# Ontario's Long-Term Energy Plan

Understanding Carbon Emissions, the Role of Nuclear, and Electricity Trade with Quebec

Perspectives drawn from work by

STRATEGIC POLICY ECONOMICS

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## Understanding Carbon Emissions, the Role of Nuclear, and Electricity Trade with Quebec

In the fourth quarter of 2016, Ontario's Ministry of Energy reviewed its Long-Term Energy Plan through a transparent public consultation process. The Ministry is expected to release its updated LTEP early in 2017.

Some of the focus areas of the LTEP review are the province's Climate Change Action Plan (CCAP) objectives, lowering the cost of electricity for homeowners and businesses, meeting short- and long-term emission targets, and preparing for Ontario's future by securing carbon-free energy sources, including baseload nuclear, as well as renewables. The future electrification of the transportation sector will also be considered in the LTEP, because it is important the energy used to charge electric vehicles comes from non-carbon emitting sources, such as nuclear and renewables.

These lofty goals cannot be met without the continued support of the current vision for nuclear power in Ontario, which will see the life of the Bruce Power site extended through 2064, the refurbishment of Ontario Power Generation's Darlington nuclear station, and the safe operation of OPG's Pickering plant through 2024. These are the necessary and most affordable first steps in a shift towards an electricity system that will be increasingly dependent on nuclear generation and increased nuclear capacity as a source of safe, reliable and affordable power for decades to come.

Any move away from nuclear will make it more difficult for the province to reach its emission targets, as outlined in the CCAP, because renewables require carbon-intensive backups due to their unreliability, while nuclear generates vast amounts of power 24 hours a day, 365 days a year and supports tens of thousands of high skilled Ontario jobs. Also, an electricity system, with a baseload of low-cost nuclear energy, can save Ontario an estimated $6.9 billion per year off the cost of achieving the emission targets. Low-cost electricity can also save up to $1 billion annually in externally purchased allowances, accelerating the benefit of the invested proceeds to achieve emission reductions.

The LTEP must identify the lowest-cost electricity solution for Ontario, while ensuring the integrated costs of generation, transmission and distribution are reflected in its decision.

While interprovincial imports and exports will play a role in Ontario's electricity system, it's important to realize Quebec does not have a surplus for export during its frigid winters, and will have little energy to outsource, post-2025. Though the provinces work together, it's important Ontario continue to develop its home-grown solution, which centres around nuclear as the provider of its safe, reliable and low-cost baseload power.

The firm Strategic Policy Economics ('Strapolec Inc') performed two in-depth studies (*'Renewables and Ontario/Quebec Transmission System Interties*,' June 2016, and '*Ontario's Emissions and the Ontario Long-Term Energy Plan*,' December 2016), which examined future electricity demand in Ontario, as well as the options for meeting this demand in a cost-effective and environmentally prudent manner. The studies conclude the LTEP process should identify nuclear energy as an optimal source of emissions-free power that will enable Ontario's electricity system to adapt to the requirements of a reduced carbon economy.

The ongoing Life-Extension Program at Bruce Power and refurbishments at Darlington are necessary to Ontario maintaining its reliable and low-cost baseload supply of electricity, while also helping to achieve Climate Change Action Plan targets. Nuclear, which annually provides 60 per cent of Ontario's electricity, is all of these – it's carbon-free, reliable and safe electricity, which costs consumers 30 per cent less than the average residential price of power.

## And it's of utmost importance to Ontario's energy future.

# Background

Ontario continues to move forward with its climate change strategy, Cap and Trade Program, and Climate Change Action Plan (CCAP). The province has legislated its emissions drop to 37 per cent below 1990 levels by 2030, a 65 Megatonne (Mt) reduction. Two studies by Stapolec Inc. have carefully examined what programs and initiatives are required to help Ontario meet its climate change mitigation goals, and have been submitted to the Ministry of Energy during the Long-Term Energy Plan (LTEP) process.

The first study, 'Ontario's Emissions and the Ontario Long-Term Energy Plan (LTEP),' provides the LTEP consultation with background analyses that relate to emission reduction targets, the costs of emission reducing technologies, the carbon price within Ontario's Cap and Trade (C&T) Program, and the supply mix choices being developed for the next LTEP. This study consists of a two-volume report:

- **Phase 1** – 'Understanding the Challenge' quantifies the considerations of the emissions-reduction challenge that the LTEP process should consider.
- **Phase 2** - 'Meeting the Challenge' examines the cost and economic implications of supply mix choice alternatives.

The second study, '*Renewables and Ontario/Quebec Transmission System Interties*' examines the implications of expanding the electricity sharing agreement between Ontario and Quebec.

Some of the findings within the study are:

- Both provinces plan on supporting their respective peak supply needs with fossil-fired generation. Ontario can only supply Quebec's emerging winter import needs with natural gas, which will result in higher greenhouse gas (GHG) emissions in Ontario
- The provinces will have less surplus electricity to send each other as their respective systems move to electrification. Post-2025, Quebec cannot be counted on for excess power, as it is expected to have little surplus to share.
- The current transmission lines between the provinces are already being underused, so it is not necessary to invest in new infrastructure.


# Over 90 Terrawatt/hours (TWh) of new electricity demand is needed for emissions reduction

The Ministry of Environment and Climate Change (MOECC) issued Ontario's Climate Change Strategy in the fall of 2015, prior to the COP21 meeting in Paris, France. Ontario's climate strategy included a new 2030 target to achieve emission reductions of 37 per cent below 1990 levels which was then legislated in the spring of 2016 by the passing of Bill 172, the Climate Change Mitigation and Low Carbon Economy Act.

The largest sources of emissions in Ontario are transportation, building heating and industry. This study focuses on the Greenhouse Gas (GHGs) emission-reduction opportunities in these sectors. The primary sources of GHGs in Ontario are natural gas, primarily for building heating and industry, and petroleum used primarily in transportation.

The analysis undertaken by Strapolec Inc. shows that Ontario's ability to meet its emission-reduction targets by 2030 will require more new, non-emitting electricity generation than is assumed in the Independent Electricity System Operator's (IESO) Ontario Planning Outlook (OPO). If Ontario is to meet its 2030 emission targets, 90 Terrawatt-hours (TWh) of new, low-carbon capacity is required by 2030.

By 2030, only 30 to 40 per cent of the energy supply required to achieve the 2030 emission reductions will be available. This suggests that Ontario could miss its 2030 targets by 60 per cent unless Ontario makes earlier commitments to non-emitting generation sources such as new nuclear builds.

The ability to achieve Ontario's emission targets and the cost of doing so will be driven by the feasible pace at which new electricity generating capacity is developed to meet this demand. Achieving the needed supply in time is particularly important given the anticipated retirement of the Pickering Nuclear Generating Station in 2024.

As carbon pricing is implemented, clean nuclear power becomes even more important to the people of Ontario, because it provides 60 per cent of Ontario's energy with no carbon penalties.

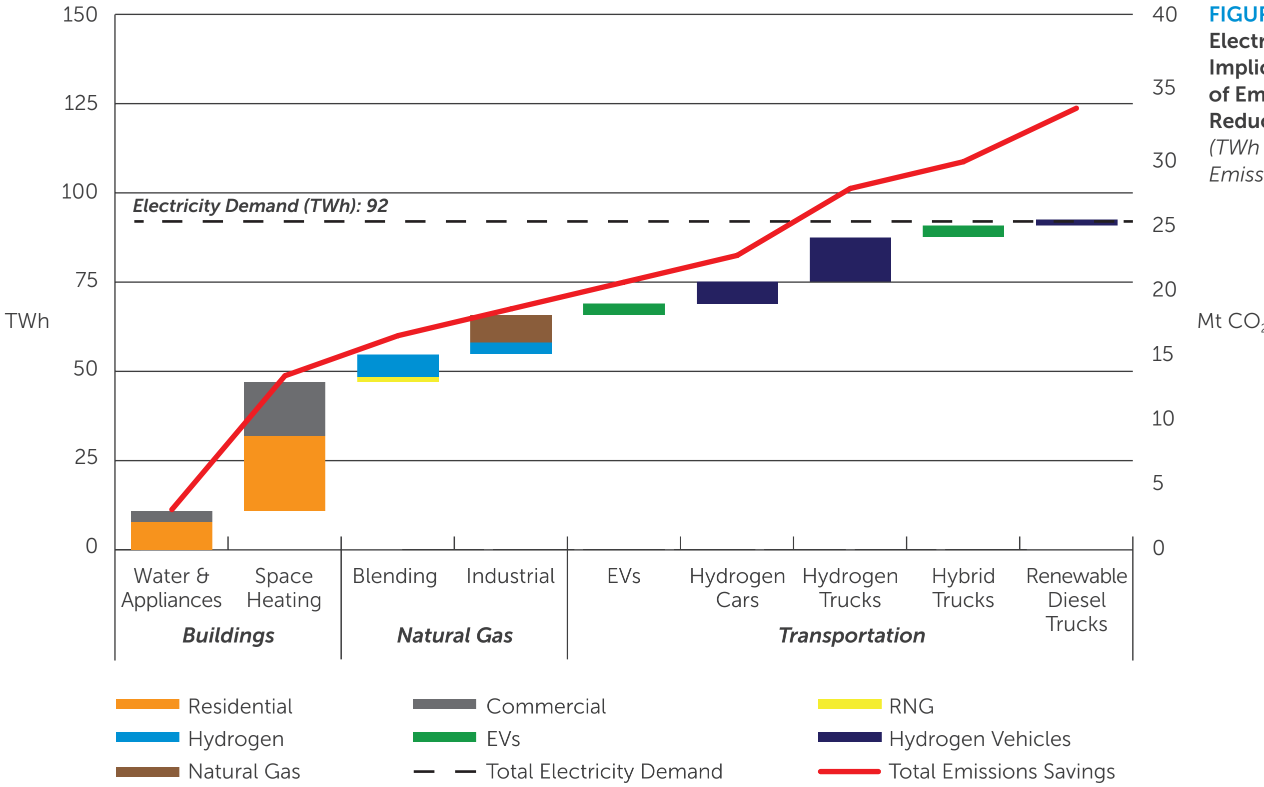



**FIGURE 1**
**Electrification Implications of Emissions Reductions 2030**
*(TWh vs. Mt $CO_2$ Emissions)*

*Meeting emission reduction targets in 2030 requires needed electricity much sooner than provided for in the IESO Outlooks. If Ontario is to meet its 2030 emission targets, 90 TWh of new low carbon capacity is required by 2030. The 90 TWh is incremental to the BAU IESO Outlook B forecast. The Figure below illustrates the demand forecast from this analysis compared to the IESO Outlooks B and D. Achieving 2030 emission targets by 2030 may not be practical.*

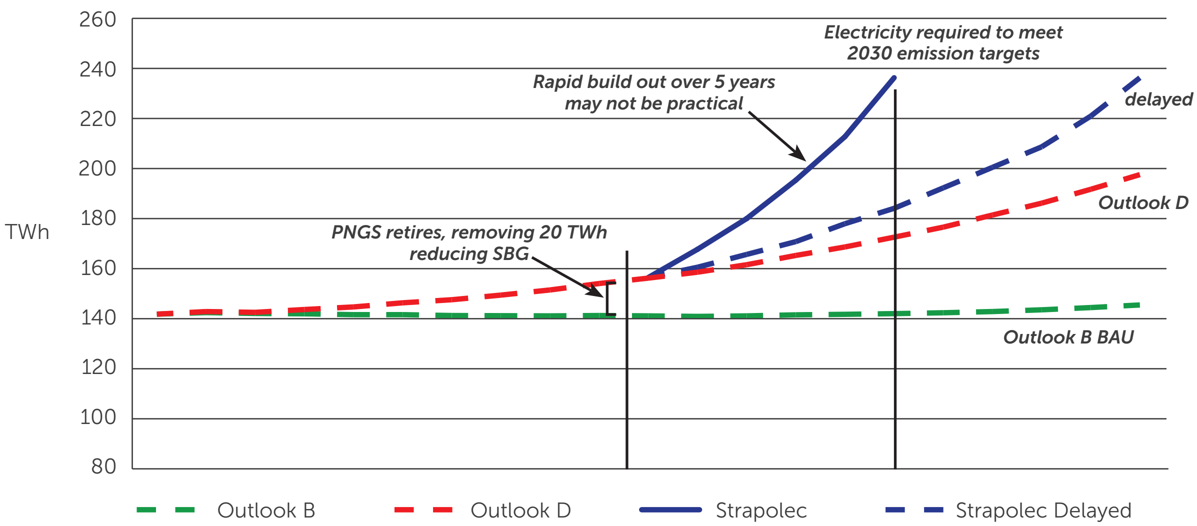



**FIGURE 2**
**Comparison of Annual Electricity Demand Across Outlooks**
*(TWh/year)*

*The LTEP process should consider making low cost low, carbon electricity generation rapidly available. If this is achieved by mid to late 2020s, PNGS retirement could be made to dovetail providing continuity of low carbon supply.*

# Not all new electricity demand is the same

The Strapolec analysis shows there is a need to generate more clean electricity on an earlier timeline to support Ontario's 2030 emission target. This requires consideration of the type of energy sources that will be needed, while also addressing the heating requirements that are central to achieving emission reductions in the building sector. Ontario's current policy direction indicates there will be a significant ramp-up in electricity demand to supply home heating needs.

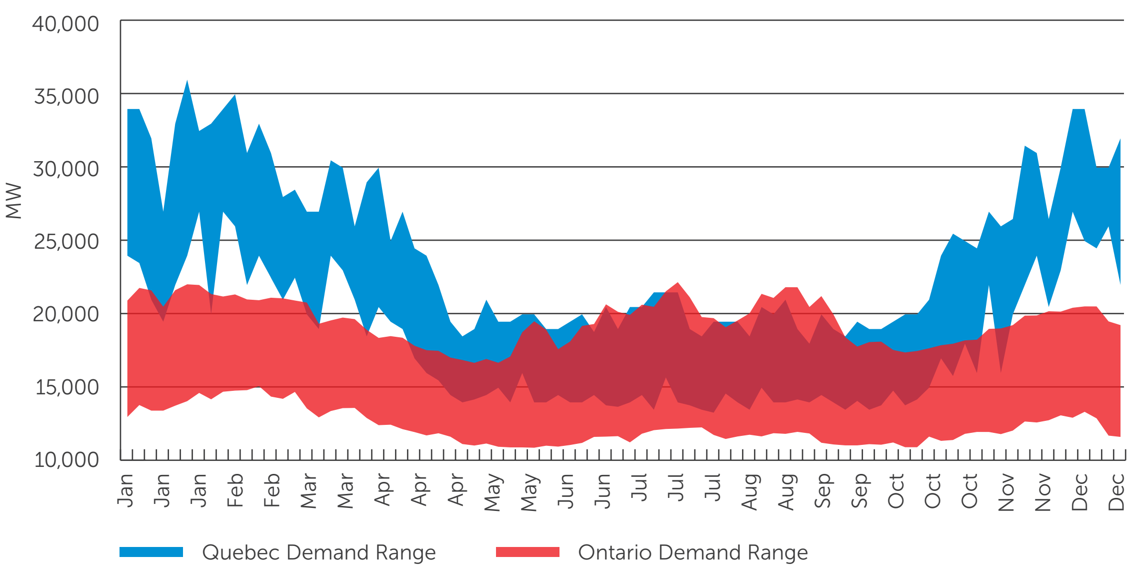
There are three types of new demand that will emerge as emissions are reduced, including:

- Home heating, a seasonal demand that Ontario currently meets with fossil fuels. To reduce GHGs, Ontario will have to use a different method to meet its emissions targets. This is considered the largest challenge to the energy system, particularly the distribution network.
- Electric vehicles and water heating represent daily demand that is driven by consumer behaviour. There is a belief that much of this demand can be accommodated through smart controllers and, consequently, the use of off-peak energy as much as possible.
- The industrial applications and development of an Ontario hydrogen industry, for electricity storage and energy services, could be an important part of Ontario's baseload capacity mix.

When these new demand profiles are overlaid on existing demand, much of the mid-year seasonal and daily demand variability is smoothed. This creates a more stable demand profile, well suited to baseload supply resources.

**FIGURE 3**
**Quebec and Ontario Electricity Demand**
*(Quebec 2014, Ontario Average 2013-2015, MW)*

*Source: IESO, HEC Montreal, Strapolec analysis.*



*Ontario's current policy direction indicates there will be a significant ramp-up of electricity to supply home heating needs. When these new demand profiles are overlaid on existing demand, much of the seasonal variability is smoothed. This may create a more stable demand profile, suited to be supplied by increased baseload resources.*

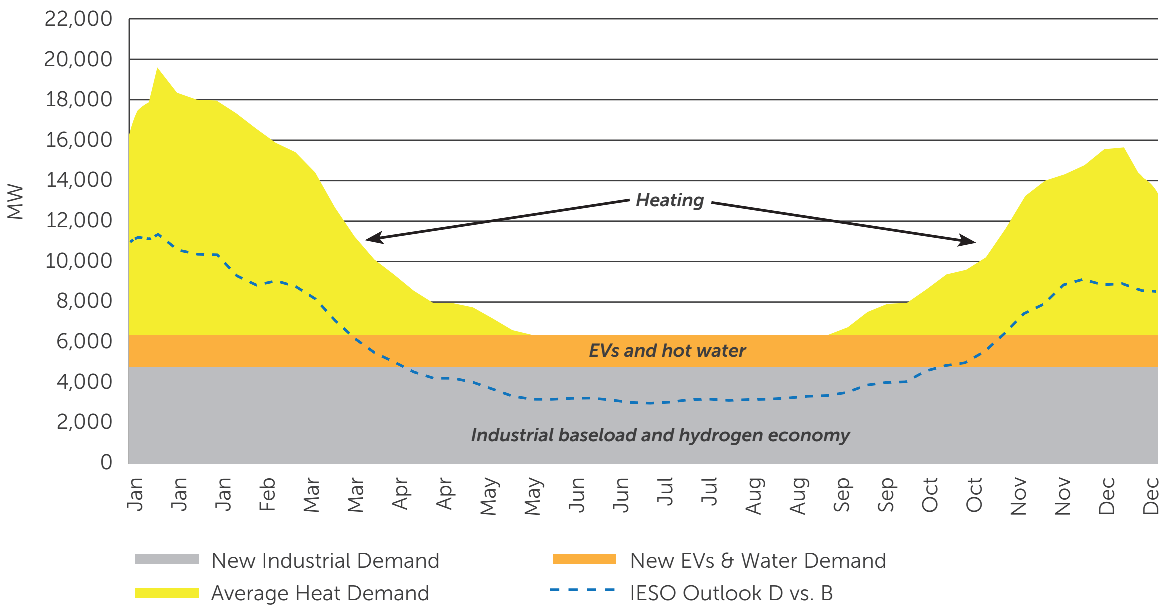



**FIGURE 4**
**Incremental New Ontario Electricity Demand Profile vs OPO D**
*(MW)*

*More electricity, including more heating is anticipated than provided for in the OPO D outlook.*

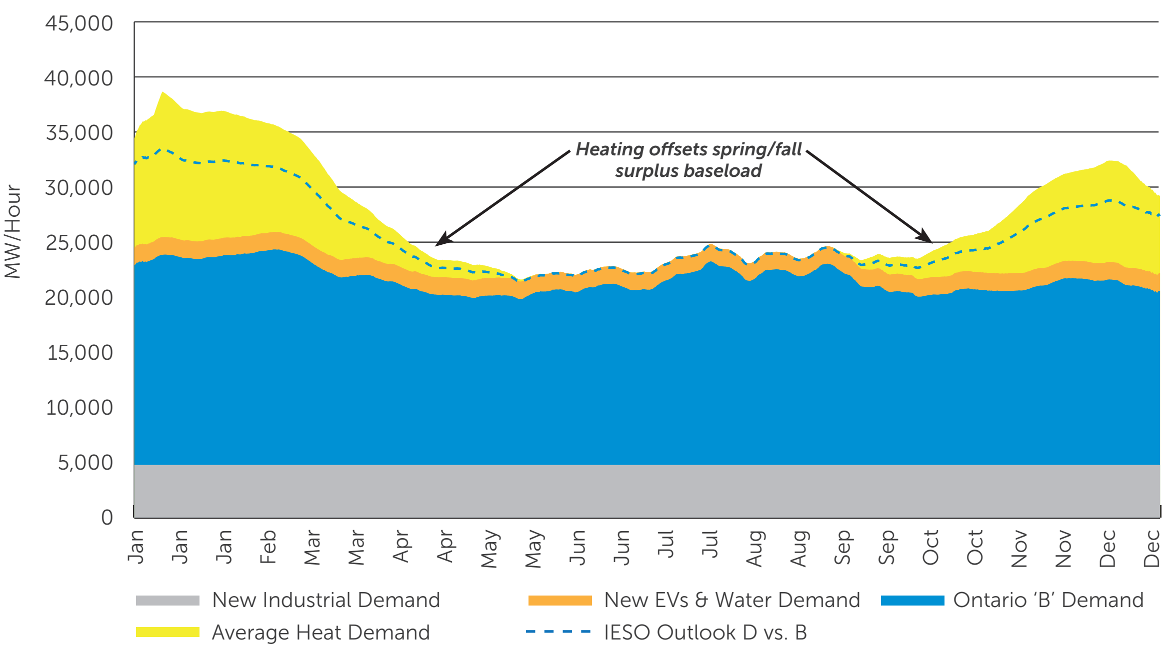



**FIGURE 5**
**Ontario New Demand Growth Profile**
*(MW)*

# New supply options face challenging physical and geographic realities

## ONTARIO/QUEBEC TRANSMISSION SYSTEM CHALLENGES

Historically, Ontario has exported and imported significant amounts of electricity to and from Manitoba, Quebec, Michigan and New York. These arrangements help ensure Ontario has sufficient reliable energy and capacity to meet provincial demand. Most recently, Ontario and Quebec have been engaged in discussions regarding electricity exchanges that would benefit both provinces. The Long-Term Energy Plan review has considered the costs and benefits of electricity imports from Quebec as one of the province's supply choices.

The Quebec/Ontario transmission agreement is sufficient to meet currently forecasted peak reserve capacity needs for the next 10 years. The shortfall in Ontario is not forecasted to exceed 1,000 Megawatts (MW) for at least the next 15 years, and is not expected to exceed 2,000 MW in Quebec by 2025. Nearly half of the peak reserve capacity shortfalls in both provinces are the result of the additional reserve capacity needed due to the intermittent nature of the wind capacity that has been added to the supply mixes in Ontario and Quebec in recent years.

Ontario's energy supply and demand mix, the transmission system, and geographical constraints currently combine to limit the transfer of Ontario's wind energy to the Quebec border to less than 10 per cent. Ninety per cent of Ontario's wind supplies are over 800 km from the Quebec high-voltage direct current transmission corridor east of Ottawa, which is the only line with Quebec that dynamically supports the load variations associated with tracking wind patterns. Currently, the characteristics of Ontario's overall electricity system and low demand for Ontario's surplus in export markets is effectively bottling about 40 per cent of the generated wind energy within transmission network zones, and limiting its delivery east of Toronto.

Forecasts indicate there will be insufficient low-carbon energy sources in both provinces to meet demand beginning in the mid-2020s. Quebec has a near-term surplus created by the recent expansion of several hydro facilities and the addition of wind resources to the province's supply mix. However, Quebec is now forecasting higher industrial demand growth and, after the Pickering Nuclear Generating Station retires in 2024, Quebec will no longer be able to profit from Ontario's surplus. Thus, it is expected the current Quebec surplus will erode within the next 10 years, suggesting Quebec is not a long-term option for Ontario's electricity grid.

Currently, both provinces plan on supporting their respective peak supply needs with fossil-fired generation. Ontario can only supply Quebec's emerging winter import needs with natural gas, which will result in higher GHG emissions in Ontario.

In the future, both provinces will need substantial new low-carbon, baseload generation options such as nuclear. If new generation is developed, strategic transmission enhancements could offer future benefits and help to optimally locate the new generation. These could also enable more reliable energy transfers, while also potentially enhancing combined exports to the U.S., if accompanied by electricity market reform.

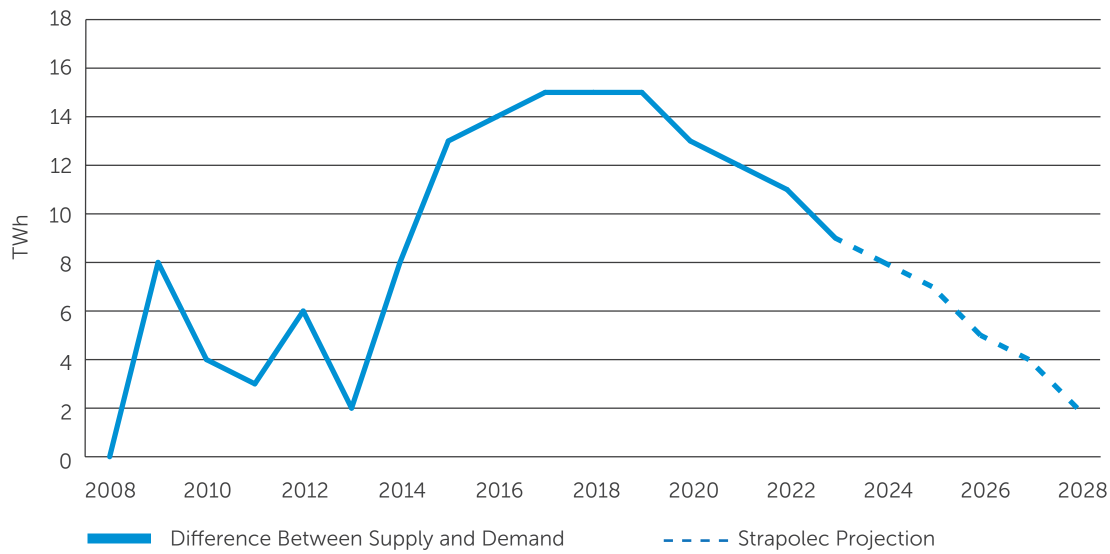



**FIGURE 6**
**Difference Between Quebec Supply and Demand**
*(TWh)*

*Quebec has no winter supply available, and will have little surplus to share post 2025.*

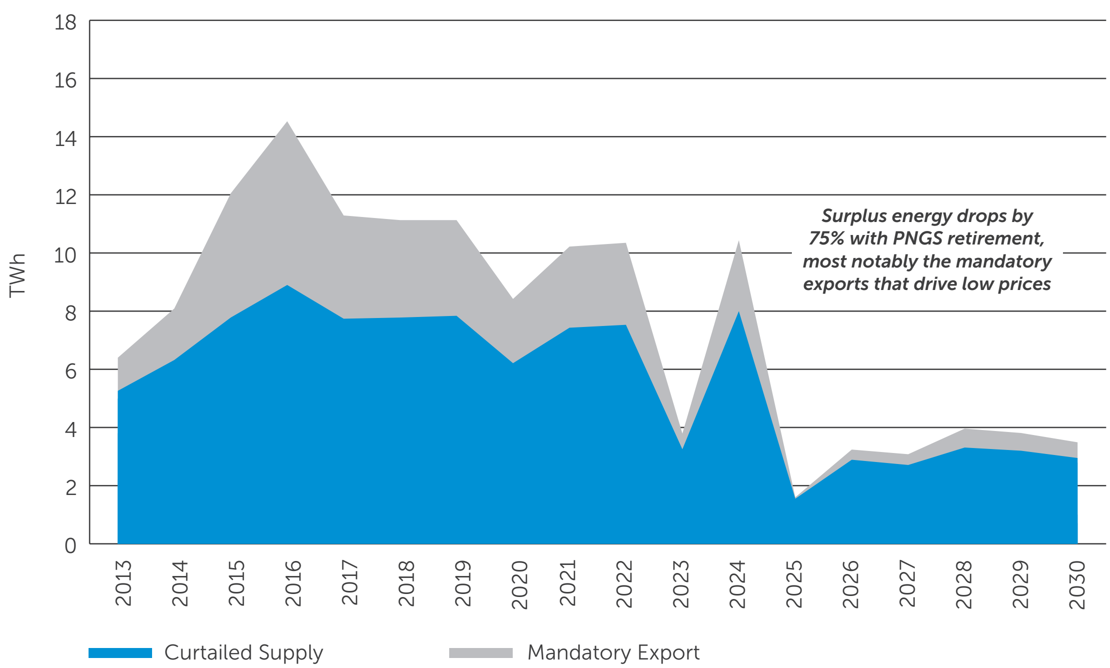



**FIGURE 7**
**Projected Surplus Energy**
*(TWh)*

*Forecast surplus baseload energy will decline significantly from the 15 TWh seen in 2015 to a predicted 4 TWh post 2025. Wind surplus will persist in the 2 to 3 TWh range.*

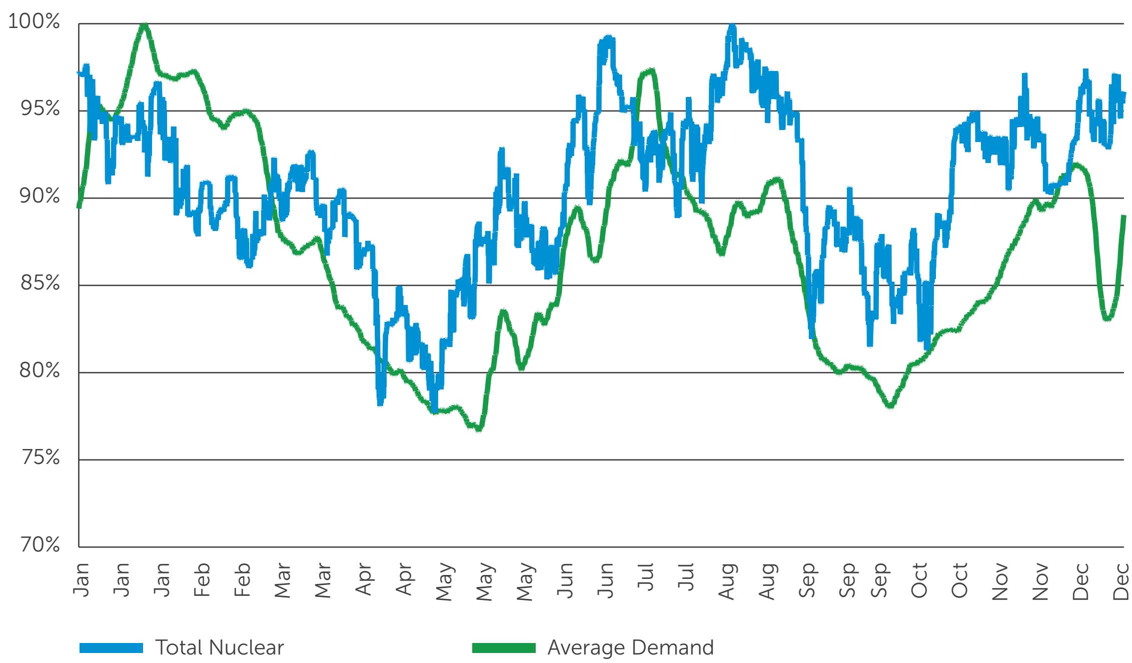
### HYDRO ASSUMPTIONS CHALLENGED

Building new hydroelectric power capacity involves managing inconsistent weather and the availability and flow of water. Ontario's need for winter heating energy is impacted by the freezing of the lakes and rivers in northern Ontario and Quebec, where the remaining hydro potential exists. Meeting the incremental demand and the winter heat load would require the construction of new reservoirs to provide the seasonal storage capability that Quebec is now fully using in its James Bay complex. The Ontario Planning Outlook (OPO), which developed a series of demand forecasts for the Long-Term Energy Plan review process, acknowledges that waterpower development comes with cost and consultation challenges. The OPO also recognizes the remaining waterpower potential in Ontario is in remote northern regions without transmission access, which results in the significant costs. The OPO also explains that costs are expected to be higher than in the past and projects will involve longer lead times, so there are only small opportunities for expanded hydro capacity in the southern part of the province, including redevelopments at existing dams.

### NUCLEAR CAN BE MANAGED TO MATCH SEASONAL DEMAND

By managing planned maintenance outage schedules, Ontario's nuclear output has been aligned with the province's seasonal demand profile. In addition, Bruce Power's eight units provide up to 2,400 MW of flexible supply to help manage surplus conditions, the only nuclear producer in Ontario with this capability.

**FIGURE 8**
**Ontario Demand vs. Nuclear Fleet Generation**
*(Average 2011-2015, % of Max)*




*Nuclear supply can be managed to match seasonal demand.*

# Capacity options differ in cost and emission reduction impact

Ontario's Cap and Trade (C&T) program will collect proceeds from residential and business consumers that have not switched to lower-carbon fuels. An effective use of these revenues may be to employ them as subsidies to influence the purchasing decisions of individual users. The advantage of government carbon programs is they can spread the costs of emission reductions throughout the entire economy, which can accelerate adoption and enable emission reductions at much lower market carbon prices than may otherwise be required.

At the outset, the funds raised on allowable emissions will be quite extensive. Reinvesting C&T proceeds can subsidize higher cost options to make them economic at the market carbon price level set by the program. This use of proceeds to subsidize higher cost emission reducing technologies helps achieve the target.

The cost of new electricity generation can have a large impact on the market carbon price and achievement of the province's emissions target. The Independent Electricity System Operator (IESO) provided an outlook of future electricity costs for four scenarios outlined in the OPO. While the OPO total cost for each scenario suggests similar outcomes, a deeper analysis shows that significant incremental cost differences exist among the options.

Carbon price is dependent on both the cost of electricity and the effectiveness and efficiency of the process implemented for the reinvestment of C&T proceeds. An electricity system, with a baseload of low-cost nuclear energy, can save Ontario an estimated $6.9 billion per year off the cost of achieving the emission targets. Low-cost electricity can also save up to $1 billion annually in externally purchased allowances, accelerating the benefit of the invested proceeds to achieve emission reductions. The IESO has identified nuclear as the lowest-cost option in the OPO.

As carbon pricing is implemented, clean nuclear power becomes even more important to the people of Ontario, because it provides 60 per cent of Ontario's energy with no carbon penalties.

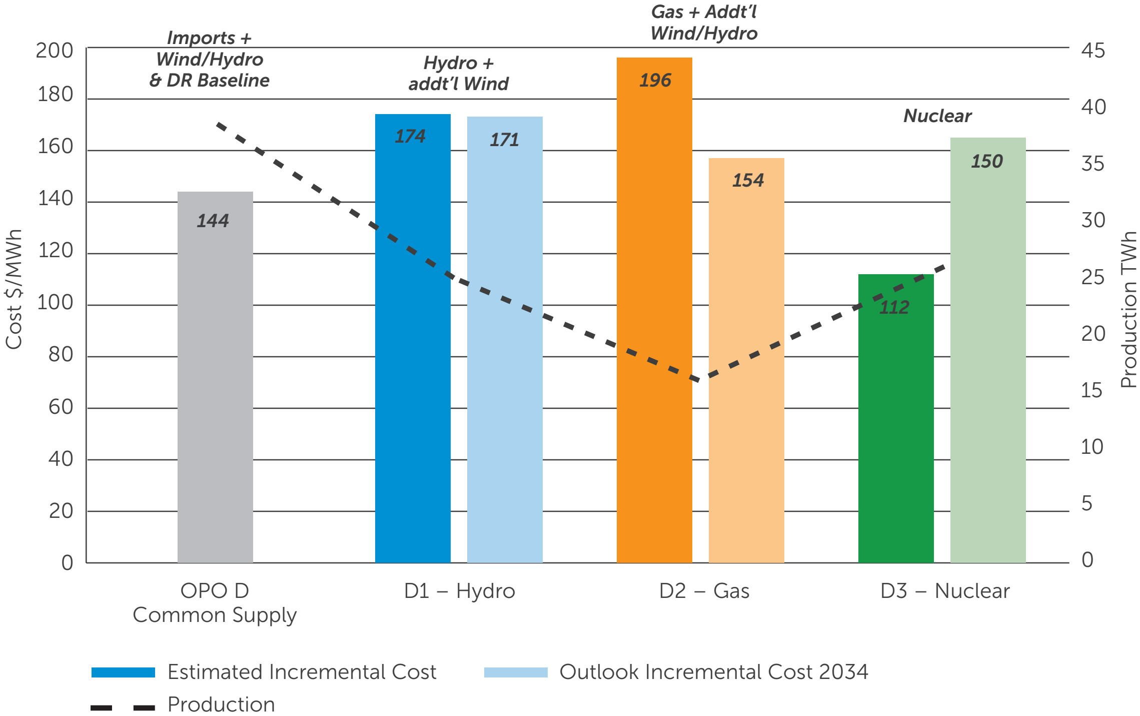



**FIGURE 9**
**IESO Outlook D Incremental Supply Cost**
*($/MWh of Energy Produced)*

*The IESO provided an outlook of expected future costs of electricity for the various scenarios included in the OPO. While all scenarios appear to have similar average cost consequences, a deeper analysis shows that significant incremental cost differences exist.*

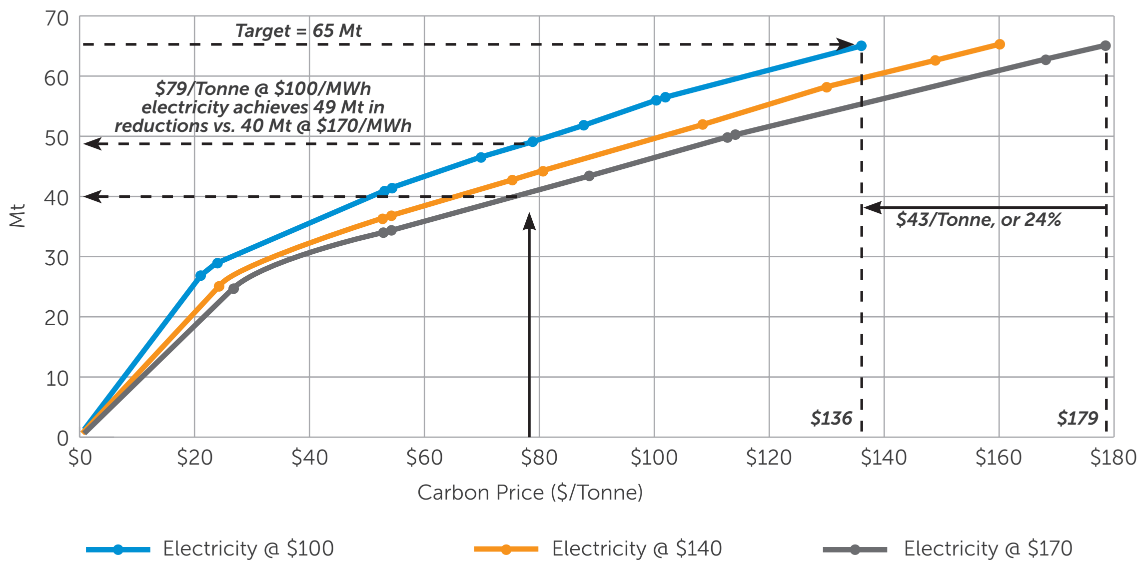



**FIGURE 10**
**Impact of Electricity Cost on Emission Reduction**
*(Mt)*

*Lower cost of electricity, leads to a lower required carbon price to achieve emission reductions. This in turn implies that switching applications will become economical earlier. The sooner these applications are economically switched to low carbon options, the further the use of proceeds can be stretched. It is, therefore, important to achieve lower electricity costs.*

Recognizing the significant role nuclear generation will continue to play in reducing GHG emissions in Ontario, while providing safe, reliable and low-cost power, will be an essential part of the LTEP process. Given that cost and carbon reductions will remain key drivers, the demand for baseload nuclear will continue to increase.

Imports from Quebec and the development of new hydro options are complimentary to, but not a substitute for, a continued commitment to nuclear in Ontario.

Ontario's electricity demand curve will continue to shift and flatten, and baseload generation such as nuclear will play a more prominent role in the supply mix to meet increasing demand. Sustaining Ontario's commitment to Bruce Power's Life-Extension Program and the refurbishment of OPG's Darlington station is a logical and affordable first step in achieving this outcome.

**FIGURE 11**
**Comparing Nuclear with Other Options**

| | NUCLEAR | HYDRO | IMPORTS | WIND |
|---|---|---|---|---|
| **Rapid Decarbonization**<br>*Zero-carbon incremental supply, clean electricity system by 2030* | ↑ | ↓ | ↑ ? | ↓ |
| **Secure domestic energy supply**<br>*Improves trade balance, economic growth, government taxes, energy security* | ↑ | ↑ | ↓ | ↓ |
| **Enable lowest cost energy**<br>*Improves competitiveness of all business, attracts investment, creates jobs*<br>*Leverage carbon price/accelerate climate action* | ↑ | ↓ | ↓ | ↓ |
| **Nurture business opportunity**<br>*Enable emergence of globally capable firms able to export products and services* | ↑ | ● | ↓ | ↓ |
| **Re-invent innovation**<br>*Nurture science, technology, and innovation for leverage by rest of economy* | ↑ | ● | ● | ↓ |

*Nuclear is the only option that contributes measurably to all policy priorities.*

# Conclusion

Ontario should plan for a future supply mix that best creates a competitive advantage for Ontario's economy. All generation sources should be evaluated based on their supply profile (intermittent vs dispatchable), their ability to support Ontario's climate change goals, their overall unit cost of electricity (including generation and transmission costs), and their contribution to Ontario's economy.

The Ministry of Energy's current nuclear plan of extending the life of the Bruce site's eight units, refurbishing Darlington's four units, operating Pickering until 2024, and exploring new nuclear builds is the best way to power the province and reduce carbon emissions in the coming decades. Relying on Quebec to export surplus electricity carries many challenges, including the fact it has a shortfall in the winter and forecasts to lose its capacity surplus after 2025.

Moving forward with infrastructure projects at Ontario's nuclear stations will help build reliable, low-cost and carbon-free baseload generation for the province, which will benefit families and businesses over the next 50 years.

Simply put, nuclear generation is the best supply option to meet all of Ontario's policy priorities.

Four important facts about nuclear are relevant to the LTEP consultation process:

- Nuclear is Ontario's lowest-cost clean energy provider today and into the future.
- Nuclear has been Ontario's engine for reducing GHGs, and Bruce Power provided 70 per cent of the incremental electricity the province needed to shut down its coal plants.
- Nuclear provides a flexible supply that can be matched to seasonal demand.
- Ontario's nuclear technology has been a source of innovation and job creation in communities across southern Ontario and supports Ontario's Gross Domestic Product through both domestic and export value.

CONTRIBUTING PARTNERS



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