Bruce Power
Project 2030

# Powering Ontario's Hydrogen Potential

CLEAN ENERGY FRONTIER
BRUCE • GREY • HURON

# Executive Summary

Bruce Power, and the potential for future hydrogen production from nuclear power, was recognized in Ontario's Low-Carbon Hydrogen Strategy, which was released in April 2022. Non-emitting nuclear generation provides a significant competitive advantage for the Province of Ontario in developing a low-carbon hydrogen economy and Bruce Power's Project 2030 enables that opportunity.

All the basic requirements are in place to develop, build and successfully demonstrate a world-class Clean Energy Frontier (CEF) Nuclear Hydrogen Hub near the Bruce Power site. The CEF demonstrates excellent conditions to deploy hydrogen technologies, including the unique baseload ability of non-emitting electricity from nuclear power to convert optimized output into non-emitting hydrogen (i.e. pink hydrogen), local geological formations suited to storage, existing infrastructure and demonstrable project buy-in from stakeholders.

Hydrogen holds tremendous potential. Due to its many advantages and applications, some estimates suggest hydrogen could be used to eliminate up to 25 per cent of greenhouse gas (GHG) emissions in Ontario. To capitalize on this potential, it begins with recognizing our clean energy advantages. In Ontario, thanks in large part to clean power from the province's nuclear sector, the electricity grid that supplies our homes and businesses with power is more than 90 per cent carbon free. This presents the province with a strategic advantage in comparison to other jurisdictions.

As the demand for low-carbon hydrogen grows over the next decade, Bruce Power could be positioned to provide an increasing supply of both clean electricity and low-carbon hydrogen to meet the changing needs of Ontarians throughout the Clean Energy Transition. Our electricity system will be the backbone of a clean economy—cleanly powering homes and businesses and enabling other sectors (like transportation and manufacturing) to decarbonize. However, this does not come without challenges. As Ontario moves toward Net Zero, significant questions around meeting future electricity demand must be answered.

Bruce Power is helping to meet this challenge by unlocking the potential of using optimized output generated from Project 2030. Project 2030 is focused on achieving a Bruce site net peak goal of upwards of 7,000 megawatts (MW) through continued asset optimization, innovations and leveraging new technology, which could include integration with storage and other forms of energy such as hydrogen. Project 2030 will enable Bruce Power to optimize its supply of both clean electricity and hydrogen based on the market conditions and demand for both products to meet the province's needs over the coming decades.

# Ontario's Nuclear Advantage

## A carbon-free source of energy

Zero-emissions nuclear power is the backbone of Ontario's clean electricity system, providing reliable, carbon-free power for the dynamic needs of our province.

Nuclear power is one of the lowest carbon intensity feedstocks for producing hydrogen.

**FIGURE 1: Ontario Electricity Output By Fuel Type 2022**

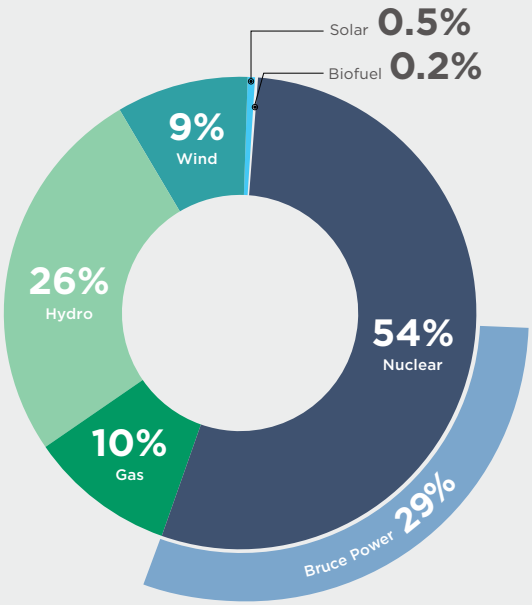
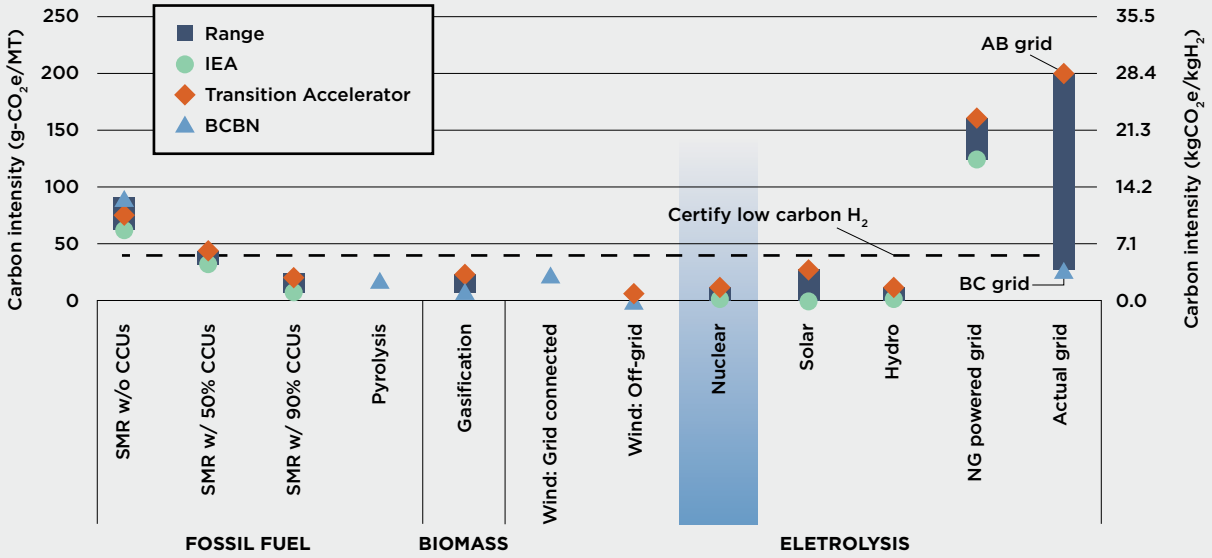



**FIGURE 2: Carbon Intensities of Hydrogen from Different Production Pathways**




Source: Hydrogen Strategy for Canada Publication, Natural Resources Canada, Dec. 2020.

# Nuclear: Powering Ontario's Hydrogen Potential

Operating at very high-capacity factors, nuclear energy is well placed to produce zero-carbon hydrogen as an emerging energy carrier with a wide range of applications. Nuclear reactors produce heat, which is used to generate electricity. In addition to the intrinsic benefits of nuclear energy, such as being decoupled from the fossil-fuel energy market, a high-capacity factor and a security of supply, this generated electricity can be supplied to a range of technologies that produce hydrogen.

Nuclear power, generated at the Bruce Power site, provides the following key competitive advantages in producing low-carbon hydrogen.

**PROJECT 2030** – Bruce Power could dedicate a portion of its power production to the production of hydrogen as it seeks to uprate total capacity via Project 2030. In agreement with the owners of the hydrogen plants, Bruce Power could ramp up and ramp down, in real time, the hydrogen production to provide grid services to IESO at an agreed price to offer this flexibility in the Operating Reserves and Demand Response markets.

**INCREMENTAL STEAM FLEXIBILITY** – Through the investment and innovation of Project 2030, incremental steam generated as a result of the increase in baseload supply from the reactors could be harnessed and utilized for electrolysis. This could translate into significant amounts of hydrogen produced that could be stored and distributed, helping the province to further decarbonize.

**SUPERIOR ECONOMICS** – High-capacity factors and a strong reliability record provide a steady supply of energy required to power electrolyzers and reduce the levelized cost of hydrogen, when compared to other non-emitting sources such as renewables for both behind-the-fence and grid connected installations.

**SCALABILITY** – As demand grows, optimized output from Project 2030 could be utilized for purposes of hydrogen production. This would result in a natural progression from the pilot/demo stage proposed to a large commercial scale (hundreds of megawatts) using existing nuclear infrastructure, enabling huge economies of scale.

**MULTIPLE END-USE APPLICATIONS** – Nuclear generation provides a source of high heat, along with electricity, for industrial processes creating a synergy in the development of clean synthetic fuels. These end-use products are vital in the Clean Energy Transition for hard-to-abate sectors such as aviation, transportation and petrochemical.

Project 2030 would see Bruce Power increase its nameplate capacity by upwards of 700 MW of incremental output.

# Project 2030

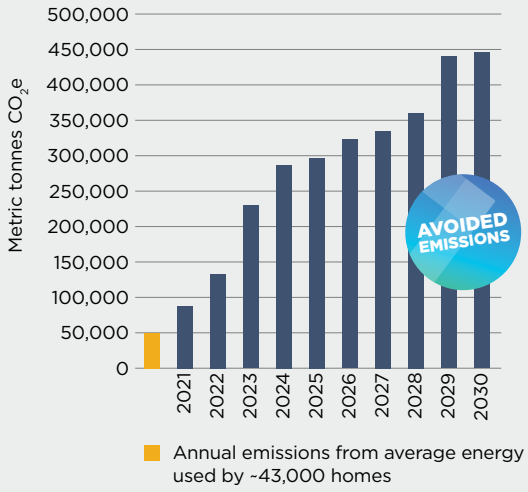
Project 2030 is a Bruce Power initiative that will support Ontario's climate change targets and future clean energy needs by targeting a site net peak capability of upwards of 7,000 MW for the 2030s. Project 2030 will incrementally increase the site generation output through asset optimization, innovation and leveraging new efficient technology. This optimized output could be leveraged to produce hydrogen or other clean fuels at the Bruce site.

This additional generation will be nearly equivalent to adding a ninth large-scale reactor to our site without the need to build additional infrastructure. By building flexibility into the Project 2030 implementation plan, Bruce Power is ensuring the option of potential production of large scale low-carbon hydrogen when the long-term market conditions warrant investment.

Project 2030 would see Bruce Power increase its nameplate capacity by upwards of 700 MW of incremental output. The initial stage of Bruce Power's Project 2030 will increase site output to 6,750 MW and will lead to avoided emissions, estimated at almost 450,000 metric tonnes of $CO_2$ e-equivalent annually, which equals taking about 100,000 cars off the road.

Project 2030 would also further enable GHG reduction through the production of hydrogen.  For each tonne of hydrogen used to displaced natural gas, 6.3 tonnes of GHGs are removed from the atmosphere. This GHG reduction is also 30 per cent higher when the hydrogen is being used to displace diesel.

FIGURE 3:
**Avoided GHG emissions from additional incremental output from Bruce Power facility over output generated from fossil fuel natural gas**




BrucePower™ Project2030


# Hydrogen Production at the Bruce Power Site

Bruce Power, and the potential for future hydrogen production from nuclear power, was recognized in Ontario's Low-Carbon Hydrogen Strategy, which was released in April 2022.

As the demand for low-carbon hydrogen grows over the next decade, Bruce Power will be positioned to provide an increasing supply of both clean electricity and low-carbon hydrogen to meet the changing needs of Ontarians throughout the Clean Energy Transition. Bruce Power will aim to work with the Province to ensure optimized output, leveraged through the ongoing successful implementation of Project 2030, will be able to meet the province's needs over the coming decades.

A hydrogen hub located in the Clean Energy Frontier is a value proposition that would lead to a local economy of competitive non-emitting hydrogen production that will mobilize local actors toward decarbonization of the CEF, including participation of Indigenous communities in the co-development of these projects.

## The Bruce Site

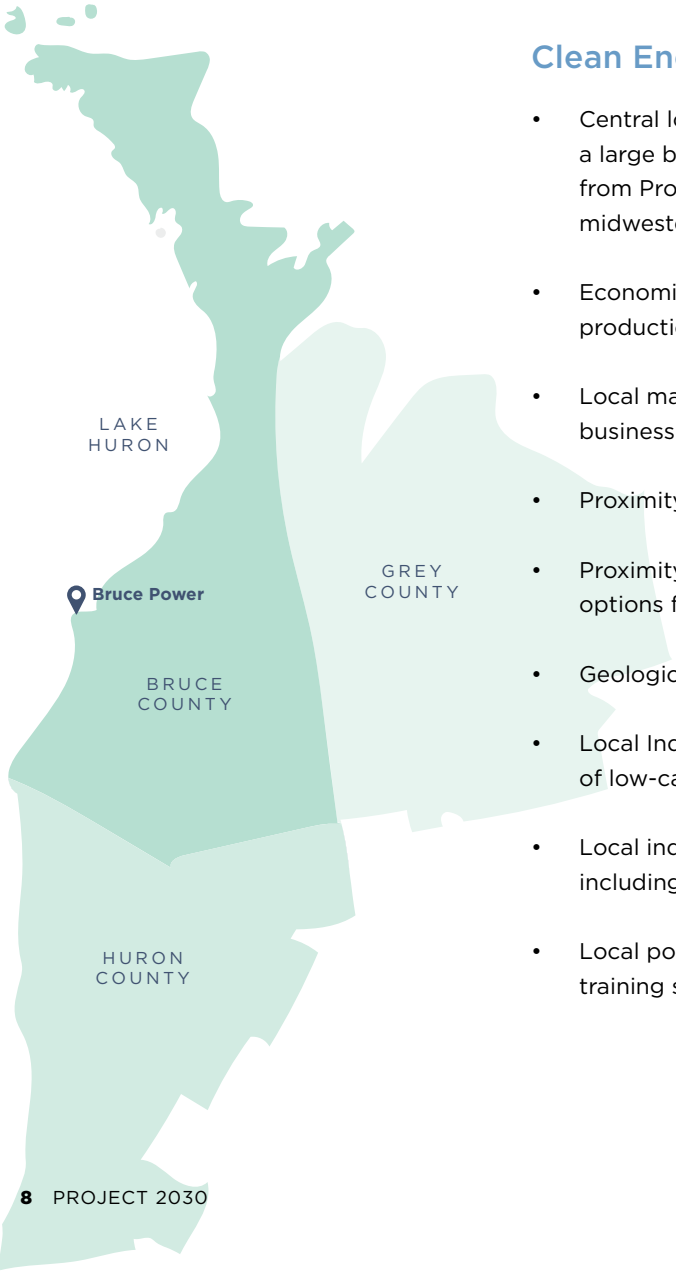
Co-locating a hydrogen production facility at the Bruce Power site would allow for some synergies between electricity supply and the generation of hydrogen.

**Bruce A** – Bruce A has pre-existing infrastructure which could enable taking superheated steam from the boilers to support the production of hydrogen or other end-use applications, subject to completion of additional technical studies and required capital investment for equipment upgrades.

**Bruce B** – The Bruce B main steam system was never configured to permit taking superheated steam off of the boilers. As such, the Bruce B main steam system would need to be cut into, modified, re-qualified seismically, etc. These changes would be result in a substantial cost and further complicates the economics of producing hydrogen at scale.

## Surplus Baseload

For the foreseeable five to 10 years, the amount of surplus baseload generation is expected to be low given the nuclear refurbishments underway (as highlighted by the IESO). However, moving forward opportunities to leverage increases in baseload supply could be utilized to enable the use of hydrogen as a storage resource.




## Clean Energy Frontier Hydrogen Hub Advantages

- Central location for low-carbon hydrogen production combined with a large baseload nuclear generator utilizing optimized output created from Project 2030, supplemented by renewable wind generation in midwestern Ontario.
- Economic benefits from made-in-Ontario hydrogen manufacturing, production and local end-use.
- Local manufacturing driving growth in jobs and attracting local business to the CEF.
- Proximity to Sarnia, connecting regional hubs together over time.
- Proximity to the Great Lakes Waterway, enabling transportation options for hydrogen and/or its carbon derivative.
- Geologic formations suited for hydrogen storage.
- Local Indigenous communities as potential project partners and users of low-carbon hydrogen or derivatives.
- Local industrial expertise in the production of low-carbon fuels, including a potential source of bio-genic $CO_2$.
- Local post-secondary education partners to support education and training such as through the Nuclear Innovation Institute.


A first-of-its-kind hydrogen hub in the Clean Energy Frontier would support Ontario's long-term energy plan.

## The Business Case for Nuclear Hydrogen Production

Bruce Power, the CEF Partners and Hatch Ltd. prepared a technical feasibility study, which outlines the opportunities to develop a first-of-its-kind hydrogen hub in the Clean Energy Frontier which can support the Province of Ontario's long-term energy plan, help decarbonize local industries and, at the same time, introduce an innovative electrolyzer technology developed by Hydrogen Optimized, an Ontario-based company.

The report found that all the basic requirements are in place to develop, build and successfully demonstrate a world-class CEF Nuclear Hydrogen Hub near the Bruce Power site to serve the CEF region of Bruce, Grey and Huron counties. Through strong partnerships there is a significant opportunity to enable hydrogen production enabled by nuclear power.


# Recommendations and Next Steps

As the government moves forward to identify potential pilot projects, Bruce Power will aim to work with the Province so the optimized output generated through the successful implementation of Project 2030 will be used to meet the province's needs.

A Nuclear Hydrogen Hub in the Clean Energy Frontier is aligned with the federal Hydrogen Strategy for Canada and Ontario's Low-Carbon Hydrogen Strategy and could play a key role in providing operating experience for the communities within the CEF, as well as other hubs and entities, as they look to develop their own initiatives. The Clean Energy Frontier demonstrates excellent conditions to deploy hydrogen technologies, including the unique baseload ability of non-emitting electricity from nuclear power to convert optimized output into non-emitting hydrogen, local geological formations suited to storage, existing infrastructure, and demonstrable project buy-in from stakeholders.

The Hub has significant potential to increase low-carbon hydrogen production over the long run, as demand and market conditions dictate. Bruce Power looks forward to working with government as it continues to action its Hydrogen Strategy.

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