



Reaching Canada's clean energy potential with hydrogen

Parallel pursuit of export markets and domestic use of hydrogen can help accelerate the energy transition



Canada has an important role to play in global energy transition and a unique opportunity to position itself as a leading clean energy exporter. The country's vast natural resources, coupled with world-class energy producers, puts Canada in an enviable position to become a powerhouse in low-carbon hydrogen supply and production.

Looking forward, this will require government support and incentives to kick-start and develop the industry, mitigate risks associated with hydrogen projects, accelerate the time to market, and enable the industry to achieve scale.

Canada is well known for its abundant energy resources. The country ranks fourth and sixth in global crude oil and natural gas production, respectively. In renewable energy generation, Canada is also a leader, ranking as the third-largest hydro and 10th-largest renewable electricity generators in the world. According to Natural Resources Canada, the energy sector represents 8.1% of Canada's Gross Domestic Product (GDP), directly employs a workforce of 293,000 strong, and supports over 552,500 additional jobs indirectly, representing 4.7% of total employment in the country.¹

As a net exporter of most energy commodities, Canada is uniquely positioned to benefit from global energy market conditions. Elevated natural gas prices in Europe and Asia substantially improved the relative cost competitiveness of low-carbon hydrogen in 2022. Moreover, both regions are increasingly focused on securing their energy supplies, helping to spur Canadian hydrogen producers to pursue domestic sales and export markets in parallel.

This dual focus is accelerating the deployment of various

hydrogen production technologies in Canada and creating a virtuous circle of accelerated cost reduction and cost competitiveness of low-carbon hydrogen versus alternative fuels.

A snapshot of Canada's export-driven energy market

Canada's fossil fuel infrastructure is well integrated with the United States, allowing a significant portion of production to be exported. This integration has also spurred considerable industry development, as shown by statistics from Natural Resources Canada (NRCAN), increasing Canadian crude oil production by 57% since 2010, with U.S. exports accounting for 75% of production. Natural gas and natural gas liquids production and utilization in Canada is similarly intertwined with the U.S. market, with net exports making up 30% of Canadian production in 2020.²

Overall, energy exports account for 18% of total Canadian exports and deliver a positive \$64 billion trade balance.¹ As the world strives to reduce its reliance on fossil fuels, the challenges of the energy transition become clearer. Increasingly, it becomes important for Canada to set a path that helps to reconfigure its energy export mix and retain a favourable trade and economic position.

¹ Natural Resources Canada, *Energy Fact Book 2021-2022*, https://natural-resources.canada.ca/sites/nrcan/files/energy/energy_fact/2021-2022/PDF/section1_energy-factbook_december9_en_accessible.pdf

² Canada Energy Regulator, *Provincial and Territorial Energy Profiles* – <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-canada.html>

Answering the demand for natural gas & electricity exports

The global energy transition has shifted the focus to natural gas, which has a lower emission profile than other traditional energy sources. When used for power generation, natural gas emits 51% less CO₂-equivalent per kWh of energy generated than coal and 30% less than energy generated from crude oil³. Natural gas-based power generation can also increase or decrease to match changing demand and address supply intermittency of renewable generation technologies. Finally, natural gas can be exported globally as liquified natural gas (LNG).

In response to global demand, numerous Canadian LNG export terminal development projects were proposed in recent years. However, the LNG industry's growth is hampered by increased scrutiny over new fossil fuel development projects, extensive and complex pipeline investment requirements, divergent local and national stakeholder interests, and extensive permitting processes.

Lifecycle Emission Factors (gCO ₂ e/kWh) ³	
Solar	43
Hydropower	21
Wind	13
Nuclear	13
Natural Gas	486
Oil	840
Coal	1001

Electricity exports are another natural alternative to increase the longevity of Canadian energy exports and their economic benefits in a world focused on energy transition. Over 80% of Canadian power originates from low-carbon sources,² and as per NREL hydro, wind, or nuclear power is estimated to generate near zero or over 98% less CO₂-equivalent per kWh of energy generated than coal.³

Currently, 70% of the country's exports to the U.S. originate from eastern Canada, primarily from Quebec and Ontario, with additional export capacity planned in the Champlain Hudson Power Express high-voltage transmission lines to New York.⁴

Reaching other electricity export markets is constrained by a lack of efficient technology which would allow for seaborne electricity shipments.

The growing global importance of hydrogen

Hydrogen (H₂) is the most abundant element on Earth and is used in refining and petrochemical processes for decades. While it cannot be mined, hydrogen is a fuel that can be produced to replace fossil fuels or electric power for industrial, transportation, heating, and other uses.

Currently, there are multiple drivers behind hydrogen's global adoption. Depending on the production method, hydrogen may be near zero emissions when produced from renewable power and water through the electrolysis process (green hydrogen) or from natural gas with carbon capture (blue hydrogen, or, collectively, clean low-carbon hydrogen). Recent developments in electrolysis and carbon capture technologies, and the ongoing cost reduction of renewable energy generation, have made low-carbon hydrogen increasingly cost-competitive.

Importantly, hydrogen's potential role in securing energy supply has become top of mind for net-energy importer countries. This is largely a response to the fact that natural gas markets have experienced unprecedented volatility over the past year because of global conflicts and supply disruptions.

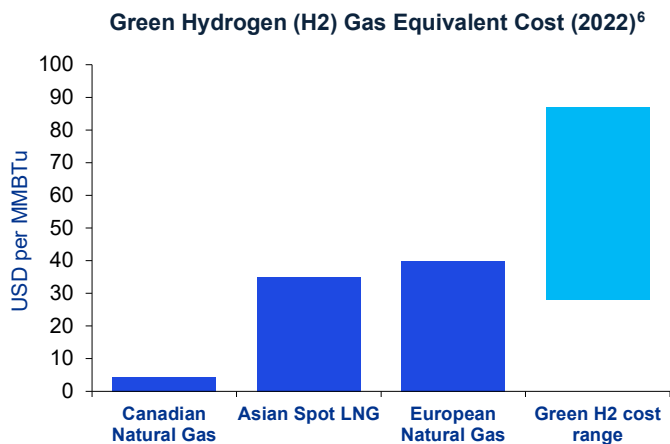


³ NREL, Life Cycle Greenhouse Gas Emissions from Electricity Generation: Update (Sep 2021), <https://www.nrel.gov/docs/fy21osti/80580.pdf>

⁴ Canada Energy Regulator, Market Snapshot: Canadian electricity exports to the U.S. focused on renewable power exports to specific markets, <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2017/market-snapshot-canadian-electricity-exports-u-s-focused-renewable-power-exports-specific-markets.html>

Improved hydrogen cost competitiveness

According to Lazard's October 2021 levelized cost of hydrogen (LCOH) study, certain green hydrogen production methods can now deliver as low as US\$28/MMBtu gas equivalent cost for green hydrogen without accounting for any value to the emissions savings or subsidies.⁵ This is more than Canadian natural gas prices but is at a level that is increasingly competitive with 2022 European and Asian spot natural gas import prices. This competitiveness might be partially due to the unusually tight global gas market environment in the last year; however, it does not account for non-economic benefits, including environmental benefits and security of supply-based considerations for low-carbon hydrogen.



Is technology the driver of the low-carbon hydrogen market?

According to Lazard's analysis, electricity costs represent up to 70% of green hydrogen production, with additional significant cost drivers being the capital cost of the electrolyzer equipment and its average utilization.⁵

To achieve high utilization, non-intermittent renewable power is required. Canada's low-cost, abundant low-carbon and non-intermittent power supply offers a natural competitive advantage for green hydrogen production.

The improving cost competitiveness of electrolyzer technology is likely the key global driver of capital cost reductions. Electrolyzers are forecast to follow similar learning curves to those that have been observed for various established renewable energy technologies (e.g., solar, wind, and batteries) in the past based on research by scientists

Way, Ives, Mealy and Farmer. Consistently, there is consensus amongst industry forecasters that green hydrogen will achieve a material reduction in LCOH by 2030. Way, Ives, Mealy and Farmer, also note in their paper that past energy-economy models have often underestimated cost improvements and speed of adoption for novel renewable energy technologies, highlighting the importance of accelerated technology deployment in delivering cost reductions.⁷

The Canadian hydrogen market advantage

Canada has solid foundations for low-carbon hydrogen adoption on the supply and demand side. It has an abundance of cheap and largely non-intermittent renewable power through hydroelectric generation, while other production process inputs (e.g., abundant water and natural gas supply) underpin the country's supply-side case for competitiveness and adoption potential.

On the demand side, Canada is clearly differentiated by its fuel cell sector in the Greater Vancouver Area, where home-grown players are joined by international investors to benefit from the local ecosystem. In addition, the industrial heartlands of Alberta and Ontario offer plenty of hydrogen adoption potential.

Despite these sell and buy-side strengths, the 2022 global natural gas shortage and concurrent European and Asian supply crises have highlighted the importance of maintaining a global demand perspective in Canada, and the obvious focus on domestic hydrogen adoption. In Europe and Asia, low-carbon hydrogen is increasingly considered an alternative fuel to natural gas and, in the case of a low-enough gas-equivalent cost, can generate positive substitution economics to industrial or other end-users.

Hydrogen exports will accelerate industry development

Given Canada's clean energy advantages and global gas supply constraints, we believe that export market development may represent the best immediate economic option for monetizing any low-carbon hydrogen production in the coastal areas. In addition, the parallel pursuit of export and domestic use can help accelerate the cost reduction of the technology through a faster production ramp-up in Canada.

⁵ Lazard, *Levelized Cost of Hydrogen Analysis – Version 2.0*, <https://www.lazard.com/media/451922/lazards-levelized-cost-of-hydrogen-analysis-version-20-vf.pdf>

⁶ KPMG Analysis based on IHS Markit, *Asia Spot LNG Price average Jan to Dec 2022*

⁷ Rupert Way, Matthew C. Ives, Penny Mealy, J. Dooyne Farmer, *Empirically grounded technology forecasts and the energy transition*, Taken from *Joule*, [https://www.cell.com/joule/pdfExtended/S2542-4351\(22\)00410-X](https://www.cell.com/joule/pdfExtended/S2542-4351(22)00410-X)

To date, governments have focused their support on helping the industry make low-carbon hydrogen production more cost-competitive. With rising global demand for hydrogen, the focus will now shift to how exports can contribute to the developing Canadian hydrogen landscape and overall economy.

Canada's federal policy is supportive

The Government of Canada set out its commitment to develop a clean hydrogen economy in 2020, releasing its Hydrogen Strategy for Canada. It reconfirmed that commitment in the 2022 Fall Economic Update and recent 2023 Federal Budget with various funding and financing mechanisms, including:⁸

- Up to 40% investment tax credit for clean hydrogen production investments.
- Additional 30% investment tax credit for clean technologies, including renewable power generation investments developed to feed green hydrogen production facilities.
- C\$15-billion initial commitment to the newly established Canada Growth Fund to support low-carbon hydrogen and other decarbonization initiatives through various offtake contract mechanisms, debt, and equity investments.
- C\$20-billion Canada Infrastructure Bank funding earmarked to finance clean electricity and infrastructure projects.



Development risks are decreasing

Low-carbon hydrogen export projects are potentially less likely to face similar public opposition to new fossil fuel projects like LNG terminals or gas pipelines. Similarly, long-term, low-carbon hydrogen purchase agreements - a pre-requisite for the lowest-cost project financing structures - are consistent with international energy transition objectives. As such, green hydrogen production sites can also be established in existing coastal industrial areas like ports or fuel terminals, mitigating many stakeholder issues and minimizing supply infrastructure needs to transmission lines.

Despite the apparent advantages of low-carbon hydrogen development projects to traditional fossil fuels, their development process remains a complex multi-stakeholder process that requires provincial, federal, and Indigenous engagement.

To effectively mobilize private-sector investment, regulatory and permitting-process requirements will need to be tailored to low-carbon hydrogen and its derivative products both on a local and federal level. The Government of Nova Scotia has taken a significant step in alleviating regulatory risk for developers via their recent legislative actions summarized in the following table.

Nova Scotia legislative actions enabling hydrogen investments⁹

- Electricity Act amendment to allow green hydrogen projects wholesale customer status, a pre-requisite for obtaining cost-efficient electricity supply outside the regulated rate structure.
- Underground Hydrocarbons Storage Act scope expansion to include hydrogen, ammonia, carbon sequestration and compressed air energy storage, thereby providing a specific regulatory framework for alternative low-carbon hydrogen input and derivative product outputs.
- Pipeline Act scope extension to include pipelines built for the transportation of hydrogen and its blends.
- Gas Distribution Act amendment to allow for the Nova Scotia Utility and Review Board to also consider hydrogen as part of a gas distribution system and the rate-setting mechanism.

With other other provinces following suit, Canada may be best positioned to capture the emerging global demand for low-carbon hydrogen and to maintain the benefits of its energy-exporter status during the energy transition.

⁸ Government of Canada, <https://www.budget.canada.ca/>

⁹ Government of Nova Scotia, News release – Legislation Supports Green Hydrogen Development, <https://novascotia.ca/news/release/?id=20221017007>

Reaching Canada's clean energy potential

While the long-term future of Canada's fossil fuel exports may be less certain, the country is poised to retain its role as a leading energy exporter and has the potential to boost its profile as a leading global supplier of low-carbon energy by developing a hydrogen export market. Doing so will require continued support from various levels of government in incentivizing and promoting hydrogen exporters, mobilization of private capital, and public-private cooperation to ensure competitive time to market.

KPMG has long been partnering with clients to help them secure Canada's position in the future of clean energy. Our interdisciplinary team of energy and infrastructure professionals is helping governments and corporations plan and implement long-term energy transition strategies.

We assisted governments with:

- streamlining government policy
- identifying economic development opportunities
- planning and managing complex project procurement processes
- raising development financing
- supporting lifecycle asset management.

In serving corporations, our team has supported:

- market entry strategies
- grant and other funding program applications
- power and energy supply contract negotiations
- investment appraisal, and commercial and technical diligence.

KPMG recognizes that navigating a global energy transformation requires global collaboration. That's why our engagement teams work closely with peers worldwide to deliver cutting-edge insight to domestic producers of low-carbon hydrogen. It's also why our professionals are members of KPMG's Global Decarbonization and Hydrogen networks that connect professionals working at the forefront of the energy transition globally.

KPMG is committed to helping Canada's energy exporters find their place in the ever-evolving energy market. We look forward to working alongside public and private sector leaders to help advance the country's clean energy export potential.

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