PEMBINA institute

January 18, 2020

Hon. Jeff Yurek, Minister of the Environment, Conservation and Parks
College Park 5th Flr, 777 Bay St.
Toronto ON M7A 2J3

Dear Minister Yurek,

Re: Ontario low-carbon hydrogen strategy discussion paper

The Pembina Institute welcomes the opportunity to provide input into Ontario's discussion paper on a low-carbon hydrogen strategy. There is a lot of interest in the role of hydrogen contributing to achieving net-zero emissions. While Ontario is well-positioned to build out a low- and zero-carbon hydrogen economy given the presence of Ontario-based companies that cover multiple elements of the hydrogen supply chain, the scale and potential roles of hydrogen in Ontario's decarbonization pathways is not yet clear in the discussion paper and should be identified in the final strategy.

Hydrogen is not a one-size-fits-all solution for reducing carbon emissions. In order for Ontario to achieve the full decarbonization potential of hydrogen, the strategy must support and advance an ambitious climate plan and must also form a part of a longer-term energy plan. A robust low-carbon hydrogen strategy should, at a minimum, include comprehensive analysis that identifies the sectors that will most benefit from hydrogen deployment, introduce policies to encourage hydrogen production and use, account for regional contexts, and include an investment component that identifies funding of research and commercialization of new and cost-effective technologies and infrastructure.

As the federal government has recently released the *Hydrogen strategy for Canada*, and other provinces are in the midst of developing their own strategies, we encourage Ontario to work with its federal and provincial counterparts when developing and implementing the strategy. Our comments are predominately focused on five pillars outlined in the discussion paper: vision, reducing greenhouse gas emissions, using hydrogen where it makes sense, generating economic development and jobs, and reducing barriers and enabling action. We offer 10 recommendations on how the province can create a strong low-carbon hydrogen strategy. Those recommendations, described in greater detail below, are:

1. Define a declining GHG emission intensity threshold for hydrogen to be deemed "low-carbon" that approaches near-zero by 2030.

2. Establish a standardized methodology to estimate the life cycle GHG emission intensity from existing and emerging hydrogen production pathways.
3. Assess the life cycle impacts of existing and upcoming hydrogen production techniques on the environment and communities in Ontario.
4. Evaluate hydrogen in comparison to emerging or incumbent technologies or other fuels across various sectors to prioritize the best end uses of hydrogen.
5. Assess the ability for hydrogen blended with natural gas to achieve meaningful GHG emission reductions.
6. Identify financial investments and training programs needed to support the development of zero-emission vehicle technologies, including hydrogen fuel cell vehicles.
7. Examine the opportunities to invest in power-to-gas facilities to take advantage of excess renewable electricity production in Ontario that would otherwise represent lost revenue for electricity generators.
8. Examine the opportunities to fund demonstration projects to prove the reliability of hydrogen and fuel cell technology.
9. Set clear timelines for the price on carbon and support the rollout of Canada's forthcoming Clean Fuel Standard.
10. Introduce sector-specific regulations, incentives, and an investment and infrastructure plan to support the appropriate use of hydrogen in certain sectors and end uses.

Vision

We support the government of Ontario's efforts to create a low-carbon hydrogen strategy. We encourage the Ontario government to assert that the ultimate goal of this strategy is to achieve significant GHG emissions reductions in hard-to-abate sectors. In doing so, a hydrogen strategy can be a key lever to help Ontario achieve its 2030 climate target and achieve net-zero by 2050.

Reducing greenhouse gas emissions

Hydrogen's greatest value may lie in its potential to reduce carbon pollution from hard-to-decarbonize sectors and end uses where electrification is not an option, such as high-heat industrial processes and long-haul heavy-duty freight transportation where there may be limitations to battery electric technologies. Hydrogen can also be used in the production of fuels made by synthesizing (or combining) different types of gases. Hydrogen, however, is not a one-size-fits-all solution for reducing greenhouse gas (GHG) emissions.

Only a fraction of hydrogen used today around the world is produced without GHG emissions. The GHG emission intensity of hydrogen is a key metric to look at, and a number of jurisdictions are already exploring the possibility of adopting a GHG intensity threshold for hydrogen to be deemed "low-carbon."[1] The development of such a threshold would allow for the prioritization of hydrogen projects that can help Ontario meet its 2030 climate target. However, it is also critical that the province create GHG emission intensity thresholds that approach zero to meet targets beyond 2030. The adoption and expansion of hydrogen technology will not happen overnight and will require long-term goals. The province should solidify long-term climate targets in line with the federal target of net-zero by 2050 and ensure that future GHG emission intensity thresholds for hydrogen align with this goal.

In their recent *Hydrogen strategy for Canada*, the federal government has stated that near- and mid-term projects must meet a GHG emission intensity threshold of <36.4 g CO_2e per MJ with this threshold declining after 2030.[2] This threshold, however, is above the GHG emission intensity of blue hydrogen produced in Canada using a carbon capture and storage (CCS) rate of only 80%.[3] We recommend the Ontario government set a GHG emission intensity threshold that would require, at the very least, CCS at rates of at least 90% or greater.

It is vital that the GHG emission intensity threshold for low-carbon hydrogen decline rapidly towards zero over time to ensure that long-term climate targets are met. When setting declining targets, the Ontario government should consider cost parity. Some studies show that hydrogen produced from renewables using electrolysis will become cost competitive with current methods of hydrogen production (i.e. steam methane reforming of natural gas) by as early as 2030.[4]

Governments, in consultation with stakeholders, need to establish a standardized methodology to estimate the life cycle GHG emission intensity of various hydrogen production pathways. This will enable a fact-based conversation on the respective climate benefits of various pathways and identify levers to further decarbonize hydrogen production, when needed. Such

[1] Both the European Union and the B.C. government are developing a carbon intensity threshold that defines low-carbon.

[2] Natural Resources Canada, *Hydrogen Strategy for Canada* (2020), XXII. https://www.nrcan.gc.ca/climate-change/the-hydrogen-strategy/23080

[3] Maddy Ewing, Benjamin Israel, Tahra Jutt, Hoda Talebian and Lucie Stepanik, *Hydrogen on the path to net-zero emissions* (Pembina Institute, 2020), 3. https://www.pembina.org/pub/hydrogen-primer

[4] IHS Markit, "IHS Markit: Production of carbon-free "green" hydrogen could be cost competitive by 2030," *IHS Markit*, July 14, 2020. https://news.ihsmarkit.com/prviewer/release_only/slug/bizwire-2020-7-15-ihs-markit-production-of-carbon-free-green-hydrogen-could-be-cost-competitive-by-2030#:~:text=By%202030%20the%20production%20of,analysis%20by%20the%20IHS%20Markit

methodology needs to clarify for each production pathway the upstream sources of GHG emissions to be included in the GHG emission intensity (i.e. activity map), as well as propose a province-specific emission factor for each source of emissions.

Lastly, the production of hydrogen – or the feedstock required for this – can generate non-climate environmental and social impacts. Those impacts need to be examined with a life cycle approach to ensure we don't compromise other facets of the environment in the interest of GHG emissions reductions. For example, the large-scale production of hydrogen from electrolysis requires large volumes of fresh water to be diverted from the hydrologic cycle. Meanwhile, the use of nuclear energy to produce hydrogen could generate difficult-to-manage radioactive waste, and the release of radioactive and hazardous pollutants.[5] Further, hydrogen produced from natural gas bears a wide range of negative effects on the environment and communities in regions where natural gas is developed. Impacts from unconventional natural gas production[6] include groundwater availability and quality, land, biodiversity, air quality, seismicity as well as the health and well-being of communities – including Indigenous communities.[7]

Recommendation #1: Define a declining GHG emission intensity threshold for hydrogen to be deemed "low-carbon" that approaches near-zero by 2030

Recommendation #2: Establish a standardized methodology to estimate the life cycle GHG emission intensity from existing and emerging hydrogen production pathways

Recommendation #3: Assess the life cycle impacts of existing and upcoming hydrogen production techniques on the environment and communities in Ontario

Using hydrogen where it makes sense

As an overarching principle, hydrogen should be prioritized in applications when it is the only low-carbon alternative or where it offers benefits over other low-carbon alternatives. Sectors that are likely well-suited for hydrogen deployment includes heavy-duty long-haul transport and/or heavy industry, but it depends on regional context and conditions.

[5] Mark Winfield, Alison Jamison, Rich Wong and Paulina Czajkowski, *Nuclear power in Canada: An examination of risks, impacts and sustainability* (2006), 3. https://www.pembina.org/reports/Nuclear_web.pdf

[6] Unconventional natural gas represents the bulk of the natural gas produced and consumed in Canada.

[7] Some of these impacts are still not fully well understood, leading some jurisdictions—such as Québec, France, the Netherlands, Scotland, Vermont, New York State, and Maryland—to place moratoriums on the development of unconventional natural gas resources.

The final hydrogen strategy should include a comprehensive review that compares hydrogen to emerging and incumbent technologies on the basis of technology readiness, performance and ability to achieve meaningful life cycle GHG emissions over time (2030 to 2050). For example, hydrogen fuel cell electric vehicles should be evaluated against diesel, natural gas, biofuels and battery electric vehicles for long-haul freight transport, or against natural gas for steel manufacturing. Performance indicators should be developed and weighted differently based on the goals of the strategy (e.g. environmental performance indicators should be weighted with a higher importance).

In these evaluations, we encourage the government to take into account the overall energy efficiency of hydrogen and fuel cell technologies in comparison to incumbent or emerging technologies. In particular, hydrogen and fuel cell technologies tend to be much lower in overall efficiency than electrification as a result of efficiency losses throughout the supply chain. For example, the energy efficiency ratio (i.e. the ratio of energy output to input) of passenger fuel cell vehicles (ratio of 2.5) is considerably lower than that of battery electricity vehicles (ratio of 3.4).[8] Thus, hydrogen technologies should only be prioritized when electrification isn't feasible. Identifying these priority sectors is an important step in determining the role that hydrogen will play in meeting Ontario's climate targets.

A critical evaluation of hydrogen blends (e.g. with natural gas) should be performed in order to determine whether or not blends are expected to result in significant enough life cycle GHG emission reductions over emerging or incumbent technologies to merit deployment. Due to important differences in calorific value of hydrogen on a volumetric basis, the substitution of 20% of natural gas with low-carbon hydrogen will only decrease life cycle GHG emissions by approximatively 8%.[9] Ultimately, blending hydrogen and natural gas is only expected to deliver incremental climate gains. Blending may also require significant investment in repurposing natural gas pipelines to accommodate hydrogen (materials and safety) as well as investment in end uses (appliances and equipment) that may not be able to accommodate hydrogen at more than a modest level ~5%.

Recommendation #4: Evaluate hydrogen in comparison to emerging or incumbent technologies or other fuels across various sectors to prioritize the best end uses of hydrogen

[8] *Hydrogen Strategy for Canada*, 78.

[9] E.A. Polman. J.C. de Laat, M. Crowther et al, *Reduction of CO_2 emissions by adding hydrogen to natural gas* (IEA Greenhouse R&D Program, 2003).

Recommendation #5: Assess the ability for hydrogen blended with natural gas to achieve meaningful GHG emission reductions

Generating economic development and jobs

Economic impact studies estimate that the growth of the hydrogen fuel cell industry in Ontario could create 14,500 to 23,000 new jobs and contribute $1.2 billion to $2.5 billion in revenue over the next 10 years.[10,11] The build-out of a low-carbon hydrogen economy in Ontario could lead to job creation in activities that are directly associated with low-carbon hydrogen production and distribution and in industries like zero-emission vehicle manufacturing.

More broadly, there is significant economic growth and job creation potential and climate gains by building Ontario's zero-emission vehicle market. A study by Navius Research Inc. estimates that, with a national zero-emission vehicle mandate and subsidy for electric vehicle manufacturing, the zero-emission vehicle economy in Canada could account for $152 billion ($2015) of Canada's GDP and employ 1.1 million workers by 2040.[12]

However, as the sector moves towards zero-emission technologies like battery electric or hydrogen fuel cell, Canada's auto manufacturing sector has been slow to adopt these trends: only 0.4% of the light duty vehicles produced in Canada are electric (including battery electric, plug-in hybrid electric and hydrogen fuel cell electric), which is 80% lower than the global average of 2.3%.[13] Additionally, within the heavy-duty vehicle sector – where hydrogen fuel cell technology is likely to play a role in achieving decarbonization – Canada only accounts for 0.03% of global heavy-duty electric vehicle sales, with under 50 units sold in 2018.[14]

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[10] Wenqi Zhao, *The Present Status of Hydrogen Technologies and Project Deployments in Ontario and Canada with an Overview of Global H_2 Activities* (2019).

https://www.researchgate.net/publication/332973809_The_Present_Status_of_Hydrogen_Technologies_and_Project_Deployments_in_Ontario_and_Canada_with_an_Overview_of_Global_H2_Activities

[11] Green Ribbon Panel, *Clean air, climate change and practical, innovative solutions to grow the economy and reduce greenhouse gas emissions in Ontario* (2020), 37.

[12] Navius Research, *Simulating zero emission vehicle adoption and economic impacts in Canada* (2020), 31. https://theicct.org/publications/zev-impacts-canada

[13] Ben Sharpe, Nic Lutsey, Cedric Smith and Carolyn Kim, *Power Play: Canada's Role in the Electric Vehicle Transition* (International Council on Clean Transportation and Pembina Institute, 2020), 4. https://www.pembina.org/pub/power-play

[14] Ibid, 1.

We encourage the Ontario government to convene discussions with industry, labour and unions, manufacturers, and other relevant actors toto identify the resources and supports needed to support manufacturing and development of zero-emission technologies.

Ontario also has a clear opportunity to benefit from the production of low-carbon hydrogen using excess renewable electricity. Ontario's supply of renewable electricity can at times exceed demand. For instance, Ontario reduced its renewable electricity generation by 6-8 TWh in 2016, representing significant lost revenue.[15] Excess renewable electricity in Ontario could instead be used to produce low-carbon hydrogen through the process known as power-to-gas. This hydrogen can then be sold to end users in various sectors, or converted back to electricity using fuel cells during peak demand periods. A power-to-gas facility in Markham has been piloting this pathway over the past two years for the purposes of enhancing grid stability.[16]

Recommendation #6: Engage key stakeholders associated with the auto manufacturing sector and relevant technology companies in Ontario to identify the financial investments and training programs that are needed to transition the sector to one that is centered around zero-emission vehicle technologies, including hydrogen fuel cell vehicles

Recommendation #7: Examine the opportunities to invest in power-to-gas facilities to take advantage of excess renewable electricity production in Ontario that would otherwise represent lost revenue for electricity generators

Reducing barriers and enabling action

Though hydrogen and fuel cell technologies are not necessarily new, the applications and potential costs and benefits need to be communicated to the public. Demonstration projects can be useful to showcase the reliability and net-benefit of hydrogen and fuel cell technology in hard-to-abate sectors. For instance, while the use of hydrogen in steel production has enabled carbon-neutral steel manufacturing, it has not yet occurred on a large scale.[17] Demonstration

[15] *Hydrogen Strategy for Canada*, 23.

[16] Enbridge Gas Inc, "Enbridge gas announces a $5.2M hydrogen blending pilot project to further explore greening of the natural gas grid," *News Wire*, Nov 18, 2020. https://www.newswire.ca/news-releases/enbridge-gas-announces-a-5-2m-hydrogen-blending-pilot-project-to-further-explore-greening-of-the-natural-gas-grid-849137548.html#:~:text=The%20Markham%20Power%2Dto%2DGas%20facility%20was%20commissioned%20in%202018,demand%20and%20ensure%20system%20reliability.

[17] Christian Hoffmann, Michel Van Hoey and Benedikt Zeumer, *Decarbonization challenge for steel: Hydrogen as a solution in Europe* (McKinsey, 2020), 8-10. https://www.mckinsey.com/~/media/McKinsey/Industries/Metals%20and%20Mining/Our%20Insights/Decarbonization%20challenge%20for%20steel/Decarbonization-challenge-for-steel.pdf

projects can prove the viability of hydrogen technology for sectors like steel manufacturing in Ontario.

Ontario's hydrogen strategy should send strong regulatory signals in support of low-carbon hydrogen technologies. Broadly, this includes both a price on carbon and support for the federal government's forthcoming Clean Fuel Standard. Scheduled increases on the price of carbon pollution will help reduce emissions in a fair, cost-effective and flexible way, and will make low-carbon solutions more affordable while providing certainty for business and investors. A Clean Fuel Standard can help drive billions of dollars of investment into additional production capacity for low-carbon fuels like hydrogen.[18] Opposing these policies would be counterproductive to the goals of this strategy.

Once the Ontario government identifies the best application of hydrogen, consideration should be given to setting sector-specific regulations and incentives to grow demand. As an example, a zero-emission vehicle sales mandate has shown to be effective in increasing the available supply of ZEV models.[19,20] Ontario could benefit from a mandated ZEV sales target that encompasses light-, medium- and heavy-duty vehicles.

An infrastructure and investment plan is needed to support the implementation of Ontario's low-carbon hydrogen strategy. For example, should heavy-duty long-haul transport be identified as a priority area, a plan to buildout adequate private and public refueling infrastructure would be important. Without access to hydrogen refueling infrastructure, the transportation sector is unlikely to adopt fuel cell vehicles. Considerations should also be given to incentive programs to grow wide-spread demand.

Recommendation #8: Examine the opportunities to fund demonstration projects to prove the reliability of hydrogen and fuel cell technology

Recommendation #9: Set clear timelines for the price on carbon and support the rollout of Canada's forthcoming Clean Fuel Standard

[18] Pembina Institute, *Canada's Clean Fuel Standard* (Pembina Institute, 2020), 10. https://www.pembina.org/reports/clean-fuel-standard-setting-the-record-straight.pdf

[19] John Axsen, Suzanne Goldberg and Michael Wolinetz, *Accelerating the Transition to Electric Mobility in Canada: The case for a zero-emission vehicle mandate* (Equiterre, 2017),10, 53-54. https://www.equiterre.org/sites/fichiers/repac_en.pdf

[20] Environnement et Lutte contre les changements climatiques, *Zero Emission Vehicle (ZEV) Standard: Report on the Results of the First Compliance Period* (2020), 7. www.environnement.gouv.qc.ca/changementsclimatiques/vze/bilan-norme-vze-periode-1-en.pdf

Recommendation #10: Introduce sector-specific regulations, incentives, and an investment and infrastructure plan to support and grow the use of hydrogen in certain sectors and end uses

The Pembina Institute appreciates the opportunity to submit comments on Ontario's *Low-Carbon Hydrogen Strategy – Discussion paper*. We look forward to remaining engaged in the strategy development process.

Yours sincerely,

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