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CNA Comments on the IESO Pathways to Decarbonization Report.

Nuclear energy has a key role to play in the path to Ontario's decarbonization.

The IESO Pathways to Decarbonization Report suggests that the provinces nuclear energy resources should double in size by 2050 to meet decarbonization and energy security goals. Ontario is leading the way in nuclear power in Canada. Nuclear energy has already played a key role in decarbonizing the Ontario grid through facilitating the shut down of the province's coal-fired electricity generation plants. And it has a bright future.

Both the Darlington and Bruce nuclear stations are undergoing refurbishments to extend their lives into the 2050s and beyond, and a decision to refurbish the Pickering power station is pending. Bruce Power's Units 1 and 2 were refurbished in 2012 and Unit 3 is ongoing. Bruce Power has added significantly to the facility's capacity in the refurbishment of Unit 6 (to be returned to service later in 2023), on time and on budget. On May 12, Bruce Power announced a contractual agreement with the consortium, Shoreline Power Group, to extend the lives of Units 4, 5, 7 and 8 to 2064.

Ontario Power Generation (OPG) and partners are leading the way to deploy Canada's first grid-scale, 300 megawatt (MWe) Small Modular Reactor (SMR) at the Darlington site with commercial operation planned for 2029. OPG is also exploring the potential deployment of SMRs at industrial sites to help in their decarbonization efforts by providing heat/steam energy as well as clean electricity, and of Micro Modular Reactors (MMR) in remote communities.

The world's first MMR by Global First Power was just announced for the Canadian Nuclear Laboratories (CNL) Chalk River facility.

Collectively these companies produce approximately 60% of the Ontario's electricity, with it's continued use displacing millions of tonnes of CO_2 per year. They are also helping to drive the innovation and investment in the sector. Supporting development by these leaders will support the energy transition not only in Ontario but across the country.

We must start now.

To get the energy infrastructure in place in time and at the scale required to meet climate and energy security goals, planning and investment must start now. But it will be critical to plan methodically, so that early investment decisions do not forestall others that would make more sense over the long term. Natural gas will have to continue to play a role in the near term, until other clean energy sources such as nuclear, renewables, large scale storage and hydrogen can be brought on stream.

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The province would do well to develop and implement a long-term strategy to procure the right mix of resources that optimize the grid infrastructure, and maximize cost-effectiveness, safety, security, and environmental and human health benefits.

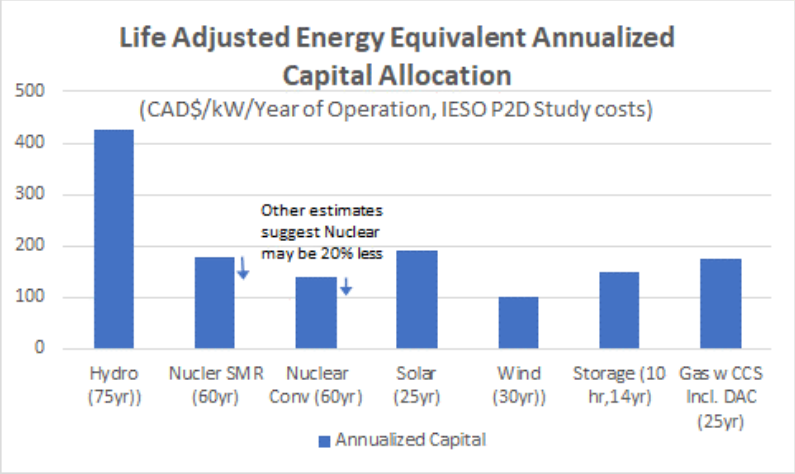
The costs to the electricity system and ratepayers must consider the full life-cycle costs of the resources. For nuclear energy resources to be developed at the scale outlined in the Pathways report to meet the key base-load power requirements, investment must start now. Broad consensus shows that Ontario needs a minimum of 17-19 GW of new nuclear.

Nuclear power can support Ontario's transition by both generating clean electricity for the grid and by providing heat, electricity, hydrogen, and other products to decarbonize industry.

Consultations regarding the planning and siting of new generation, storage facilities and grid infrastructure must take place early and often. The nuclear energy sector recognizes the critical role of early engagement and consultations with the public and particularly Indigenous peoples and will strive to get these underway as soon as possible as a key component to streamlining the Impact Assessment (IA) process.

The Nuclear Energy Cost Advantage.

There is no question that achieving Canada's climate and energy security goals is going to require contributions from all clean energy resources and cost money. However, work done for the CNA Nuclear for Net Zero project by Strapolec Consulting shows that nuclear energy is cost competitive with other low-carbon electricity generation options and will prove to be a worthwhile investment.



Source: Strapolec analysis, exchange rate conversion based on similarity of US/Cda labor costs (IESO Pathways to Decarbonization (P2D) study cost, capacity factor and asset life assumptions, 2022; Strapolec analysis; CER 2021 for CCGT with CCS; Navius 2021 for Direct Air Capture (DAC). DAC needed to address the 90% CCS efficiency.)

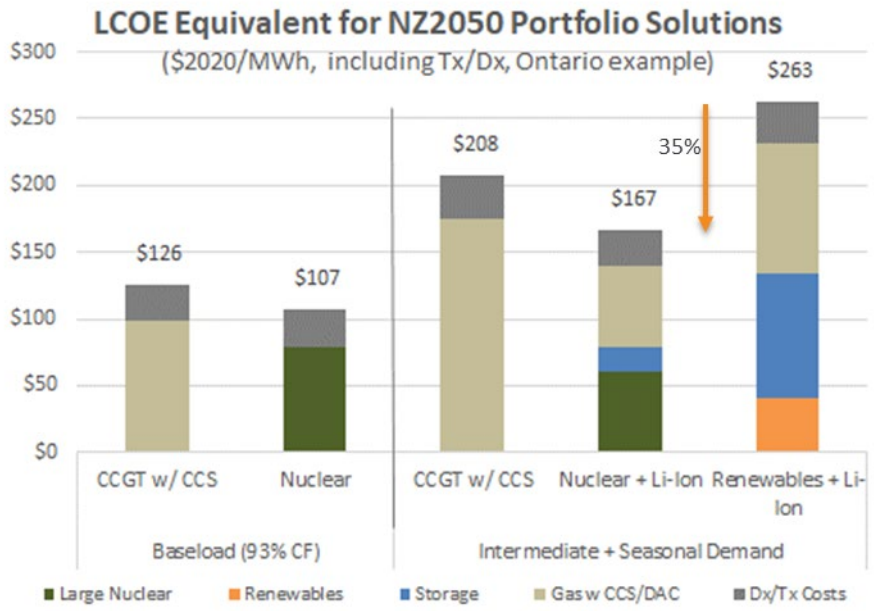
The consensus across several studies indicates that forecast grid-based nuclear energy costs are very competitive. Despite public perception, even IESO's high nuclear capital costs are competitive when considering energy/emissions and asset life equivalency.

Integrated nuclear flexible supply options have clear cost advantages over other low-carbon resources. Modelling in the surveyed studies fail to identify the full costs of integrating renewables. Supplying baseload and intermediate demand requires reliably dispatchable solutions, and for renewables to function in this way, they must be integrated with storage and backed up by flexible generation.

Baseload supply options and intermediate supply options differ:

- Baseload options may be straightforward, such as hydro, nuclear, or gas equipped with Carbon Capture and Sequestration (CCS) or may be addressed by portfolio solutions like required to supply intermediate load or daily demand.
- To meet intermediate demand, all generation options, other than gas require additional investments in storage and gas-fired backup. Furthermore, whenever gas-fired generation is used, the cost of ultimate sequestration is required as well as alternatives for direct air capture to compensate for the 90% efficiency of CCS.

To reliably act as a dispatchable supply, renewables must be integrated with storage and backed up by flexible generation. Modelling used by the surveyed studies have insufficient temporal fidelity to capture the intermittency of renewables and their need for backup supply. The Strapolec models have the fidelity to identify the full system costs of baseload and intermediate supply options, yielding the dramatic outcome that nuclear could be 35% less costly than other options.



Source: Strapolec Consulting for CNA Nuclear for Net Zero Program, 2023

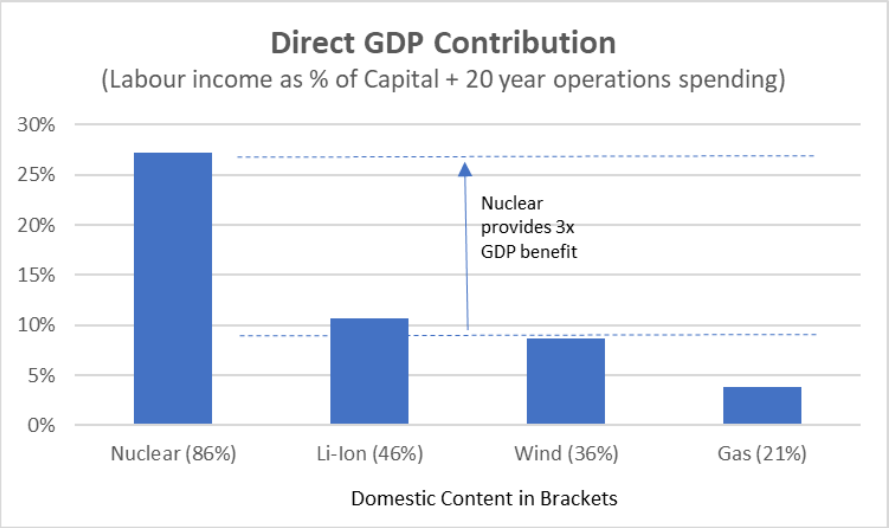
The chart above reflects the Strapolec study findings that nuclear options may be the lowest cost for both baseload and intermediate applications.

Financing Nuclear Power

Although analysis shows that nuclear energy is a cost-competitive, if not cheaper, long-term solution for the transition to a low-carbon future, it is a capital-intensive option and with significant up-front costs. Access to capital and low financing costs are important to support the build-out of the sector.

The Federal Budget 2023 announced several mechanisms, including investment tax credits, tax refunds, funding etc. to support the nuclear value chain. CNA and member companies are now working to provide input to the government in developing these mechanisms so that support is maximised. It is also anticipated that the federal government will incorporate nuclear energy into its green bond framework following the UK's lead, which help the sector attract much needed investment.

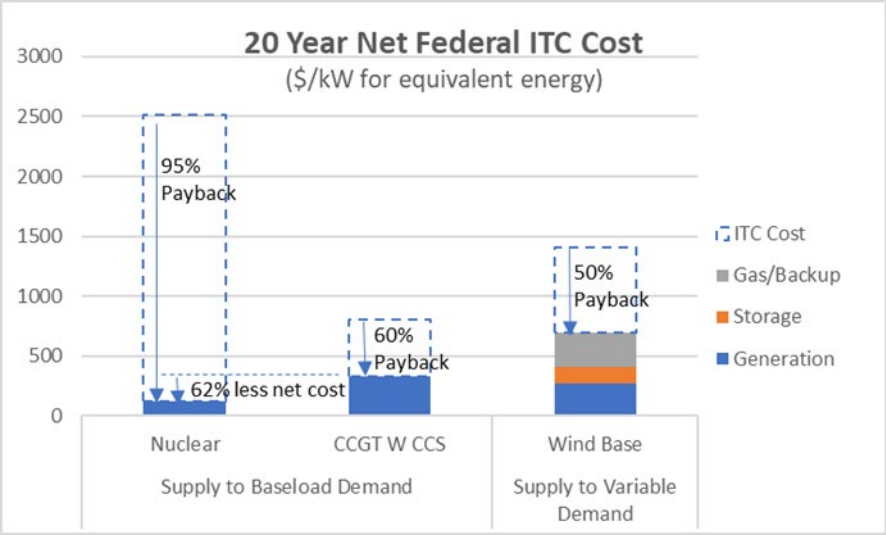
Nuclear energy is a prudent investment. Analysis conducted by Strapolec for the CNA has shown that tax credit investment in nuclear energy yields much higher GDP driven tax revenues than other options. The charts below show that the high domestic content of nuclear initiatives provides more than three times the GDP contribution of renewable and gas alternatives.



Source: Strapolec analysis for CNA, 2022. Based on extrapolations from OPG commissioned economic impact assessments.

Further, this analysis has shown that tax credit investments in nuclear energy yield the highest government returns, as higher GDP contributions translate into higher tax revenues. For illustration, a 30% ITC funding of a project costing $8300/kW would award ~$2500/kW to the project proponent. Over 20 years the tax revenues on the nuclear project would pay back 95% of the ITC funding –

costing the Federal government only $100/kW. Over a 60-year plant life the ITC funding will be more than fully paid back through tax revenues.



Source: Strapolec Consulting analysis for CNA, 2022.

The implications of this finding for Provincial governments are important. As total tax revenues are split approximately 60% federal/40% provincial, the provincial government will benefit similarly in terms of a good return on these types of investments and should consider additional provincial funding.

An important consideration for Investment Tax Credits and other funding is that nuclear energy facilities are capital intensive up-front, while operating and fuel costs are relatively low. Structuring such mechanisms to provide funding to support design and other up-front costs, and to flow through the development phase are critical to de-risking these investments and ensuring these projects are developed in the time and scale required to meet decarbonization objectives.

To allow funds to flow from project conception to completion, aside from structuring of funding mechanisms to do so, governments can also act to remove regulatory and other hurdles that impede this critically important de-risking mechanism. **Specifically, the government of Ontario could allow project proponents to recover early costs such as siting and Indigenous engagement to get projects moving.** Changes to the IESO contracts with the nuclear project proponents and other regulatory and policy mechanisms might be required.

Streamlining and modernizing regulatory regimes is critical.

The nuclear energy sector in Canada is regulated by the Canadian Nuclear Safety Commission (CNSC), and interfaces with other Federal and Provincial agencies through legislation, regulations and policies including the Impact Assessment Act. The Canadian Standards Association (CSA) plays a key role in developing the sector's applicable codes and standards. CNSC generally integrates the federal and

provincial legislation/regulations and policies as well as the CSA standards into its regulatory requirements to protect health, safety, security, and the environment. A key issue for new nuclear deployment is that these requirements were generally designed for CANDU reactors and require updating to be applicable to the new generation large reactors and small modular reactors. Further, building out the nuclear fleet in the time and at the scale required to meet Canada's climate and energy security goals will require an alignment of regulatory requirements across provinces and territories so that designs and assessment results can be shared to improve the efficiency of regulatory approval timelines.

A potential gap in existing standards and opportunity for more efficient regulatory requirements exists with respect to the co-location of nuclear energy facilities with other industrial process plants such as those using thermal energy (heat) or to produce hydrogen, in terms of multi-hazard risk assessment and separation of the nuclear island from the adjacent plant.

The Impact Assessment Act is currently designed with too many barriers and timelines that are too long to enable efficient and timely decisions. Another factor is the potential for overlapping but disparate environmental approval requirements in some Provinces, therefore Federal and Provincial alignment is critical. Streamlining and standardizing the various aspects of the impact assessments is critically important and a top priority. This is a potential showstopper: if the IA process is not fixed the sector will not be able to build out at the pace and scale required to deploy fleets of reactors and meet Canada's climate change goals.

The province could support a streamlined federal IA process by participating in the consultation and engagement sessions and the IA process, harmonizing processes, and supporting the acceptance of previously approved IA on brownfield sites for new units on the same site.

The province could also support the intra-national and inter-national standardization of regulatory requirements to support seamless movement of technology, fuels, human resources, and supply chain.

A continuing role for natural gas over the near term.

As per the comments above, there are a variety of options to supply the electricity required in Ontario and replace the flexibility that natural gas currently provides the system. However, these changes can't happen overnight, and natural gas services will be required in the near term until these other options can be brought online. While hydrogen production using natural gas through the steam methane reforming (SMR) method is well proven and in use in many areas, future production of hydrogen in this way will be limited. SMR produces high levels of CO_2, and with seemingly little potential for CCS in Ontario, increasingly stringent carbon emission limits will restrict likely this option for the province.

Production of hydrogen using nuclear power is feasible, and low carbon. However, using nuclear energy for the increased production of electricity and/or new hydrogen production, in the quantities

required to decarbonize the market requires time and significant investment. The necessary storage options to support new renewables at the scale required are still in development.

In the near term, natural gas will therefore have to continue to provide its services to the grid, while nuclear, storage and other options can be developed and deployed over the medium to long-term.

Demand-side management and conservation programs have a key role.

Demand-side management and conservation programs can make an important contribution. Such programs can play an integral role in the long-term planning of the system and should be integrated with other supply options to optimize Ontario's electricity resources.

Hydroelectric power provides a key energy service.

Hydroelectric power, like nuclear power, plays an important role in meeting energy demands in the province. We are not able to comment on the potential development capacity of Hydro in the province. Private-, Indigenous-, and government-owned projects should be encouraged for any or all low-carbon energy options, including hydro or nuclear.

Decisions around whether to develop large hydro or other options such as nuclear energy should consider the broad spectrum of attributes. Both hydro and nuclear are good options to deliver clean, baseload energy. Existing nuclear energy in Ontario has proven itself to be reliable, cost-effective and an important tool in the path to decarbonization in the province. Compared to other low-carbon alternatives, including large hydro, nuclear energy provides unparalleled benefits, including that nuclear energy resources:

- Are also long-lived, up to 80 years or more, and even longer with refurbishments.
- Are cost competitive with other low-carbon options.
- Have a much smaller environmental footprint, to most of the options, including hydro, in terms of land use, impact on biota, etc., although the waste produced must be safely and securely managed.
- Can be located close to loads.
- Support research and development and produce isotopes for medical and industrial applications, including over 50% of the world's supply of Cobalt-60.
- Produce up to 3x the GDP impact of renewables and natural gas options through numerous high-paying jobs across the largely Canadian nuclear value chain.

The province of Ontario, like the rest of Canada, is going to need to invest in all the different low-carbon energy sources it has at its disposal. Large hydro will be part of the mix, although siting these facilities will likely be a limiting factor. Nuclear energy compares favorably to hydroelectric as a workhorse for the provincial electricity system.

Conclusion

The recommendations of the Pathways Report are solid, and reasonably reflect the challenges at hand. The CNA and member companies would be pleased to work with you on a path forward that will bring the broad spectrum of energy resources to the province required to provide cost-effective, safe, secure, clean energy.

Best Regards,

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