CANDU Owners Group Inc.

"Excellence Through Collaboration"

May 14, 2023

Ministry of Energy, Energy Supply Policy Division
Address
7th floor, 77 Grenville Street
Toronto, ON
M7A 2C1
Canada

Re. Feedback on the IESO Pathways to Decarbonization (P2D) Study

On December 15, 2022, the Independent Electricity System Operator (IESO) released the "Pathways to Decarbonization" (P2D) study. The Ministry of Energy has requessted feedback on the findings of the P2D study and its recommendations. We appreciate the opportunity to provide our input and would like to submit the following comments.

Overall, we commend IESO for its efforts to address a very complex issue. The report is well done and it helps to highlight many of the challenging issues. It provides some analysis and recommendations around the two basic scenarios presented. We have the following comments:

1. The report is a good first step to recognizing the demand needs ahead of us. It is recommended that as a next step, work be performed to fully clarify the underlying issues, risks, range of possible scenarios, and to develop actionable recommendations that will support a coordinated strategic effort based on integrated policy and planning that is required, both across all levels of government as well as with industry and the public. Part of this effort has begun under the Nuclear for Net Zero workshops that have been established by the Canadian Nuclear Association.
2. On page 6 of the report it states: The Minister asked the IESO to consider reliability and cost in the analysis, and to explore low-carbon fuels and carbon capture and storage. The opportunities related to low-carbon fuels and carbon capture, storage and utilization are significant. It is recommended that further investigation and analysis be performed on these opportunities. This is further outlined below.
3. Establishing a long-term vision and strategy is vital to guide and prioritize critical infrastructure investment and development on the scale that is required. It is recommended that the IESO work with stakeholders to develop the longer-term vision and strategy. This vision should consider circumstances that may alter the need for change in our grid infrastructure.
4. In the USA, the DOE is conducting the National Transmission Planning Study (NTP). It aims "to identify transmission [infrastructure] to provide broad-scale benefits to electric customers; inform regional and interregional transmission planning processes; and identify interregional and national strategies to accelerate decarbonization while maintaining system reliability". IESO should consider similar studies.
5. Further study is recommended to more fully address the issues and strategies for grid modernization. In particular, the introduction of "smart grid and microgrid technologies" is strategically linked to the grid's ability to evolve to meet future national, regional, local and site needs. More clarity is needed



655 Bay Street, 17th Floor ▪ Toronto ON M5G 2K4 Canada ▪ Tel: 416.595.1888 ▪ Fax: 416.595.1022 ▪ www.candu.org ▪ cog@candu.org

to understand how participation of industry and private sector investment will move us towards distributed energy resources and contribute to climate mitigation goals. This would include how existing energy producers can integrate with increasing grid demand.

6. Energy storage technologies are maturing and many jurisdictions are deploying pilot projects. This technology may offer positive benefits and may disrupt current grid design assumptions. It may also enhance our ability to integrate renewables and improve overall grid resilience. The future grid will need to accommodate growing supply volatility from intermittent resources and quickly evolving clean fuel infrastructures, as well as increased demand-side functionality with distributed energy resources and the electrification of transportation, buildings, and industry. The application of the nuclear reactors to large grid-scale energy storage systems including bulk thermal battery energy storage and bulk electrical battery energy storage is promising and further study is recommended.
7. The study assumes electrification to be the primary driver for decarbonization of the industry. There are other significant pathways to consider. Internationally and domestically, research is being conducted to understand the potential benefits of nuclear energy being used in applications "beyond electricity", i.e. specifically the use of nuclear thermal energy (high temperature steam) in a range of industrial applications. There are two significant and complementary benefits in the approach: reduced need for a significant increase in electrical supply and a capability to convert traditional fossil energy resources to clean fuels. Nuclear can be the "heat engine" to drive the conversion process. Potential applications of nuclear steam to de-carbonize conventional fossil energy-driven processes (i.e., large chemical or industrial facilities, refineries etc.) include:

    - steel-making industries (energy intensive)
    - production of clean synthetic fuels (mostly hydrogen).
    - steam methane reforming (thermo-chemical hydrogen production form natural gas)
    - methane pyrolysis (thermo-chemical hydrogen production from natural gas)
    - high-temperature steam electrolysis (for more efficient hydrogen production)
    - petrochemical processes (energy intensive)
    - ammonia production (energy intensive)
    - waste to energy (WTE) conversion processes, including municipal solid waste (MSW) and/or agricultural and forestry waste
8. The report's recommendations on further innovation need to be further expanded. The need for coordinated research and development and for joint funding should be explored to fully engage and leverage our national labs, universities and industry resources in addressing the issues.

COG is at the ready to do its part. We have the ability to mobilize expertise across the industry to address complex issues. We are able to foster industry collaboration and engage stakeholders in this challenging subject. We welcome further discussion should the Minister feel COG can assist in any way.

We hope you find this feedback useful and constructive. We encourage IESO to continue to invest effort and resources into this extremely important issue.

My best regards,

Rachna Clavero
COG President and CEO



655 Bay Street, 17th Floor ▪ Toronto ON M5G 2K4 Canada ▪ Tel: 416.595.1888 ▪ Fax: 416.595.1022 ▪ www.candu.org ▪ cog@candu.org

655 Bay Street, 17th Floor ▪ Toronto ON M5G 2K4 Canada ▪ Tel: 416.595.1888 ▪ Fax: 416.595.1022 ▪ www.candu.org ▪ cog@candu.org

# Useful References (for information only)


1. Nuclear Power in a Clean Energy System. International Energy Agency. May 2018.
2. IAEA Nuclear Energy Series. No. NP-T-4.3. Industrial Applications of Nuclear Energy. IAEA. Vienna. 2017.
3. Technoeconomic analysis of small modular reactors decarbonizing industrial process heat. Max Vanatta, Deep Patel, Todd Allen, Daniel Cooper, Michael T. Craig. Science Direct. V7, Issue 4, pp 713-737. April 2023.
4. Nuclear Cogeneration: Civil Nuclear in a Low Carbon Future, Policy Briefing, The Royal Society, London, UK, October 2020
5. Opportunities for Cogeneration with Nuclear Energy, IAEA, No.NP-T-4.1, Vienna, Austria, 2017.
6. International Energy Agency, The Future of Hydrogen – Seizing today's opportunities, Report prepared by the IEA for the G20, Japan. June 2019.
7. World Nuclear News (WNN) article: OPG, X-energy to examine industrial applications for Xe-100. 13 July 2022.
8. Deployability of Small Modular Nuclear Reactors for Alberta Applications – Phase II Report Prepared for Alberta Innovates. March 2018. PNNL-27270.
9. USAID Grid-Scacle Energy Storage Technologies Primer. Thomas Bowen, Ilya Chernyakhovskiy, Kaifeng Xu, Sika Gadzanku, Kamyria Coney. National Renewable Energy Laboratory. July 2021
10. United States Government Accountability Office. Report to Congressional Addressees. Utility-Scale Energy Storage Technologies and Challenges for an Evolving Grid. March 2023.
11. Decarbonizing Edge-of-the-Grid - Resilience Solutions - Microgrid Techno-Economic Analysis. EPRI Report. December 2021.
12. Investigation of the Technical and Economic Feasibility of Micro-Grid Based Power Systems. D. Herman. EPRI Report 1003973. Interim Report, December 2001.
13. Canadian Renewable Energy Laboratory (CANREL)- A Testbed for Microgrids. Ehsan Nasr-Azadani, Member, IEEE, Peter Su, Wenda Zheng, Janos Rajda, Member, IEEE, Claudio Ca˜nizares, Fellow, IEEE, Mehrdad Kazerani, Senior Member, IEEE, Erik Veneman, Stephen Cress, Michael Wittemund, Manoj Rao Manjunath, Nicolas Wrathall. IEEE Electrification Magazine, 2019.
14. Microgrids and Backup Power Systems - Field-scale integration of diverse energy resources. Idaho National Labs. 20-50443-031-R3. Update 2021.
15. A Smart and Flexible Microgrid with Dynamic Boundary and Intelligent Open-Source Controller. EPRI. August 2018.
16. Grid Considerations for Microgrids. EPRI Report 3002020344. February 2021.
17. Distributed Renewable Energy Generation Impacts on Microgrid Operation and Reliability. Project Manager T. Peterson. EPRI Report 1004045. Interim Report, February 2002.





655 Bay Street, 17th Floor ▪ Toronto ON M5G 2K4 Canada ▪ Tel: 416.595.1888 ▪ Fax: 416.595.1022 ▪ www.candu.org ▪ cog@candu.org