Feedback Form

Pathways to Decarbonization – February 24, 2022

Feedback Provided by:

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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.

Uncertainties

The biggest uncertainty is **not** referenced explicitly in the uncertainties chapter (Chapter 8) of the 2021 Annual Planning Outlook, namely, the progression of climate change.

The IPCC will continue to refine its understanding of climate change and what needs to be done to address it. That refined understanding, together with events demonstrating the increasingly severe effects of extreme weather, could trigger a more strident call by the public for relief that can only be provided by accelerated action to reduce carbon emissions. How quickly could Ontario respond to such a pivot in public opinion?

The IPCC Sixth Assessment Report has just been released (February 22, 2022). See https://www.ipcc.ch/report/ar6/wg2/. The following quote is from the Summary for Policymakers:

"SPM.C.2.10 Within energy system transitions, the most feasible adaptation options support infrastructure resilience, reliable power systems and efficient water use for existing and new energy generation systems (very high confidence). Energy generation diversification, including with renewable energy resources and generation that can be decentralised depending on context (e.g., wind, solar, small scale hydroelectric) and demand side management (e.g., storage, and energy efficiency improvements) can reduce vulnerabilities to climate change, especially in rural populations (high confidence). Adaptations for hydropower and thermo-electric power generation are effective in most regions up to 1.5°C to 2°C, with decreasing effectiveness at higher levels of warming (medium confidence). Climate responsive energy markets, updated design standards on energy assets according to current and projected climate change, smart-grid technologies, robust transmission systems and improved capacity to respond to supply deficits have high feasibility in the medium- to long-term, with mitigation co-benefits (very high confidence)."

The effects of climate change both on the population and on infrastructure including transmission lines is a wild card.

Availability, Reliability and Cost: the lack of a level playing field between gas-fuelled-electricity and renewable-energy-fuelled-electricity generators

The assumptions document states that the study will "evaluate opportunity to replace 2021 Annual Planning Outlook existing natural gas with incremental non-emitting resources based on availability, reliability and cost".

There is a case to be made that natural gas generators have an unfair advantage in such a comparison. The case is based on the fact that there are severe constraints placed on the addition of non-emitting resources to the grid. And those severe constraints are there precisely because non-emitting resources are a viewed as a threat to the reliability of the grid. This view of renewable generators has been in place in Ontario since the early 2010s when the technology available for the management of renewable, that is, distributed, energy resources was, relatively speaking, in its infancy. At the time, the constraints were appropriate but now ten years later, those constraints are no longer optimal.

So, gas-fuelled electricity generators are favoured to win because of the lack of availability of DER, and the lack of DER is because they are "unreliable".

I suggest that a review of these constraints is in order.

For electricity customers, I have provided a description of my experience of trying to get an offer to connect for a solar system. I have put this description in section "Applying to a distribution grid operator for an offer to connect a solar system".

The reason that these constraints are not longer optimal is that they date from the early 2010s when inverters were "dumb" compared to the "smart" inverters of 2022.

The following paragraph from an article titled "California's Rule 21: A Quick Guide on Inverter Compliance by Models and Manufacturer" explains the issue created by "dumb" inverters. See https://solar-distribution-us.baywa-re.com/solar-r-e-view-magazine/residential-solar/special-feature/californias-rule-21-a-quick-guide-on-inverter-compliance-by-models-and-manufacturer/

"Naturally, as residential solar and small renewables projects became more prevalent, conversations began on how these sources would interconnect with utility grids — and **how flux; excess flow back; sales; and distribution would be centrally managed**, given all the complexities of California's energy infrastructure and statewide infrastructure. The Institute of Electrical and Electronics Engineers (IEEE) and Underwriters Laboratories (UL) are entities that create standards for safe equipment and test to those standards. These groups developed IEEE 1547 and UL 1741SA, the standards that underlie Rule 21, **to ensure that grid profile fluctuations do not result in unnecessary inverter shutdowns — and by extension promote additional grid instability**. These standards outline how behind the meter energy generators respond to grid profile changes."

The Sunspec Alliance (https://sunspec.org) is an organization that supports the development of open standards for the distributed energy industry. Using a set of guiding principles this group developed a Common Smart Inverter Profile (CSIP) to govern the interoperability of behind-the-meter smart inverters and the distribution grid. The first three principles are:

1. All smart inverters require communications to achieve their full value as distributed energy resources.
2. Establish a complete profile – To achieve complete interoperability a complete profile is required including a data model, messaging model, communication protocol and security. Without a complete profile specification it would be impossible to achieve communications interoperability without additional systems integration activities
3. Leverage existing standards and models from both engineering (e.g., IEEE 1547) and communications (e.g., IEEE 2030.5) standards

The address for getting Sunspec's Common Smart Inverter Profile, go to https://sunspec.org/wp-content/uploads/2018/04/CSIPImplementationGuidev2.103-15-2018.pdf.

The Consequences of Not Being Able to Connect DER to the Grid

The bottom line is that under current circumstances, Ontario will not have as much DER as it could have to address increased demand going forward. Presenters at the webinars made it crystal clear that this modelling exercise implies no commitment to deploy DER. The modelling exercise may lead to a change in the definition of "proxy" generation resources in the 2021 APO. And that is right and good, except for the unfair advantage enjoyed by gas-fuelled generation, as discussed above.

Some Canadians are able and willing to spend money on DER, but are being prevented from doing so. Climate change is a global problem that is orders of magnitude more serious than covid-19. Collectively, we are in an all-hands-on-deck situation and a lot of us are being told to stay off the deck. The polls suggest that Canadians are concerned about climate change, but they are not being allowed to speak with their money as well as their mouths.

I have a personal, as well as a collective, interest in this situation. I am on a personal path to decarbonization. I have the heat pump, and I have the electric vehicle. What I don't have are the solar panels and, as I explain in section "Applying to a distribution grid operator for an offer to connect a solar system", that is because I am being told that there is not enough "capacity" to connect them.

A number of consequences flow from this inability to connect.

One consequence is that some of the power that runs my heat pump and my electric vehicle comes from gas-fuelled electricity generators. These two forms of consumption logically should be satisfied by local generation either from solar at the residence or from excess solar generated by other customers connected to the distribution stations within the domain of a single long-haul transmission transformer station.

The second consequence follows on the first. There are a lot of Canadians who would like to do their part to fight climate change by reducing their personal emissions, but are being prevented from doing so. How do you think this makes us feel?

The third consequence follows on the second. If I and others like me could connect panels to the grid, we could share our excess generation with our fellow Canadians. Obviously, that ability to share excess DER generation would help reduce our dependency on fossil-fuelled generation. So, we've come full circle back to the unfair advantage enjoyed by gas-fuelled generation in Ontario.

The 2021 Advanced Planning Outlook (APO) forecasts increased demand for heat pumps and electric vehicles this decade and expects the rate of increase in demand to accelerate over the course of this decade. Right now, the only resource that is available to meet that increase demand is gas-fuelled generation. The APO also points to the need to address the loss of generation capacity that the retirement of Pickering and the refurbishment of units at Bruce and Darlington represents. Again, the only resource that is available to make up for that lost capacity is gas-fuelled generation.

The existing gas-fuelled generation capacity is lightly utilized at the moment and can be ramped up a bit without imperilling its role of stabilizing the grid during peak demand hours. That would appear to cover the first half of this decade, but, assuming that's true, we still need to shine a light on the back-end of the decade.

The assumptions document references the carbon price as a factor to consider, but it also references the "Natural Gas fired Electricity Generation Allowance Benchmark". The latter is like a Get-Out-of-Jail-Free card since it allows gas generators to exhaust 370 t CO_2e/GWh for the rest of this decade and Ontario only has to pay the carbon price on the carbon emitted in excess of this amount. As the 2021 APO carbon pricing document says "To put this in context, the average combined-cycle gas turbine in Ontario has an emission factor of approximately 415 t CO_2e/GWh."

As climate change progresses this decade with more and more punishing extreme weather events and it becomes increasingly clear that Canada and the rest of the planet are not keeping pace with emission reductions, then the "Natural Gas fired Electricity Generation Allowance Benchmark" might disappear. The fight against climate change is just that, a fight. I would put that Allowance Benchmark in the APO uncertainties chapter.

The Allowance Benchmark is a fossil fuel subsidy. There are other fossil fuel subsidies sprinkled around the economy. The Federal Government has been promising for years that these subsidies will, one day, be eliminated. They have not delivered on this promise. Circumstances could force their hand.

Are there other fossil fuel subsidies that contribute to the maintenance of gas-fuelled electricity generation in the Ontario grid? If the retirement of these subsidies were to be accelerated, what effects would that have on the cost of electricity to the customer, on the assumption, of course, that all of these costs would be flowed through to the customer. Is this not a risk, an uncertainty? Don't these considerations belong in the APO uncertainties chapter?

What Ontario Could Learn from the State of South Australia

South Australia has a population of 1.7 million people. There is one distribution grid and its operator is South Australia Power Networks (SAPN). Currently, the SAPN distribution grid hosts 1.8GW of distributed energy resource (wind and solar, no hydro). South Australia gets 42% of its electricity from wind, 17% from solar, and 42% from natural gas. The aim of SAPN is to double the amount of installed distributed energy resource by 2030.

SAPN has a climate change position. Its statement can be found at https://www.sapowernetworks.com.au/public/download/?id=318543

To put my remarks in context, please refer to the following three documents that I attached to my email to engagement@ieso.ca.

Refer to "The observed cost of high penetration solar and wind electricity" by Andrew Blakers, Matthew Stocks, Bin Lu, Cheng Cheng (attached) for more information about Australia's march towards a 100% renewable energy grid. Google "elsevier the observed cost of high penetration solar and wind electricity". https://www.sciencedirect.com/science/article/abs/pii/S0360544221013980.

Refer also to SAPN's 2020-2025 roadmap also attached. Google "SA Power Networks 2020-2025 roadmap". See https://www.sapowernetworks.com.au/public/download.jsp?id=319084.

Refer also to the slide deck (attached) provided to me by Travis Kauschke in SAPN's strategic planning office (Innovation Centre).

I have only recently begun to dig into the details of what has allowed SAPN to achieve what it claims in the attached slide deck to be the highest penetration of renewable energy into a distribution grid in the world. There are a great many documents available publicly on the SAPN website. You can

access these documents by going to https://www.sapowernetworks.com.au and using the Search facility to locate "publicly available documents". Another good search string is "welcome to the innovation centre".

One of the first things that stands out in the long list of documents generated by the publicly available search string is that any inverter connected to the distribution grid has to support a connect command and a disconnect command. All inverters are registered and remotely visible to, and accessible by, the network operator. The communication architecture that allows for this remote access by the operator is pictured in the slide deck provided by SAPN's strategic planning office. Note the reference to IEEE 2030.5. This protocol is also used to implement California's Rule 21.

IEEE 2030.5-2018 is titled "IEEE Standard for Smart Energy Profile Application Protocol". See https://standards.ieee.org/ieee/2030.5/5897/. Inverters connected to the SAPN grid have to conform to IEEE 2030.5.

As I said in the section "Availability, Reliability and Cost: the lack of a level playing field between gas-fuelled-electricity and renewable-energy-fuelled-electricity generators", the capabilities of inverters and network devices has evolved considerably since 2010. Conformance to IEEE 2030.5 has brought about a significant change. The SAPN grid shows the extent of the change. We can follow their lead. We don't have to reinvent the wheel.

The SAPN distribution grid is connected to the Electranet long-haul transmission system. According to the Blakers et al paper, there are very limited imports from Electranet to SAPN or exports to the Electranet system from SAPN. There is, however, an important capability on the Electranet transmission system: the Hornsdale Reserve Battery. See "https://hornsdalepowerreserve.com.au". The battery was initially installed in 2017 and upgraded in 2020 to include Tesla's Virtual Machine Mode, "enabling the battery to provide inertia support services to the electricity grid". So, this is about supporting frequency stabilization. The inertia of large rotating masses such as found in coal and nuclear plants or even hydro plants, for that matter, is no longer essential.

In October 2020, SAPN embarked on a 12-month trial aimed at providing customers with distributed energy resources that have flexible, rather than fixed, export limits. The roadmap says this service will be provided in 2022. My understanding from Professor Blakers is that anyone and everyone is allowed to connect their DER to the grid. The question then becomes how much DER you are allowed to export to the grid. The goal of the flexible exports limits is to use data dynamically to alter the export limits and, at the same, maintain grid reliability.

SAPN also has an operational Virtual Power Plant (VPP) that uses Tesla technology. "The trial phases involved 1,100 Housing SA properties being fitted with solar and Tesla Powerwall home battery systems. Installations under the trial phases were completed in 2019." See https://www.energymining.sa.gov.au/growth_and_low_carbon/virtual_power_plant.

Last, but not least, for the moment, is the current under-utilization of grid bandwidth. The grid has been engineered to handle peak loads, which reign for a handful of hours during any day of the year. During the rest of the day, traffic on the wires is relatively light. The attached slide deck illustrates what this means and talks about how we could take advantage of that.

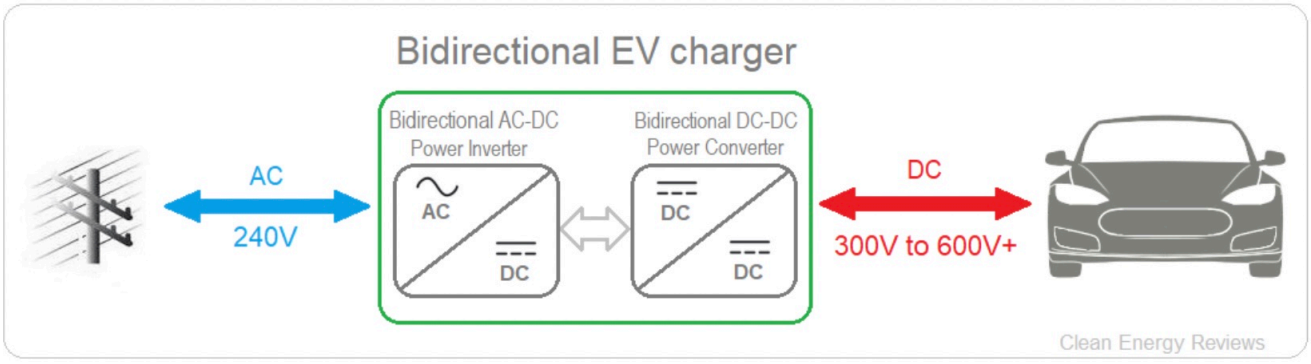
One of the ideas is to move consumption that occurs during hours of low to no renewable energy generation into hours of abundant renewable energy generation. The roadmap markers for this idea are:

- 2020 Solar Sponge Tariffs
- 2021 Smart hot water trial
- 2024 Flexible loads as standard service

Cars are parked most of the time. Right now, it makes sense to charge EV's at night when electricity prices are low. In the future, it will make more sense to charge them whenever there is abundant renewable energy generation whether solar or wind. If those EV's are connected to the grid by a bidirectional charger, they can be used as an energy source during peak demand and then recharged during off-peak periods when there is abundant renewable energy.

So, it makes sense to accelerate the deployment of electric vehicles because they combine two desirable capabilities: transportation and energy storage. The refinement of the bidirectional charger technology that would allow EV batteries to be used in this way needs to be accelerated. The Wallbox Quasar that is currently available in North America, Europe, and Australia looks to be too expensive. Exactly how the Quasar implements the functionality has to be examined more closely.

Bidirectional charging can be accomplished in more than one way and those different ways can be more or less costly in terms of power conversions, each of which causes energy losses. Here is an image that defines one way of doing it. The image is from an article titled "Bidirectional Chargers Explained - V2G Vs V2H Vs V2L". See https://www.cleanenergyreviews.info/blog/bidirectional-ev-charging-v2g-v2h-v2l.



A Bidirectional EV Charger Architecture

This image shows the connection of a car battery to the grid, which is called V2G. A vehicle to home connection would be called V2H. In a V2H the power pole symbol could be replaced by a behind-the-meter electrical panel symbol. Such a connection would imply the following conversions:

1. DC from solar panels to AC at the smart inverter connected to the electrical panel
2. AC from the electrical panel to DC at the power inverter inside the bidirectional charger
3. one DC voltage to another DC voltage inside the bidirectional charger going to the EV battery

A question that arises out of this interpretation is this: why not equip the smart inverter that sits between the solar panels and the electrical panel with a connection to the bidirectional charger that would allow a flow-through direct current directly to the EV battery. Or, maybe, better yet, put the bidirectional charger functionality inside the smart inverter. The goal would be to bypass the electrical panel altogether to charge the EV battery.

Land

Big wind and solar farms require land. Acquiring land for these farms has been problematic from the beginning of the transition to renewable energy. In this decade we will have to deploy a lot of wind and solar to reduce emissions. We can't afford much delay in the assembling of land to locate this generation capacity. Push will become shove and so, enabling rooftop solar and offshore wind is a necessity.

Assembling land for fossil fuel extraction has its difficulties too, and not only because of its toxicity. Having fossil fuel infrastructure near you does not give you any sense of safety and security. Ask anyone who lives near a refinery or the tar sands. Indigenous groups are not going to stop resisting the deployment of additional fossil fuel extraction and pipeline capacity.

Having solar on your rooftop, a heat pump heating or cooling your house and an EV able to energize your house during a power outage gives you a real sense of safety and security.

And then there are the wars fought over fossil fuels. It is likely that the Russian invasion of Ukraine is only the latest example. Russian gas keeps the European economy afloat. The EU countries are talking about removing that leverage, but it won't happen overnight. If Putin gains control over Ukraine's gas fields then he grows his leverage. Putin is an old-style believer in the necessity of brute force to acquire advantage.

Can you imagine waging war to gain control over DER?

Applying to a distribution grid operator for an offer to connect a solar system

The constraints are documented in the "TECHNICAL INTERCONNECTION REQUIREMENTS FOR DISTRIBUTED GENERATION: Micro Generation & Small Generation, 3-phase, less than 30 kW" and its companion document, "DISTRIBUTED GENERATION TECHNICAL INTERCONNECTIONREQUIREMENTS INTERCONNECTIONS AT VOLTAGES 50KV AND BELOW". These documents are available from the Hydro One Net Metering webpage. See https://www.hydroone.com/business-services/generators/net-metering.

The customer-facing method for determining these limits is the "Station and Feeder Capacity calculator.xlsm", an Excel spreadsheet that contains embedded macros. This spreadsheet can be downloaded from https://www.hydroone.com/business-services/generators/station-capacity-

calculator. Select the sheet labelled "Front" to access the cells that accept input. I did not succeed in getting this spreadsheet to work in either a recent desktop version of Excel or in a recent version of LibreOffice.

The inputs to this spreadsheet are:

1. the name of the distribution station and the name of the feeder circuit on that distribution station to which the customer's electrical panel is connected; one is supposed to be able to select this information from a list,
2. the kW size of the solar system that the customer wants to connect to the grid, for example, 10,
3. the project type: one of "Exporting DER" or "Non-Exporting DER",
4. the technology: one of "Others (non-inverter based) or Solar (inverter-based)

One clicks "Evaluate" to get a result. The output of the calculator says whether the system could be connected, or if it can't, why it can't.

An installer told me to get the name of my Distribution Substation and my feeder from Hydro One, and he would use his copy of the spreadsheet to get results. He told me that there was no capacity on Distribution Station.

I learned from talking to people in my area that a lot of people got the same result as I did. I decided to check how much capacity is available in my county for connecting DER. I talked to Hydro One and the agent put my information into the spreadsheet and the calculator returned the result that my proposal failed Test 3.

Sheet 3 in the calculator spreadsheet contains the error messages one can receive from the calculator. The Test 3 error message is the following.

"Test 3 checked for the loading vs. generating balance on the distribution feeder. This project failed because there is no available generation capacity. The acceptable generation limits on the feeder have already been reached (total generation must not exceed 7% of the annual line section peak load on F-class feeders or 10% for M Class feeders) as per the microFIT TIR (please see the microFIT TIR link located on our Feed-in Tariff webpage). Specifically, connection would not comply with anti-islanding distribution system requirements."

The agent informed me that Hydro One has recently changed the acceptable generation limits on F-class feeders from 7% to 10% and encouraged me to submit an application. I am in the process of doing that.

Concluding Remarks

I feel privileged because I have had enough money to get a heat pump and an electric vehicle. But just a handful of people like myself having these things is not enough. We all live on the same planet. We all have to have these things for us to continue to enjoy a habitable planet. This is not just a social justice issue that we are talking about here. I feel that the issue at stake here is essential, existential justice.

In the aftermath of the flooding in BC caused by atmospheric rivers originating from the mid-Pacific ocean, the Chief Highway Engineer said in a radio interview that past severe weather data could no longer be relied on to provide enough margin to satisfy the need for reliable infrastructure and that the re-engineering of the sections of the Coquihalla highway destroyed by the atmospheric rivers would have to be guided by the level of destruction forecast by scientific studies of the effects of rising GHG concentrations.

Anxiety is a common human experience. Our survival as individuals and as a species depends on being able to feel anxiety. Anxiety is our personal, and collective, early warning detection system that bids us do something about a possible danger that has appeared on the horizon. The danger is not imminent, but the threat is that it could become imminent if some action is not taken.

Only scientific investigation can truly resolve whether the anxiety is about a real threat or not. The IPCC community of scientists have concluded that climate change is a real threat and that it is imminent. Now is the time to act quickly and decisively on that certainty.

Policy

Topic	Feedback
Are the assumptions indicated reasonable and comprehensive in terms of scale and timing?	In the choice between DER and fossil fuel generation, fossil fuel generation has an unfair advantage because of the severe, outdated, constraints on the deployment of DER.

Topic	Feedback
Are there other considerations for the IESO?	Follow the example of SA Powers Networks to increase DER penetration in the distribution grid while at the same time maintaining grid reliability and stability.

Demand

Topic	Feedback
Are the assumptions indicated reasonable and comprehensive in terms of scale and timing?	The possibility exists that insufficient progress on reducing emissions and increasingly more severe weather events could trigger a call for a faster pace of emission reduction and thus a faster introduction of EVs and heat pumps in this decade and the requirement that they be fueled by renewable energy.

Topic	Feedback
Are there other considerations for the IESO?	Locating generation at the location of consumption makes sense for a host of reasons.

Resources

Topic	Feedback
Are the assumptions indicated reasonable and comprehensive in terms of scale and timing?	The goal should be replacing gas-fueled generation with DER as quickly as possible.

Topic	Feedback
Are there additional data sources that we should consider	I have attached three documents and provided many webpage addresses.

Topic	Feedback
Are there other considerations for the IESO?	Educate your customers and assist them in every conceivable way to help them make the transition to renewable energy. They will thank you for that.

General Comments/Feedback

All of my comments and feedback are in the text at the beginning of this document.