PEMBINA institute

Advancing Alberta's hydrogen strategy

Pembina Institute recommendations for implementation

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Regarding: *Natural Gas Vision and Strategy,* hydrogen strategy

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Summary

The Pembina Institute welcomes the opportunity to provide input on Alberta's hydrogen strategy. The growing interest in hydrogen lies in the potential contribution it can have in reducing GHG emissions both locally and internationally and supporting Alberta and Canada's achievement of a net-zero economy. Alberta is well-positioned to build out a low- and zero-carbon hydrogen economy, given plentiful wind and solar resources to generate electricity, low-cost natural gas production, and experience with carbon capture and storge. Hydrogen is not a one-size-fits-all solution for reducing carbon emissions. For Alberta to achieve the full decarbonization potential of hydrogen, the strategy shouldn't be limited by its relation to the natural gas sector, but be part of a broader climate plan that is aligned with Canada's 2030 and 2050 emissions reduction goals. An integral part of this is a commitment to achieving net-zero emissions by 2050.

The Pembina Institute sees low- and zero-carbon hydrogen as being able to play a role in decarbonizing Canada's energy systems. For Alberta's hydrogen to be competitive on a global scale, it will have to achieve the lowest carbon intensity possible. While hydrogen has potential applications in many sectors, its greatest value may lie in its potential to reduce carbon pollution from hard-to-decarbonize sectors and end uses, such as long-haul heavy-duty freight transportation, and high-heat industrial processes.

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, 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 Alberta to work with its federal and provincial counterparts when developing and implementing the strategy.

We offer 12 recommendations for developing a strong low-carbon hydrogen strategy:

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. Evaluate hydrogen in comparison to emerging or incumbent technologies across various sectors to prioritize the best end uses of hydrogen.
4. Examine the opportunities to invest in facilities to convert electricity to hydrogen to take advantage of cheap renewable electricity production and provide flexibility to the grid.
5. Assess the potential for hydrogen blended with natural gas to achieve meaningful GHG emission reductions.
6. Evaluate global competitiveness of Alberta's hydrogen on cost and carbon and the supply and infrastructure requirements to meet different domestic and/or international demand scenarios.
7. Develop and deploy tools and technologies to facilitate the development of both zero-carbon hydrogen production and low-carbon hydrogen production that is as clean as possible.
8. Develop a regulatory framework to clarify legal uncertainties around development of CCS and ensure permanent geological sequestration of CO_2 in carbon capture, utilization, and storage applications.
9. Consult with stakeholders and develop standards to certify hydrogen streams on a set of environmental, social and governance metrics and/or specifically on their life cycle GHG emission intensity.
10. Assess the life cycle impacts of existing and upcoming hydrogen production techniques on the environment and communities.
11. Develop a comprehensive public engagement strategy to inform and address public concerns related to hydrogen technologies.
12. Set a provincial net-zero target with defined short-term milestones and implement policy that includes clear timelines for increasing the price on carbon and support for Canada's Clean Fuel Standard.

Define a GHG emission intensity threshold for hydrogen to be deemed "low-carbon"

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 Alberta lower its greenhouse gas emissions. 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. For Alberta's hydrogen to be competitive on a global scale, it will have to achieve the lowest carbon intensity possible.

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 Alberta government set a GHG emission intensity threshold that would require, CCS capture 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 Alberta 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] As investors increasingly consider environmental performance as an important metric, Alberta's hydrogen will need to be as low carbon as possible to attract investment and compete globally if the province seeks to export hydrogen or products made with hydrogen energy.

[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

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 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. In the case of hydrogen produced from fossil fuels (e.g., natural gas), Pembina advocates the methodology include GHG emissions stemming from natural gas production operations such as fugitive, flared, and vented emissions (including release of formation CO_2) and all the emissions associated with the production of hydrogen as well as capture, transport, and storage of carbon. This tool will be critical to compare the climate benefits of various sources of hydrogen.

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.

Using hydrogen where it makes sense

Investments in hydrogen will have the best chance of success if they are prioritized in sectors where it is likely to have a competitive advantage over other low carbon fuels on cost and environmental benefits. Hydrogen may be best suited to reduce carbon pollution from hard-to-decarbonize sectors and end uses, such as long-haul heavy-duty freight transportation, and high-heat industrial processes. The Government, in consultation with stakeholders, should identify these priority sectors through a comprehensive review of hydrogen in comparison to emerging and incumbent technologies based on technology performance, life cycle GHG emissions reduction potential and cost 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, and hydrogen power plants should be compared against renewables, battery storage, energy efficiency, and demand flexibility in the power sector.

Alberta’s electricity sector has a significant opportunity to be a producer and end user of hydrogen. The province’s abundant high-quality wind and solar resources can be used to produce hydrogen, particularly during the times when electricity from renewables (at near zero cost) exceeds the demand for it. This hydrogen can then be stored and converted back to electricity when needed to meet peak demand, thereby avoiding the need for additional generation. It can also be transported to end users in various sectors, as well as to adjacent jurisdictions. This opportunity will continue to grow as the cost of renewables continues to fall and more wind and solar is built.

In these evaluations, we encourage the government to consider 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).[5] 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 reducing Alberta's emissions.

An evaluation of hydrogen blends (e.g., with natural gas) should be performed, as well, 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 approximately 8%.[6] While blending hydrogen and natural gas is only expected to deliver incremental climate gains in the long term, it could be a useful short-term strategy to scale supply. The investments required to repurpose natural gas pipelines (materials and safety) and retrofit end uses (appliances and equipment) to accommodate concentrations of hydrogen greater than ~5% may be significant should be evaluated carefully.

If Alberta is seeking to export hydrogen, it needs to assess infrastructure requirements and costs for reaching domestic and/or international markets. An assessment of potential domestic and international supply and demand scenarios is also needed to evaluate the opportunities and timelines. As hydrogen scales globally, competitiveness on both cost and carbon will be important to consider. As Alberta considers a hydrogen export strategy, an understanding of how its hydrogen will compete against global supply will be important.

Recommendation #3: Evaluate hydrogen in comparison to emerging or incumbent technologies across various sectors to prioritize the best end uses of hydrogen.

Recommendation #4: Examine the opportunities to invest in facilities that convert electricity to hydrogen, to take advantage of cheap renewable electricity production and provide flexibility to the grid.

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

[6] 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 potential for hydrogen blended with natural gas to achieve meaningful GHG emission reductions.

Recommendation #6: Evaluate global competitiveness of Alberta's hydrogen on cost and carbon and the supply and infrastructure requirements to meet different domestic and/or international demand scenarios.

Demonstrate low-carbon hydrogen production

To ensure that Canada's hydrogen production and use contributes as effectively as possible to achieving its net-zero goal, tools and technologies will need to be deployed to facilitate the development of both zero-carbon hydrogen production and low-carbon hydrogen production that is as clean as possible. This means allocating funding to the research, development and commercialization of cost-effective hydrogen production techniques that allow for an increasingly lower GHG emission intensity — or no GHG emissions at all. This includes policy and investments to reduce natural gas upstream emissions for hydrogen produced from natural gas,[7] and maximizing the rate of carbon capture for hydrogen that incorporates carbon capture and storage (CCS).[8]

Recommendation #7: Develop and deploy tools and technologies to facilitate the development of both zero-carbon hydrogen production and low-carbon hydrogen production that is as clean as possible.

Develop a regulatory framework to ensure permanent geological sequestration of CO_2 in carbon capture and storage applications

Carbon capture and storage is a key process involved in the production of low-carbon hydrogen from natural gas. One of the key building blocks of a hydrogen economy are robust regulations to ensure that the CO_2 that is captured and stored is permanently removed from the atmosphere as well as to assure public acceptance of the technology. While Alberta is a recognized leader in CCS, it has not fully implemented a regulatory framework. Improving regulatory frameworks will enable and incent the development of CCS projects as well as contribute to addressing public acceptability issues around CCS. Such regulations need to

[7] Natural gas production is associated with significant levels of GHG emissions, primarily from methane emissions (i.e., fugitive, venting, flaring), combustion to run operations as well as CO_2 formation contained in natural gas.

[8] While existing CCS projects in Canada operate with a carbon capture rate well below 90%, there is technology that can achieve capture rates above 90% to 95% but needs to be commercially demonstrated.

address legal uncertainties such as the ownership of pore space, management of long-term liability, barriers to social acceptability, monitoring of CO_2 sequestration, surveillance of possible adverse environmental impacts relative to CO_2 injection as well as possible risks posed to human health. Specifically, the recommendations of the 2013 Regulatory Framework Assessment should be implemented and regulations regarding the permanence of storage and measurement, monitoring and verification are needed for enhanced oil recovery reservoirs in addition to saline storage.

Recommendation #8: Develop a regulatory framework to clarify legal uncertainties around development of CCS and ensure permanent geological sequestration of CO_2 in carbon capture, utilization, and storage applications.

Develop standards to certify hydrogen production

Standards should be developed to certify hydrogen on a number of environmental, social and governance (ESG) metrics, which could contribute to establishing Canada's competitiveness within domestic and global hydrogen markets. Standards looking specifically at life cycle GHG emissions intensity could also be developed to guarantee the climate impact of a given stream of hydrogen, whether "low-carbon," "zero-carbon," or "carbon-negative" hydrogen.

Recommendation #9: Consult with stakeholders and develop standards to certify hydrogen streams on a set of environmental, social and governance metrics and/or specifically on their life cycle GHG emission intensity.

Assess the life cycle, non-climate environmental and social impacts of hydrogen production

The production of hydrogen – or the feedstock required for this – can generate non-climate environmental and social impacts. Those impacts need to be investigated and assessed 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. Similarly, hydrogen produced from natural gas bears a wide range of adverse impacts on the environment and communities in regions where natural gas is developed. Impacts from unconventional natural gas production include groundwater availability and quality, land, biodiversity, air quality, seismicity as well as the health and well-being of communities – including Indigenous communities.[9]

Recommendation #10: Assess the life cycle impacts of existing and upcoming hydrogen production techniques on the environment and communities.

Reducing barriers and enabling action

Though hydrogen technologies are not necessarily new, the applications, infrastructure requirements, costs and environmental impacts need to be communicated to the public. Demonstration projects can be useful to showcase the reliability and net-benefit of hydrogen in hard-to-abate sectors. Furthermore, effective communication and engagement plans to inform the public and address concerns will be necessary to ensure social license for this emerging sector. Public questions relating to safety, climate benefit, other environmental impacts, job potential, infrastructure requirements, market potential and financial investments required by the public and private sector need to be addressed.

Alberta needs to commit to achieving reductions in greenhouse gas emissions that are consistent with Canada's 2030 and 2050 targets. The province also needs to start implementing policies to achieve those goals. Hydrogen has a role to play, but must be a part of a complete plan. Complementary policies can send strong regulatory signals in support of low-carbon hydrogen technologies that will enable the hydrogen sector to take off. These include an increasing price on carbon and a commitment to the 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. The 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.

Recommendation #11: Develop a comprehensive public engagement strategy to inform and address public concerns related to hydrogen technologies.

Recommendation #12: Set a net-zero target with defined short-term milestones and start to implement policy that includes clear timelines for increasing the price on carbon and support for Canada's Clean Fuel Standard.

[9] 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.

Looking ahead

The Pembina Institute appreciates the opportunity to submit comments on Alberta's Hydrogen Strategy and looks forward to remaining engaged with all stakeholders as part of the continued strategy development.