are various carbon policies being considered by the federal government that may change the future regulatory landscape for natural gas and constrain its generation. These include: • In April 2021, Canada strengthened its Paris Agreement targets to 40 - 45% reduction below 2005 levels by 2030 (up from 30% reduction). • In summer 2021, the Government of Canada (GoC) updated the Pan-Canadian approach to carbon pollution pricing 2023-2030. The carbon tax paid by large emitters (including electricity) would go from $50/tonne in 2022, increasing by $15 annually thereafter, until it reaches $170/tonne in 2030. • On December 3, 2021, ECCC (Environment and Climate Change Canada) published a statement detailing upcoming federal consultations before the end of 2021. This included transitioning to a net-zero emitting electricity grid by 2035. Under OPG's current projections, Ontario's grid will be close to 90% non-emitting by 2030 with the existing gas generators in service. The consultation paper was recently released on March 15, 2022. It would be prudent for the IESO to consider some of the policy changes that may come forth this year if the changes occur up to a reasonable period of time.

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	A carbon price increase would increase the cost of operating the natural gas plants and would naturally raise electricity market clearing prices. This would result in some of these gas resources being dispatched less, due to real time imports being more competitive, assuming there is no carbon border adjustment. Gas assets still provide valuable capacity to the Ontario grid and should be used to provide capacity until the end of their useful life. Existing natural gas can support electrification by dealing with the demand uncertainty until Ontario can add a greater amount of non-emitting baseload generation so that CO2 emissions do not increase on a sustained basis. If all gas-fired generation is phased out, the supply deficit could reach up to 15,000 MW as opposed to the roughly 4,000 MW deficit reported in the case assuming all recontracted resources in the latest Annual Planning Outlook. Not many other supply resources in Ontario are capable of fully replicating the range of supply attributes provided by gas-fired generators. By contrast, given that wind and solar supply resources are dependent on the weather to provide energy, their supply can change very quickly, even minute-by-minute – the result of a sudden change in wind patterns or cloud cover, amongst many other factors. Once a gas-fired generator is on-line, it is capable of quickly increasing or decreasing supply in response to conditions on the grid and within the electricity market. The gas units support wind and solar generators when their supply changes unexpectedly. The timing problem between intermittent renewable generation and demand would require renewable generation to be overbuilt to minimize the total cost of renewables plus storage at a significant cost to customers. This would create large energy surpluses, potentially much larger than what Ontario experienced in the latter half of the last decade. The emerging technologies for multi-day or seasonal storage are not yet commercially mature. OPG supports the continued use of gas until end of life until there is a suitable technology that

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	provides the same flexibility associated with gas that is not punitive to ratepayers.

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Are there other considerations for the IESO?	**The baseline to which comparisons are made should assume natural gas assets operating to the end of their useful life.** Ontario's current gas-fired generation installed capacity is about 11,000 MW, accounting for about 25% of total installed capacity in the province and about 7% of energy production. The life expectancy and useful economic life of most plants, based on a total life of 35-40 years, can stretch to 2040 and beyond. Much of Ontario's current natural gas-fired generation is under contract. There is approximately 8,000 MW that will reach the end of its contractual term by 2030 with the remainder expiring by 2040. Shutting down a plant that still has useful life removes a cost-effective source of capacity from the system that may need only limited sustaining capital and fixed costs to operate. Continued operation of these gas plants would be a cost-effective option for the ratepayer, until new non-emitting generation can be placed in-service. Retiring the plants early will result in stranded natural gas generation assets, in addition to numerous pipelines and other infrastructure that may no longer be required, but will continue to be paid for by Ontario's energy customers. These are important points to consider for all scenarios. **The IESO's report should consider the economy wide carbon impact, not just focus on the electricity sector.** Although OPG understands the IESO is not intending to address the economy wide carbon impact in its scenarios, as it is an important factor in the assessment of phasing out gas plants, it should be referenced in the report perhaps outside of the scenarios. In 2019, CO_2 emissions from the province's electricity system accounted for just 2% of all CO_2 emissions – compared to more than 17% of all CO_2 emissions in 2005. Compared to other progressive jurisdictions from a carbon intensity perspective, Ontario ranks amongst the best

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	globally - Ontario's electricity system is the lowest emitter when compared to the Canadian average, USA, UK, France and Germany by a wide margin. This also means that 97%-98% of CO_2 emissions are coming from other sources, which the province's electricity system can help reduce. CO_2 emissions from the Ontario Power System are expected to remain relatively low over the next decade – even with the planned retirement of Pickering and refurbishments of other nuclear generators. By 2030, CO_2 emissions are expected to be over 70% below those of 2005. **Carbon Intensity and Carbon Border Adjustment** Ontario's US electricity trading partners are more carbon-intensive, except for Quebec. Phasing out Ontario natural gas plants, and importing cheaper but dirtier electricity from the US could result in an increase in regional CO_2 emissions. In order to level the playing field between Ontario and US electricity, imports may face a Carbon Border Adjustment (CBA). However, a CBA would increase costs as it limits cheaper energy imports. Modelling indicates that at $170/t carbon, if natural gas generation is subject to a progressively lower performance standard, transitioning to 0 T/GWh: • *With no CBA* - US thermal generation would be more economic, and imports of U.S. thermal generation would increase dramatically. This would result in increased regional total carbon emissions, and Ontario's electricity price may increase in the hours where imports are not sufficient • *With a CBA* – the CBA would prevent US thermal generation from displacing Ontario gas generation (decrease imports). However, it will push electricity prices even higher, and may not save a significant amount of regional total CO_2 emissions. The IESO should consider the design and implementation of any applicable CBA and consider how it may impact carbon leakage and competitiveness in Ontario's electricity sector. Capacity imports should still be considered in the context of the IESO's Capacity Auction, as this would be needed in the post-Pickering world even without phasing out existing natural gas generation. Note that importing capacity with

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	little energy content has a negligible impact on CO2 emissions, similar to capacity from Ontario gas generation. In the IESO's Pathways to Decarbonization Assumptions document, for Scenario 2, it was quoted that the Emissions Performance Standards Allowance Benchmark will taper off to 0 tonne CO2e/GWh by 2035. The federal government announced in late 2021 that they would initiate consultations on transitioning to a net-zero emitting electricity grid by 2035. Would the IESO provide clarification whether the 0 tonne CO2e/GWh by 2035 is intended to reflect the federal net-zero electricity grid by 2035 policy, or whether it is something different. Additionally, the federal government is expected to table its 2030 Emissions Reduction Plan mandated under the *Canadian Net Zero Emissions Accountability Act* by the end of March 2022. The IESO, in its development of assumptions and scenarios, should ensure the foreseeable range of policies are included. **The IESO should consider the changes that may be required to the electricity market structure to achieve zero emissions.** The current Ontario electricity system was designed to accommodate the majority of electricity coming from large generators or grid-scale supply sources. A zero emissions grid may be designed and operated differently than the current electricity system to accommodate new sources of energy and a different distribution of energy sources. This change in the electricity system represents climate change transition risk that is due to a rapid change in society and/or technology to achieve climate change mitigation targets. This is particularly true as Ontario is already experiencing the impacts of Distributed Energy Resources (DER). Greater flexibility of the grid is also likely to result in a more reliable and resilient grid as extreme weather events increase due to climate change. The costs of implementing some of these solutions should be balanced with the benefits that could accrue from the increased reliability benefits. The IESO should consider integrating some of the following into the analysis of their pathways:

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	• Future changes required due to high DER presence in the future and the possibility for a more decentralized energy system • The impact of demand-side management and integrated energy storage in the path to zero emissions. This could de-couple the timing of demand from electricity production. • The potential for smart grid technologies to manage the timing of generation and demand as well as the impact of DER.

Demand

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Are the assumptions indicated reasonable and comprehensive in terms of scale and timing?	**Appropriate demand growth needs to be considered.** Currently the IESO is assuming a 1.3 – 1.8% demand growth, which includes some level of decarbonisation in the building and transport sectors. . If decarbonisation of these sectors were to occur at a greater pace, then the demand would have to grow at a higher rate. The IESO has already indicated that the high electrification scenario in the current APO, many no longer be high enough. The IESO should update its high electrification scenario to reflect the demand growth needed to decarbonize Ontario's economy as per known policies. To promote transparency and alignment, the IESO should publish the high electrification scenario that will be used in the study, if it is different from the current published set in the APO. Studies have shown that burning gas to help electrify the transportation sector is an economically prudent way to deliver targeted CO2 savings. Switching from higher-emission fuels to low-carbon electricity in transportation could play a significant part in reducing overall province-wide emissions. As noted in IESO's assumptions, in June 2021, the federal government announced a mandatory target for all new sold light-duty cars and passenger trucks to be zero-emission by 2035, accelerating Canada's previous goal of 100% sales by 2040. Accelerated EV adoption will require a demand growth greater than 1.3-1.8%, and sooner.

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Are there other considerations for the IESO?	Click or tap here to enter text.

Resources

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Are the assumptions indicated reasonable and comprehensive in terms of scale and timing?	**Table of Assumptions (Potential Resource Options) – Large Nuclear** • Project life should be called Operating life. • The operating life for large nuclear is 60 years, but the asset can run for another 20+ years based on real world experience. The NRC in the USA has issued extended operating licenses to many plants for up to 74-100 years. A 60-year life should be used in the business case to determine Levelized Cost of Energy (LCOE) for purposes of comparing alternative options/investment decisions. • OPG does not have any current Large Nuclear cost estimates and other more current sources should be considered. **Table of Assumptions (Potential Resource Options) – Small Modular Reactors** • It is difficult to capture all SMRs in one category; suggest that SMRs could be broken down into three categories: vSMR (very Small/Micro SMR); Gen III+ SMR's like the GEH BWRX-300 ALWR technology selected by OPG, and Gen IV SMR's such as the X-Energy or ARC-100 models. Each of these Gen IV reactors will have different cost ranges, fuel types, etc. therefore, it is difficult to generalize the assumptions. OPG can provide some generalized information based on what we know about the Gen III+ SMR's. Information is preliminary and captured in a range. ***OPG's information for large nuclear and SMR is preliminary, requires updating and is subject to several assumptions. We are willing to meet with the IESO to discuss the information we have along with its confidence level.*** **Any reliance on imports needs to be carefully considered.** If the system needs to rely on less gas generation, its contribution needs to be replaced to maintain reliability of the grid. Currently there are over 6,500 MW of import capability from interconnections with neighboring markets, however; only a fraction would be available at the time of system need. Ontario's transmission system has been designed and constructed based on existing load centers and large generators. Gas-fired generators are already built

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	and strategically located where demand is highest. This helps to reduce congestion on transmission lines that may reduce the amount of supply that can flow from distant generators. A shift to large-scale imports would require an expansion of the transmission system that moves electricity from one region of the province to another. Large transmission system expansions generally take seven to ten years to complete and include rigorous environmental assessments, local community engagement (and opposition in some cases) and engineering.
	
	The IESO needs to reconsider the import capacity identified in the assumptions table – a good reference would be the IESO's assumptions in the "Ontario Quebec interconnection capability report May 2017". Specifically the hydro winter capacity assumption from Quebec may be too high based on historical flows from Quebec.
	
	The role of Hydroelectric
	Hydropower can play a big role in meeting the future electricity supply needs for Ontario as it provides:
	
	• Opportunities for energy and capacity at large scale
	• Flexibility and ancillary benefits to the grid which are unmatched from other generation sources
	• A good generation mix in Ontario requires hydropower to maintain reliability
	• Ontario made solution, economic and socioeconomic benefits for the Province
	
	In addition to historic hydro assessments, OPG has commenced a study to evaluate hydropower in the North to meet Ontario's demand, as part of the Ministry of Energy directive. As part of the response OPG is recommending:
	
	• Further analysis of hydroelectric opportunities to be conducted collaboratively with the IESO as part of its Pathways to Decarbonization Study including assessment of:
	  o which sites would be most cost effective to implement soonest compared to the electricity system value, indigenous community participation and benefits and other regional socio-economic benefits and
	  o how the orderly development of hydroelectric sites across northern Ontario

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	can be planned to enable and share costs with other economic development activities. **The cumulative impact from incremental solar and additional energy storage has diminishing value, this needs to be factored into the supply mix analysis rather than just assuming a set impact for each source added.** This issue has been previously identified by OPG. The main points have been summarized for brevity. In the past few years changes in grid-connected demand shape (due to increasing embedded generation, storage, demand management, etc.) has caused a shift of the peak hours and summer-peak season. The addition of embedded solar capacity over the past several years has shifted the peak demand hour to later in the day and later in the summer season. Several seasonal peaks have occurred in September after sunset, diminishing the peak contribution of solar capacity. When the peak is pushed to the hours when solar can no longer generate, there is no additional peak contribution from incremental solar generation. The marginal incremental peak contribution from wind and solar would likely be less than 10%. The UCAPs identified in the assumptions table for summer and winter using the incremental peak contribution are too high (with the exception of solar for winter) based on historical data in Ontario. The annual capacity factors shown are also too high for Ontario. Special consideration must be given to energy storage and its peak contribution, as more storage is added to the system. The differential between the daily minimum and maximum demand has been greatly reduced due to the addition of new solar generation. This diminishes the value of energy storage. Energy storage itself has diminishing returns for the grid. The peak contribution of energy storage flattens with increasing installed capacity and, shorter duration energy storage offers less and less effective capacity.. There is a limit to how much energy storage can be charged off-peak. In moving from a 4 to 8 hour storage the costs would increase roughly by 25%. In the extreme, multi-day storage may be required to handle peaking demand during a heat wave or cold weather event.

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	OPG would like to obtain clarification on the construction lead-times. If the construction lead-times are meant to cover the period of time from start of construction to in-service, then they seem to be in the right range. If however the construction lead-times are meant to be the lead-time from project inception to in-service, then the low end of the range is too low and an additional 1-2 years should be added to account for time needed to go through the connection process and regulatory approvals. Pumped storage costs should be shown separately from battery storage. Pumped storage has a higher upfront cost, however this can be offset by the much longer facility lifetime (e.g. 90+ years), similar to traditional hydroelectric facilities.

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Are there additional data sources that we should consider	Click or tap here to enter text.
Are there other considerations for the IESO?	**The IESO should consider the impacts of climate change in their operability and reliability analysis** The impacts of climate change are already being experienced in Ontario. The best modelling and analysis shows an increased frequency and intensity of extreme storm events, which could cause disruptions to the electricity system. The analysis extending out to the 2050 period should incorporate the physical impacts of climate change on the electricity system.

General Comments/Feedback

Technology policy choices should consider the least implied marginal CO2 cost and land use.

The Federal Government's goal is to achieve a net zero carbon economy by 2050. This will require the addition of substantial new baseload generation to the system. While wind and solar are expected to have a lower average cost than say Small Modular Reactors (SMRs), they are less effective at removing CO2 due to their low annual capacity factor and low peak contribution factor. As more intermittent non-emitting generation is added to the system, more of their contribution will be to surplus generation and less towards displacing gas generation. Wind and solar's contribution to displacing gas diminishes much faster than nuclear and therefore the amount of CO2 they displace, diminishes faster. In addition incremental wind and solar add little to meeting the peak demand, thus the implied CO2 cost for wind and solar increases dramatically as more of them are added to the system. Technology policy choices, in general, should be based on the least implied marginal CO2 abatement cost and not the average cost of energy. In addition, considering the life cycle CO2 emissions further increases the marginal CO2 abatement cost of renewable generation, especially solar compared to wind and nuclear.

SMRs are one efficient option in particular when considering land use. Solar's land-use requirements are approximately 100 times more than nuclear's and wind's is about 500 times that of nuclear. The output of Darlington Nuclear at 28 TWh/year is close to how much natural gas generation is expected to be dispatched in Ontario when Pickering closes its operation. The land-use of Darlington is approximately 5 sq km. To supply that amount of energy would require 500 sq km from solar and 2,500 sq km from wind.

OPG would like the IESO to provide the total system cost including the breakdown per technology, capacity and energy. The costs that IESO will be receiving from the American source (NRE) may not be accurate since Ontario has much higher taxes, labour rates and land costs. These would have to be factored into the US cost estimates. Additionally, OPG would like to request to see the assumed cost of batteries for the forecast period.

Would the IESO please provide a work plan and table of contents with a break down of the concept of the report. The IESO's final report is scheduled to be issued at the end of this year. Stakeholders would welcome the opportunity to provide comments before the final report is published.