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Natural Gas Phase-Out Impact Assessment

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Introduction

The IESO: Who we are and what we do

- Reliably operates Ontario's province-wide electricity system 24/7
- Plans for Ontario's future energy needs
- Supports innovation and enabling emerging resources
- Delivers Save on Energy conservation programs
- Works closely with communities and other stakeholders to explore sustainable options

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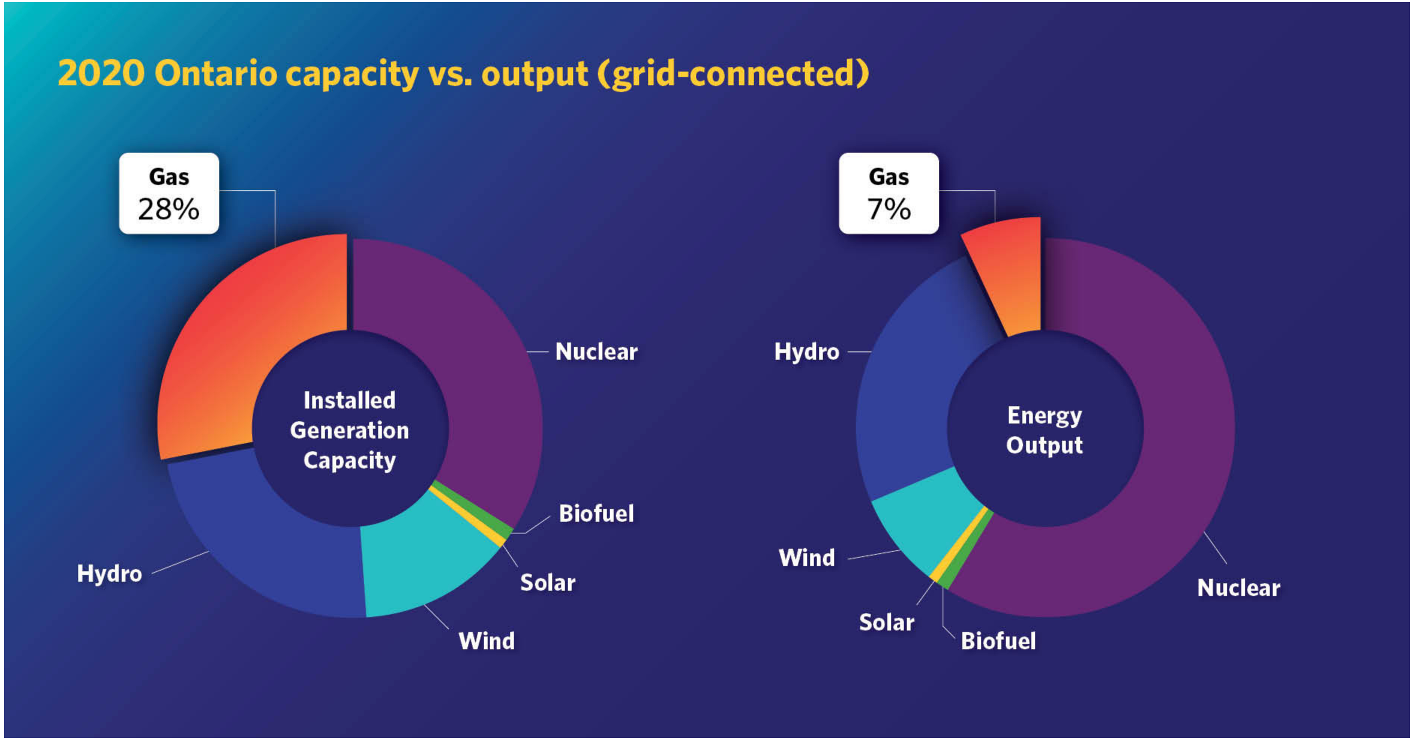
Natural Gas Generation – Available and Responsive Supply



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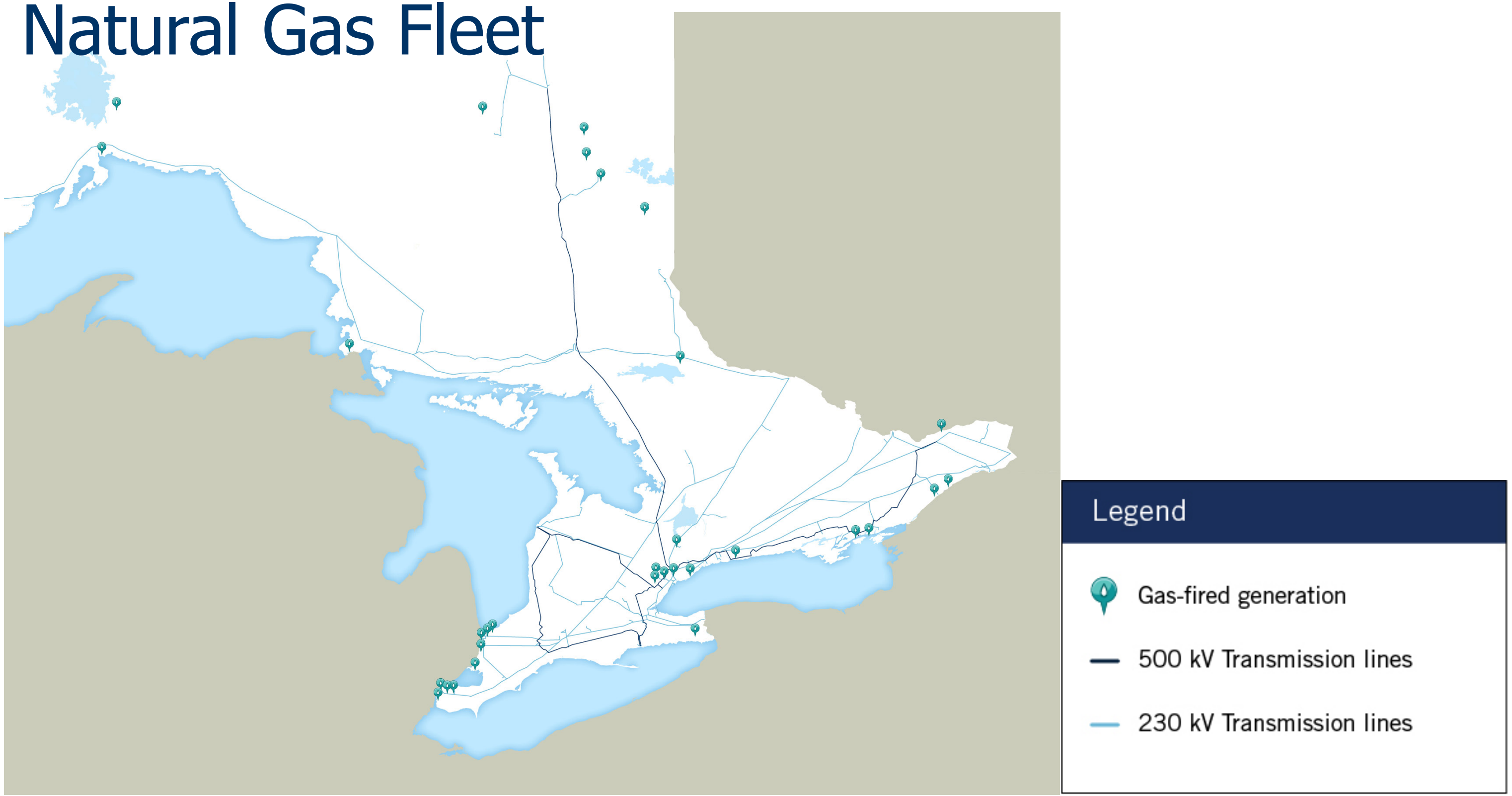
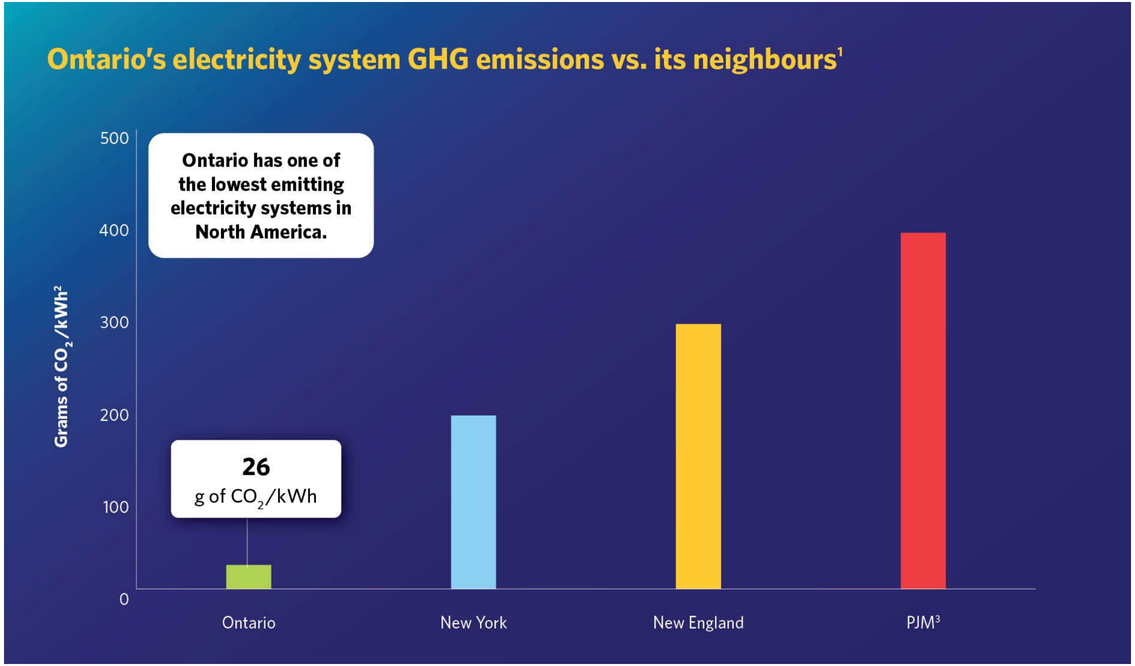
Ontario’s Natural Gas Fleet



Map of generation facilities >20 MW.

Ontario electricity system emissions low vs. neighbours



[1] This graph shows the amount of Co_2 emitted per kWh of electricity produced. This value is often referred to as the Carbon Intensity (CI)
[2] Based on 2019 data all regions.
[3] PJM is a regional electricity transmission organization serving parts of the American Midwest and East Coast.

Lessons learned from Ontario's coal phase out

- The effort represents the largest GHG reduction initiative in North America - sector emissions reduced from 21 to three per cent of total provincial emissions.
- Gas generation was available and provided a mature technology with similar but slightly less flexible operating characteristics.
- Planned for four years, it took 12 years to complete.
- It meant adding new nuclear, gas, wind and solar generation for supply, transmission expansion, and the launch of an ambitious energy-efficiency program.
- Reliability was assured throughout, but added $4 billion in system costs.

The Scenario

The Question: Can Ontario Phase Out Gas Generation by 2030?

- More than 30 Ontario city councils and organizations have called to phase out Ontario's gas-fired generation fleet by 2030.
- As the power system operator and planner, the IESO is uniquely positioned to inform this discussion, focusing on electricity system reliability and affordability.

Study Overview

- The study aimed to find a rough range of costs and identify implementation challenges for meeting 2030. It used a model resource mix of reasonable, least-cost, available and commercially feasible technologies to replace gas generation.
- The resource mix portfolio meets some basic power system requirements (capacity and energy), but makes optimistic assumptions to achieve the 2030 timeline
- The resource mix was not intended to be the definitive solution, but allows the assessment of reliability and cost impacts of eliminating gas generation in Ontario by 2030

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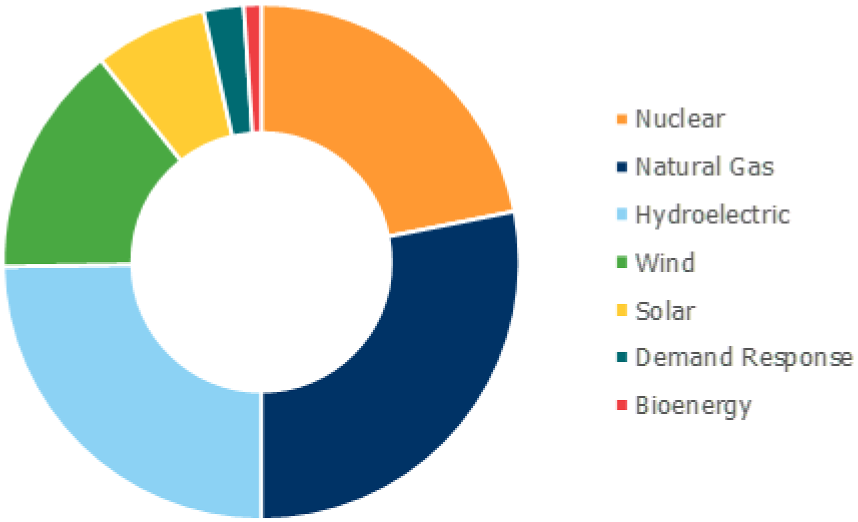
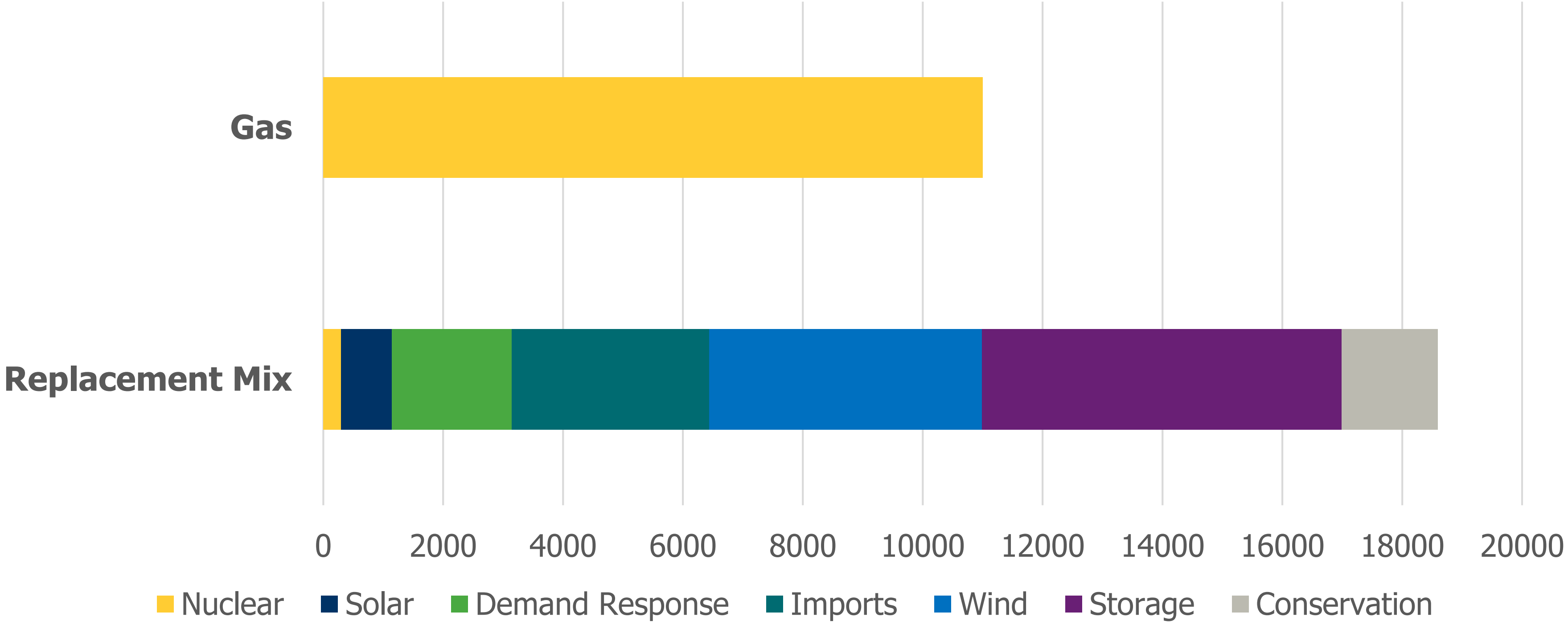
Base Case – 2020 Annual Planning Outlook, Scenario 1

- 2030 Forecast
  - Total Net Demand: 159 TWh
  - Summer Peak: 25.5 GW
  - Winter Peak: 24.6 GW
  - Installed Capacity: 38 GW
- Reflects continued availability of existing resources following contract expiry, as applicable.



Model Supply Mix: No Like-for-Like Replacement



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Key Findings

- A complete phase-out of gas generation by 2030 would lead to blackouts, as electricity would not always be available where and when needed.
- The IESO's modelling of how to replace gas by 2030 would require more than $27 billion to install new sources of supply and upgrade transmission infrastructure.
- There are significant practical reasons why it would not be possible to build substantial amounts of new supply and reorient the system by 2030.
- While the study highlights the complexity of change within the electricity system, it also reveals the broader possibilities.

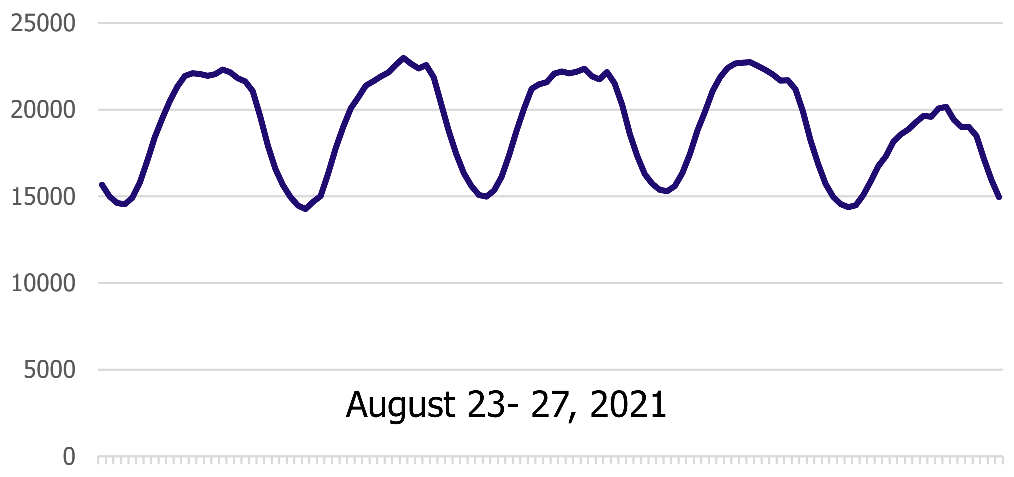
Assumptions

A number of assumptions were required in order to create a supply mix that did not include gas generation:

- Storage and demand response would function in quantities much higher than current experience suggests would be possible.
- Quebec could supply energy all year, though today it requires winter imports.
- Integrating large amounts of supply wouldn’t result in operability challenges.
- Major transmission projects could be planned and built simultaneously and more quickly than in the past.

Still, the Supply Mix Fell Short at Peak

- During successive days of high demand, there would be insufficient supply at peak.
- Generation would reach maximum output, imports would be maxed out and storage would no longer have enough charge left after days of supplying the system.



- Shortages would be managed through rotating voltage reductions, conservation appeals and rotating blackouts, affecting most areas of the province.

Transmission Challenges

- Phasing out gas has significant implications for transmission – given the highly integrated nature of the system.
- Major transmission upgrades and expansions would be needed to bring supply from Quebec to population centres.
- Upgrades might also be needed to support centres like the GTA if replacement supply can't be located there.

Costs

- The capital investment required for the replacement resource mix is at least $27 billion – an annual electricity service increase of $5.7 billion, due to:
  - Building new generation
  - Upgrades/expansion of transmission lines
  - Additional ongoing operating costs
- Unknown costs include additional transmission, compensation to asset owners if generators are retired before end of contract, and stranded investments in a number of relatively new facilities
- High electricity costs would deter consumers from investing in carbon reduction

Decarbonization and the future of Ontario’s grid

Decarbonization – What's Next?

- Ontario's electricity system can support decarbonization within the sector – and in the broader economy. The IESO will further evaluate what's needed to support this effort while maintaining reliability.
- The Annual Planning Outlook (APO) will incorporate new demand forecasts to reflect the latest developments in electrification.
- APO will provide a deeper dive into the potential for electrification to increase demand forecasts, taking into account the many variables that influence its growth.

Decarbonization – What's Next?

This study relied heavily on increasing amounts of storage, demand response, energy efficiency. Given more time, the following options would be available to further reduce emissions from the system:

- Building new hydro and nuclear generation would be feasible
- Siting of new wind/solar facilities would be more likely
- Emerging technologies would mature
- A staged retirement of gas facilities would enable a managed transition

The Ongoing Shift To A Cleaner Grid

While currently dependent on gas generation for reliability, Ontario's electricity system is evolving, shifting toward more flexible, non-carbon and localized supply sources.

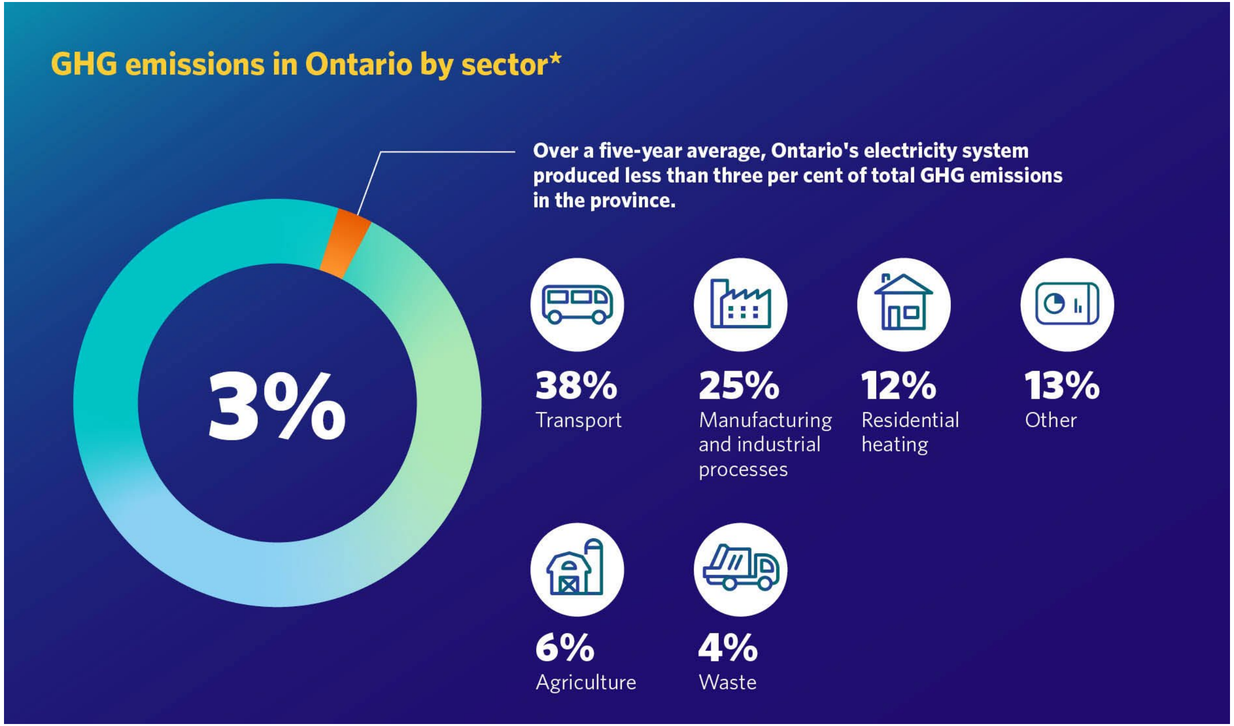
- Demand response competing with traditional generation through capacity auctions
- Enabling participation of new resources through the Hybrid Integration Project and Distributed Energy Resources (DER) Roadmap
- New forms of storage, like batteries, are being tested on the bulk system

The Ongoing Shift To A Cleaner Grid (2)

While currently dependent on gas generation for reliability, Ontario's electricity system is evolving, shifting toward more flexible, non-carbon and localized supply sources.

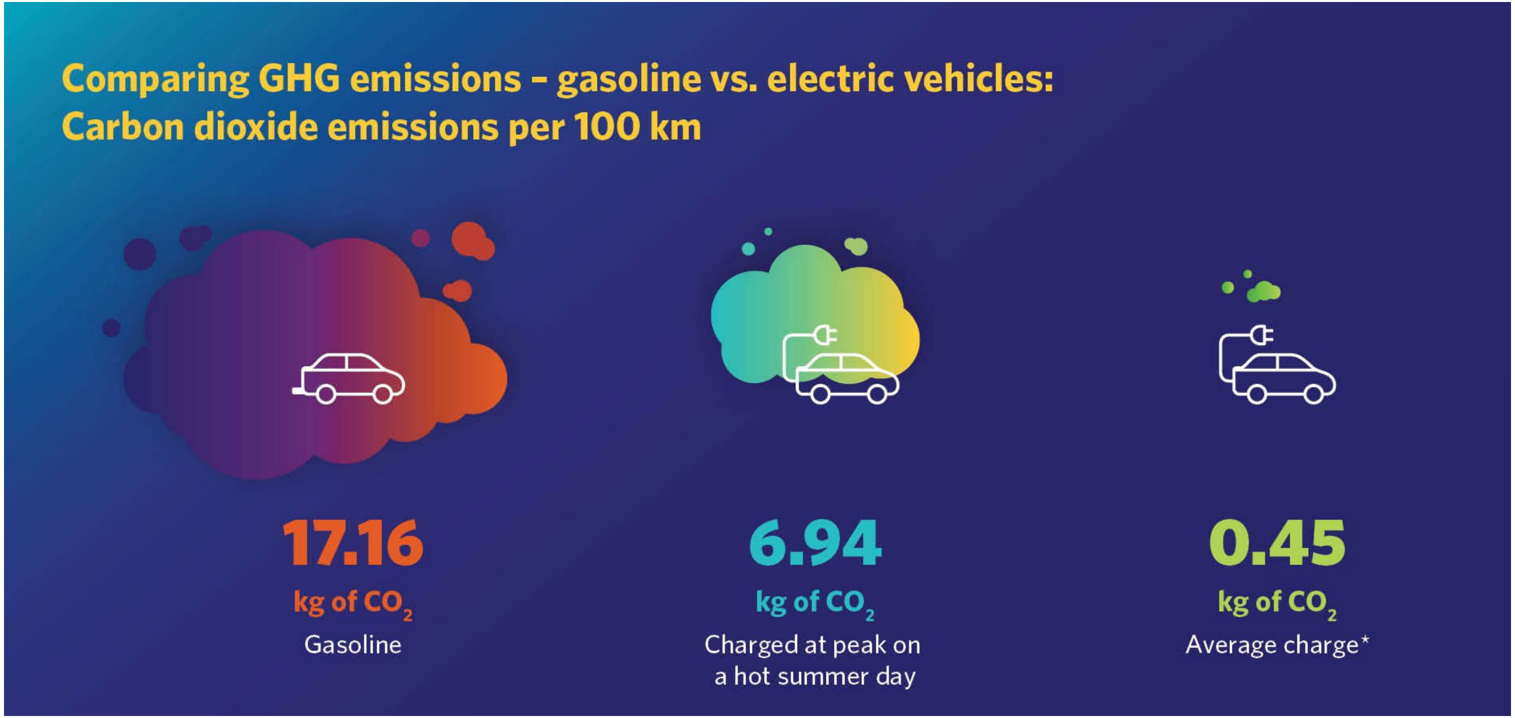
- Pilot projects are demonstrating how local power projects contribute to overall reliability
- Save on Energy programs are evolving to support overall system and regional needs
- Technologies such as hydrogen and renewable gas represent future possibilities

A grid well-positioned to support electrification



* Percentages have been rounded and as a result will not add to 100.

Supporting decarbonization of other sectors



* For 2019

The Work Ahead

The Work Ahead

In response to the IESO study, the Minister of Energy's letter has requested additional work:

1. Evaluate a moratorium on the procurement of new natural gas generating stations in Ontario.
2. Develop an achievable pathway to phase-out natural gas generation and achieve zero emissions in the electricity system.

The Work Ahead (2)

With respect to the pathway, the IESO's work should consider:

- First and foremost, the reliability of the electricity system
- Cost to electricity ratepayers
- Timeline on which this is achievable
- Effect on electrification of the broader Ontario economy (i.e. industry, transportation, etc.) and reaching the province's overall climate goals

The Work Ahead (3)

With respect to the pathway, the IESO's work should consider:

- The possibility of maintaining the generating facilities but replacing natural gas with green fuels
- The role of technologies like pumped storage, battery storage combined with non-emitting resources, hydro, nuclear, and demand response to eliminate emissions in the electricity system

Stakeholder Feedback – Key Themes

Key Feedback Themes

- Prior to commencing the work on the Gas Phase-Out Impact Assessment, the IESO hosted a webinar on June 24 to seek stakeholder input to help inform the work ahead
- Detailed responses to stakeholder feedback has been published in a response document posted on the Gas Phase-Out engagement webpage

Key Themes

The following twelve (12) themes summarize the feedback received:

1. Recommended scenario changes and additions
2. Distributed energy resources (DERs), various technologies or other options that can play a role in replacing natural gas (NG) facilities
3. Increase imports from Hydro-Québec
4. Upgrades to grid infrastructure and potential local solutions
5. Federal government carbon emission targets and pricing
6. Refurbishing Pickering nuclear generation units

Key Themes, continued

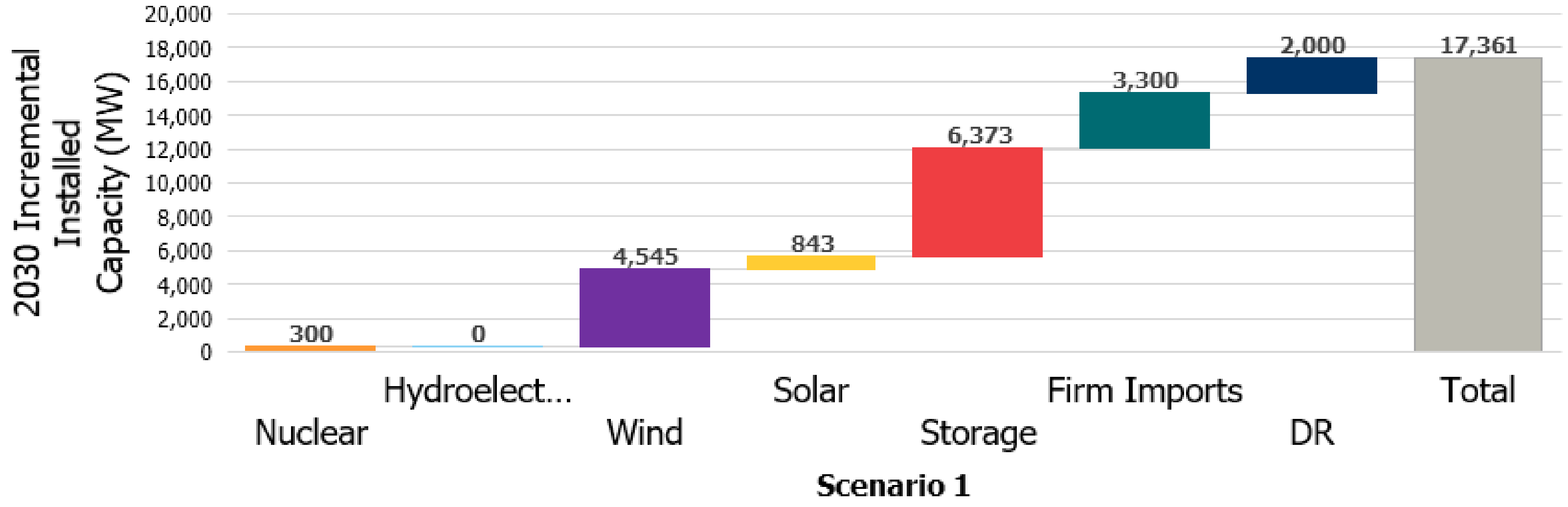
7. Alternative approaches to reducing emissions from NG generation
8. Cost of terminating NG generator contracts
9. Consideration of impacts to wholesale market design and benefits accruing to ratepayers from the Market Renewal Project
10. Appropriate authority to make a decision to phase-out NG
11. Consideration to include social costs, environmental costs or other costs in the assessment as well as benefits
12. Advocating support for/against phase-out of NG generation

Response to Feedback

- Stakeholder feedback was very helpful in producing a final report
- Responses to specific feedback are available in a few different ways:
  - Most verbal and written questions were answered during the live session itself (note: a recording is available here)
  - Responses to written feedback after the webinar are available in the IESO response to feedback document
  - Answers to other comments or questions can be found in the assessment itself

Appendix – High level assumptions

Replacement Scenario - Resource Mix



- Scenario 1 examines a portfolio of replacement resources assuming all existing gas is phased out by 2030.
- The incremental supply above the Base Case required to completely replace natural gas generation by 2030 is about 17,000 MW. Large nuclear and hydro are not feasible in this timeframe.
- In addition, energy efficiency of 1,600 MW peak savings was included as part of the lowest-cost resource mix.

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Resource Characteristics and Costs

Resource	Levelized Unit Energy Cost ($2021/MWh)	Capacity Cost ($2021/kW-year)	Capacity Factor	Notes
Wind	54		39%	Cost projection based on average of industry capital cost projections.[1]
Solar	52		17%	
Energy Storage	NA	135	11.4%	
Hydro-electric	Cost Curve		50%	Cost curve from Hatch Acres hydro potential study adjusted to reflect recent hydroelectric project costs.
SMRs	120		85%	A 300 MW SMR was included as a base assumption, with a cost of $3B
HQ Firm Imports	Average import price from energy modelling runs	135	Variable	
Energy Efficiency	Four achievable potential scenarios from the 2019 APS			
DR	NA	67	NA	Cost based on recent capacity auctions.

[1] Projection Sources: Energy Information Administration (EIA), National Renewable Energy Laboratory (NREL), International Energy Agency (IEA), Lazard, & Center for Advancement through Technological Integration (CEATI)

Resource Mix Modelling Details

- The resource mix from the capacity expansion model was fed into IESO's energy simulator to assess the utility of the resources selected, and if requisite high-level flexibility could be achieved
  - Essentially hour-to-hour ramp and load following, keeping in mind that real-time dispatch is at five-minute intervals
  - Concerns about the frequency of activation of demand response and storage were identified, especially under extreme conditions
- Although firm import considerations were limited to jurisdictions with clean resource mixes (Quebec and Manitoba), economic imports were permitted from all jurisdictions

Areas of Assessment

Area of Assessment	Analysis
Reliability and Operability*	• Diversity of resources for energy and capacity • Locational requirements for siting resources, or transmission required to offer alternatives • Basic capacity, energy, operating reserve and flexibility (ramping/load following) adequacy assessments
Costs and the Wholesale Market	• Least cost replacement resource portfolio, using costs for known conservation potential, supply technologies and transmission • Impact on wholesale market design, pricing and value of system needs
Implementation Timing	• Plan development • Typical lead-times associated with conservation program development, and construction of generation and transmission

*Model portfolios were developed at an aggregate level, to determine the rough cost implications. Detailed locational information would need to be developed before a detailed operability assessment could be completed.

Assumptions and Limitations (1/3)

Category	Assumption	Comment
Storage	Large-scale energy storage can be completely operationalized. Storage is simplistically modelled to provide capacity, Operating Reserve and flexibility (ramping/load following).	IESO has limited experience with candidate storage technologies, pumped hydro aside. Modelling limitations raise questions as to whether storage can provide the full suite of these services, especially during periods of consistently high demand, weather-limited fuel supply or contingency events.
Market Interface	IESO will have increased visibility and dispatchability of incremental resources on distribution systems.	IESO systems to be upgraded to allow for continuous monitoring, dispatch, and contingency analysis.

Assumptions and Limitations (2/3)

Category	Assumption	Comment
Operability	Resource siting does not result in operability challenges – local or global – and all requirements for load following, voltage support, frequency response, etc. can be met.	To fully assess potential operability challenges, detailed information on size, location, and operating characteristics of the replacement fleet would be required.
Land-Use	The study assumes that resources are sited where needed, even with the large volume of renewables contemplated in the resource portfolio.	A near doubling of the transmission-connected wind and solar fleet may require off-shore wind, currently paused by an Ontario moratorium.
Transmission Planning	The resource portfolio is assumed to leverage the existing transmission system, to the extent possible, but upgrades are needed to enable resources in the North, increase imports from Québec, and add to GTA supply.	A proper Transmission Planning exercise is required, and would take 12 to 18 months.

Assumptions and Limitations (3/3)

Category	Assumption	Comment
Policy	Enabling policies are in place to support increased energy efficiency and the fast-tracking of permitting and construction to enable siting of resources in key electrical areas.	Any change in policy, for or against the replacement of natural gas-fired generation, will take time, and may shift with government policy.

- The carbon pricing assumptions used are $50/tonne starting in 2022 (held constant thereafter) and a benchmark emissions rate of 370 tonnes CO_2/GWh allowance for existing natural gas generation, consistent with the 2020 APO base case.