Hydrogen Roadmap - Policy, Regulation and Prospects for Future Development in Alberta

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1. Introduction

The world is decarbonizing and as a result must address the question of how to reduce and ultimately replace reliance on fossil fuels. This question is particularly acute in certain segments of the economy, such as trucking and aviation, both of which do not easily lend themselves to transitions from fossil fuels to alternatives. Further, among certain governments and industries, there is a keen desire to manage the transition to lessen or avoid significant declines in economies heavily reliant on traditional oil and gas development. Hydrogen, unique among clean energy alternatives, is put forward as a path which can balance these tensions. Hydrogen is considered a "clean" fuel as its only by-products on consumption are heat and water. Hydrogen applications, in the form of fuel cells, make it attractive for use in vehicles and other long distance transportation sectors such as long-haul trucking. Moreover, hydrogen production through thermal processes utilizes natural gas, in conjunction with carbon capture, making it attractive to the oil and gas industry. Taken together, hydrogen is a promising option for jurisdictions that are both seeking to tackle climate concerns while finding new markets for existing petroleum resources. This fact has not been lost on many governments around the world, including in particular the Government of Alberta.

Against this backdrop, we examine the policy, regulation, and prospects for future development of hydrogen. Our analysis, divided into four sections, is set out in parts 2-5 of this paper. In Part 2, we provide a high level overview of hydrogen, discussing the properties of hydrogen that make it attractive as a "clean" fuel, the processes by which hydrogen is made, and the applications that hydrogen currently and potentially has. In Part 3, we dissect the current policy landscape as found in each of Alberta, Canada, and internationally. In Part 4, we move beyond the policy landscape and assess the regulatory environment within which current hydrogen projects are assessed, permitted, and constructed. By bringing together the Alberta, Federal, and international perspectives we ask and answer the question of whether regulatory reform in Alberta is needed, including whether a dedicated regulatory regime for hydrogen, akin to the regime currently in place for oil and gas, is required. Lastly, in Part 5, we consider the prospects for hydrogen development in Alberta by specifically looking at the questions of what "clean" (i.e., low emission) hydrogen means in Alberta and whether there is need for incremental regulatory reforms to address current and future hydrogen development.

2. Hydrogen Demystified

a. What is hydrogen, and how is it made?

Hydrogen is one of the most abundant elements in the universe.[2] Despite its abundance, pure hydrogen (i.e., hydrogen which is not combined with other elements), is not widely accessible on Earth. Instead pure hydrogen must be isolated through various processes.[3] Water is an example of this dynamic; the chemical formula for water is H_2O, denoting that each molecule of water contains two atoms of hydrogen and one atom of oxygen. Hydrogen production is the process of separating the "H" molecule from the H_2O compound. As we will see, the process utilized to effect this separation is a fundamental consideration in determining the net benefit of hydrogen from a carbon emissions standpoint.

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[2] U.S. Energy Information Administration, "Hydrogen Explained" (March 12, 2022), online: <https://www.eia.gov/energyexplained/hydrogen/>

[3] *Ibid*

At present, there are multiple ways to produce hydrogen including processes involving water, fossil fuels, nuclear power, wind power, solar power and biomass.[4] Production of hydrogen using water and fossil fuels, mostly natural gas, are by far the most common methods.[5] For example, the process of fossil fuel reforming is a thermal process involving steam reacting with a hydrocarbon fuel (e.g., natural gas, diesel, gasified coal) to produce hydrogen.[6]

b. Hydrogen uses

Currently, most hydrogen uses are industrial in nature and include applications for oil refining, ammonia production, methanol production and steel production.[7] Emerging areas for hydrogen use include long range transportation (i.e., rail and shipping) and residential and commercial heating. Long-haul trucking is a difficult sector in which to reduce emissions; however, as vehicles powered by hydrogen fuel cells are becoming increasingly viable as a fuel source, hydrogen may be the key to decarbonization of this sector. Blending of hydrogen with natural gas for use in residential and commercial buildings is gaining momentum with many pilot projects underway or planned. Moreover, regulatory changes, such as those seen in British Columbia, are facilitating cost recovery for utilities who offer blended gas.[8]

c. Benefits and challenges

Hydrogen is a "clean" fuel meaning that when consumed its byproducts are heat and water.[9] This is a significant benefit over comparable fuels such as gasoline or diesel. Further benefits of hydrogen include the fact it can be produced from a variety of methods, including renewable processes.[10] Because of this versatility, hydrogen can also function as a method of storing renewable energy (i.e., using renewable power to create hydrogen, then using that hydrogen for power generation).

Hydrogen can be stored in several ways, including mixing with ammonia or, potentially, by injecting hydrogen into underground caverns.[11] Hydrogen storage poses significant technological, safety, and cost challenges, however. Owing to the nature of hydrogen, compression of hydrogen

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4 Office of Energy Efficiency and Renewable Energy, "Hydrogen Fuel Basics" U.S. Department of Energy (March 12, 2022), online: <https://www.energy.gov/eere/fuelcells/hydrogen-fuel-basics>

5 IEA Paris, "The Future of Hydrogen", International Energy Agency (March 12, 2022), online: <https://www.iea.org/reports/the-future-of-hydrogen>

6 *Supra* note 4, wherein it is stated, "Thermal processes for hydrogen production typically involve steam reforming, a high-temperature process in which steam reacts with a hydrocarbon fuel to produce hydrogen. Many hydrocarbon fuels can be reformed to produce hydrogen, including natural gas, diesel, renewable liquid fuels, gasified coal, or gasified biomass. Today, about 95% of all hydrogen is produced from steam reforming of natural gas."

7 *Ibid*

8 *Supra* note 6; See also Jay Lalach, Adriana Da Silva Bellini, Jimmy Burg, Emma Hobbs and Gabrielle Matheson, "Is Hydrogen the Silver Bullet?", Energy Regulation Quarterly, Vol. 9, Issue 3 2021

9 *Supra* note 5

10 The prime example of renewable hydrogen production is Electrolysis. Electrolysis involves the use of an electric current to split water into hydrogen and oxygen. If the electricity is produced by renewable sources, such as solar or wind, the resulting hydrogen will be considered renewable as well.

11 *Supra* note 6

gas is required to increase the density and thereby ensure efficient storage.[12] Even when compressed, hydrogen gas occupies more space than natural gas or liquid hydrogen, thereby necessitating large and costly tanks or storage areas.[13] Creating liquid hydrogen is a complex process in and of itself. For one thing, special tanks are required to address and minimize losses due to hydrogen evaporation.[14] Moreover, liquid hydrogen requires cryogenic cooling to -240 C, followed by storage in vacuum-insulated vessels that are maintained at – 253 C.[15] All of which is costly and complicated.

Transporting pure hydrogen through pipelines is a challenging endeavor which has yet to be undertaken on a large scale in Canada. Blending hydrogen with natural gas is viewed as a cost-effective alternative but is limited by the volume of hydrogen that can be blended (in the range of 15% to 20% by volume).[16] This is because of "hydrogen embrittlement", a phenomenon which occurs when hydrogen interacts with metal under stress in a pipeline. Due to the exceptionally small size of hydrogen molecules, hydrogen can diffuse through most materials which may result in degradation of steel and contribute to crack propagation.[17]

To address hydrogen embrittlement, pipelines need to be "made of high quality non-porous materials such as stainless steel."[18] Pipes can also be insulated, embrittlement-resistant steels used, or small quantities of other gases can be added.[19] Plastic pipes are not dependable as "hydrogen permeates through plastic four to six times as fast as natural gas."[20] Fittings, gaskets and other materials need to withstand hydrogen diffusion as well.[21] Due to the cost prohibitive nature of the aforementioned mechanisms required to facilitate the transport of hydrogen via pipeline, existing natural gas and other industry infrastructure is not presently capable of handling pure hydrogen streams.

In sum, despite being a clean and powerful source of energy, with many current and future uses, hydrogen development and utilization is not without limitations. From production methods that produce copious quantities of emissions to difficulties with storage and transportation, we may

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[12]Giuseppe Sdanghi et al., "Towards Non-Mechanical Hybird Hydrogen Compression for Decentralized Hydrogen Facilities", Energies 2020, 13, 3145

[13] Andrzej Rusin and Katarzyna Stolecka, "Modeling the Effects of Failure of Pipelines Transporting Hydrogen", Chemical and Process Engineering 2011, 32(2)

[14] *Supra* note 13; The loss of hydrogen is particularly acute owing to the small molecular size of hydrogen which allows it to escape more easily than other gases

[15] Muhammad Aziz, "Liquid Hydrogen: A Review of Liquefaction, Storage, Transportation, and Safety", Energies 2021, 12, 5917

[16] Andrew J. Slifka et al., "Fatigue Measurement of Pipeline Steels for the Application of Transporting Gaseous Hydrogen", Journal of Pressure Vessel Technology, February 2018, Vol. 140 / 011407-1

[17] G. Gabetta et al., "Hydrogen Embrittlement in Pipelines Transporting Sour Hydrocarbons", Procedia Structural Integrity 13 (2018)

[18] R. Kleijn et al., "Resource Constraints in a Hydrogen Economy Based on Renewable Energy Sources: An Explanation", Renewable And Sustainable Energy Reviews, 14(9), 2784-2795. doi:10.1016/j.rser.2010.07.066

[19] *Ibid*

[20] *Ibid*

[21] *Ibid*

not yet have the appropriate technological capability or investment confidence needed to develop hydrogen to its full potential on an expedited basis. However, much of the policy guidance currently swirling around hydrogen acknowledges and seeks to address these shortcomings.

3. Current Policy Landscape

In this section, we discuss the current policy landscape surrounding hydrogen development. We start locally, with a detailed look at the Alberta Hydrogen Roadmap. We then move to consideration of the Government of Canada's National Hydrogen Strategy. We briefly touch on hydrogen policy in other Canadian jurisdictions before concluding with a review of international hydrogen policy in the European Union, China, Japan, and the United States.

a. Alberta - Hydrogen Roadmap

In November of 2021, the Alberta Hydrogen Roadmap ("**Roadmap**") was published.[22] As the name suggests, the Roadmap sets out the provinces' vision for the development of a robust hydrogen industry with long-term export potential.[23] As for why Alberta is well suited to capitalize, the Roadmap cites four rationales: (1) Alberta is home to large natural gas reserves which can be used to produce hydrogen, (2) Alberta has abundant carbon sequestration capacity well-suited to storing emissions associated with natural gas production of hydrogen, (3) Alberta has a large and rapidly developing renewable energy sector, and (4) Alberta has the existing assets needed to produce low cost hydrogen.[24]

Using the five broad categories set out in the Roadmap to guide our discussion, we consider the contents of the Roadmap to draw conclusions on the viability of hydrogen development in Alberta. These categories are:

1. *Clean Hydrogen in Alberta* – focuses on assessing the logistical questions associated with hydrogen, such as production, storage, and distribution.
2. *Carbon Capture Utilization and Storage* – looks at the interplay between natural gas hydrogen production and the need for CCUS in order to achieve realizable emissions reductions.

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[22] Alberta Hydrogen Roadmap, Ministry of Energy, November 2021, online <https://www.alberta.ca/hydrogen-roadmap.aspx>

[23] It is noteworthy that the genesis for the Hydrogen Roadmap was in fact a separate government document, namely the *2020 Alberta Recovery Plan and Natural Gas Vision and Strategy*. This document highlighted the ambition of incorporating hydrogen into Alberta's current energy systems, in large part as a means of ensuring ongoing demand for Alberta natural gas.

[24] *Supra* note 22, at pg. 4; It is also worth noting that the Hydrogen Roadmap does not use the terms "green, blue or grey" hydrogen. These terms are often seen in other contexts to denote the carbon intensity associated with a particular type of hydrogen production. For example, hydrogen produced using renewable energy is classified as green hydrogen, hydrogen produced from fossil fuels coupled with carbon capture is classified as blue hydrogen, or if no carbon capture such production is classified as grey hydrogen. The absence of reference to these classifications is telling. Alberta's current hydrogen production, and indeed proposed short-term production methods, would be considered grey, or at best blue but with levels of carbon intensity that they might face scrutiny.

3. *Technology and Innovation* – considers the gaps in current technology that need to be addressed to make large scale hydrogen a reality.

4. *Alberta's Hydrogen Markets* – discusses the various markets for hydrogen with an emphasis on domestic (i.e., Alberta) uses and consideration of potential export markets.

5. *Alberta's Hydrogen Future* – considers scenarios for how hydrogen development may unfold over the coming years, and what actions are needed today.

i. Clean Hydrogen in Alberta

Focusing primarily on the current production methods employed in Alberta and notable pending projects, the Roadmap includes a discussion of logistical matters such as storage, transportation, distribution, and international standards of emissions intensity. Natural Gas Steam Methane Reforming ("**SMR**") is identified as the dominant production method for hydrogen in Alberta. SMR is an industrial thermochemical process that combines hydrocarbons and steam into hydrogen and CO_2.[25] The combined hydrogen and CO_2 gas is subjected to a further water gas shift reaction to increase the yield of hydrogen before the final separation process is used to obtain a stream of high purity hydrogen.[26] This process is not low emission. Rather, to make the process "clean" an additional step is required, namely carbon capture and storage.[27]

An alternative to SMR is Autothermal Reforming ("**ATR**"). This process uses natural gas, steam, and oxygen in the reforming process. The resulting CO_2 is pure, making carbon capture more efficient. The Roadmap anticipates ATR will become the dominant method of hydrogen production in Alberta in the near term.[28]

In addition to SMR and ATR, the Roadmap outlines alternative methods of hydrogen production that are in the initial stages of development, but which eventually may be considered for wider use in Alberta. These include renewable-based production through such means as solar, wind, hydroelectric, geothermal, and even nuclear. As is acknowledged in the Roadmap, these methods are presently constrained by economic and technical limitations. In addition, so called "emerging technologies" are briefly discussed as having a role to play in future production.[29] These include production of hydrogen by natural gas decomposition, biomass derived hydrogen and underground gasification.

With respect to scaled hydrogen production, the Roadmap notes that storage and transportation are complicating factors. To better meet the challenges related to hydrogen usage, such as the requirement that hydrogen be compressed or converted to liquid though costly cryogenic methods

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[25] *Supra* note 22

[26] *Supra* note 22

[27] *Supra* note 22, at pg. 18

[28] *Supra* note 22, at pg. 19

[29] *Supra* note 22

in order to be stored or shipped, the Roadmap calls for coordinated research and industrial management.[30]

Regarding pipelines, the Roadmap identifies shipping by pipeline to be the most economic means of long distance distribution, but notes there are currently limited dedicated pipelines for hydrogen and no high pressure lines for pure hydrogen in Canada. Further, given the corrosive nature of hydrogen, pipeline materials must be resilient and technology to compress hydrogen must advance with corresponding safety controls and risk management. Consequently, to address the above mentioned factors, changes are needed to pipeline standards to facilitate the transportation of pure hydrogen.

Lastly, this section of the Roadmap touches upon what is meant by "clean" hydrogen. As the overall potential of hydrogen as a low carbon energy source rests on the production method used, the international community has begun developing standards in this regard and adopted as shorthand a colour classification scheme (i.e., green hydrogen from renewables with low to no emissions, grey hydrogen from fossil fuels without carbon capture).

CertifHY, a European based entity, certifies low-carbon hydrogen projects based on a carbon intensity threshold that is inclusive of upstream emissions. The Roadmap compares current and future Alberta production methods against the current CertifHY threshold of 4.37 kg of CO_2 per kg of hydrogen, inclusive of upstream emissions. The results are not encouraging: current SMR production, even with carbon capture of 85%, would exceed the CertifHy threshold, and ATR production, with carbon capture of 91%, would just fall under the threshold. It will be important to monitor how additional or new standards in either Canadian or proposed export markets impact these and similar assessments of carbon thresholds. If other jurisdictions in Canada or internationally adopt standards that are comparable to the CertifHY benchmark, there will be pressure on Alberta to ensure its low-carbon hydrogen production meets similar standards.

ii. CCUS

Part of the solution to the issue of carbon emissions may lie in increased Carbon Capture Utilization and Storage ("**CCUS**"). The Roadmap evaluates the interplay between hydrogen production and CCUS by looking at three discrete issues: (1) the current state of CCUS in Alberta, (2) opportunities for CCUS to facilitate hydrogen production, and (3) integrating CCUS in the economy more broadly. The Roadmap discusses the history of CCUS in Alberta, including large-scale CCUS projects such as the Shell Quest project northwest of Edmonton and operation of the Alberta Carbon Trunk Line. Through analysis of the capability of existing and future projects to address CCUS associated with hydrogen production, the Roadmap implies that Alberta is better positioned than most jurisdictions to manage emissions from large scale natural gas hydrogen production.

Similarly, the Roadmap proposes the development of "industrial clusters," which are multiple hydrogen production facilities in proximity to distribution means and existing or planned CCUS infrastructure, to capitalize on opportunities to expand CCUS capability in Alberta. Alberta's

[30] *Supra* note 22; The Roadmap presents three scenarios for future distribution in Alberta (1) centralized distribution and involves the storage of produced hydrogen in one large location that is connected to various end users, (2) decentralized mode of distribution involves smaller production located near end users, (3) semi-central mode of distribution requires a hybrid involving mid-sized producers located near end users.

Heartland Region is suggested as an example of an "industrial cluster" that could be replicated elsewhere in the province to facilitate ramped-up hydrogen production.

iii. Technology and Innovation

The Roadmap identifies gaps in the current technology and scientific understanding of certain types of hydrogen production, scalability, and logistics. The Roadmap calls for these gaps to be closed to ensure the future success of hydrogen development. A robust list of areas in need of technological innovation or further study is provided, and includes: (1) underground coal gasification with CCUS and biomass conversion, (2) better understanding of the impacts of hydrogen on high-pressure steel pipes, compression equipment, welding and other aspects associated with transportation via pipeline, and (3) the ability to effectively store hydrogen, for example, in salt caverns owing to the small molecular size of hydrogen. To close the technological and scientific gaps that are a barrier to hydrogen development, both public and private support is required. To this end, the Roadmap highlights the role of public entities such as *Alberta Innovates* and *Emissions Reduction Alberta* as key vehicles to drive the understanding forward.

iv. Alberta's Hydrogen Markets

Having evaluated the current state of hydrogen development, the need for CCUS, and the technological and scientific gaps that exist, the Roadmap shifts focus to end use considerations. First, the Roadmap discusses potential markets for Alberta's hydrogen before engaging in an analysis of the future prospects for the development and scaling- up of hydrogen production in Alberta. Five "leading" markets for Alberta hydrogen are listed: (1) industrial processes, (2) residential and commercial heating, (3) power generation and storage, (4) transportation, and (5) export.

As of 2021, Alberta was the largest Canadian producer of hydrogen for industrial applications, producing approximately 2.4 million tonnes of hydrogen for this purpose alone.[31] Nearly all of this was produced using the SMR method. Many current industrial processes are highly dependent on hydrogen as input, including chemical production, and manufacturing of industrial gases.

Regarding export capability, ammonia is an important consideration, given that ammonia (NH_3) has the potential to function as a transportation vector for hydrogen. Ammonia can be transported and then "reformed," through chemical processes, back to one nitrogen atom and three hydrogen atoms. The isolated hydrogen can then be used as needed. Transporting ammonia does not present the challenges, discussed above, associated with transporting pure hydrogen. Further, Alberta is already positioned as a significant ammonia producer, with facilities like Nutrien Redwater producing ammonia whilst utilizing CCUS.

Another example is utilizing hydrogen as a means to lower greenhouse gases associated with natural gas heating and appliance uses. The blending of natural gas with hydrogen is currently being tested at the ATCO Fort Saskatchewan Blending Project, which should be operational by the summer of 2022.[32] Blending of natural gas and hydrogen in the range of 15% to 20% by

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[31] *Supra* note 22, at pg. 12

[32] For more information on the status of the ATCO Pilot Project, see <https://gas.atco.com/en-ca/community/projects/fort-saskatchewan-hydrogen-blending-project.html>

volume is considered acceptable and does not require retrofits to appliances or significantly impact existing natural gas infrastructure. The long term objective would be to transition from blending with natural gas to streams of pure hydrogen as fuel for furnaces, boilers, stoves, and other appliances currently reliant on natural gas.

A promising role for hydrogen is in power generation and storage. As with home heating, work is underway to develop gas turbines that could accept either a blend of natural gas and hydrogen, or pure hydrogen, as their feedstock. Depending on how the hydrogen is produced, the power generated could result in lower carbon emissions. Specifically, electricity generated by wind could power electrolysis which, as discussed above, separates hydrogen from water. The resulting hydrogen, which has been produced with near zero emissions using wind and water, could be used as feedstock to power generators during times of high demand, or when options such as wind are not feasible.

A more advanced use of hydrogen is in the realm of transportation, and specifically the Fuel Cell Electric Vehicle ("**FCEV"**). FCEVs are distinguishable from both internal combustion engines and battery powered electric vehicles owing to the more robust nature of the battery, which allows for greater distances to be covered between charges. As an example, the Roadmap identifies the Alberta Zero-Emissions Truck Electrification Collaboration ("**AZETEC Project"**), which has prototyped heavy duty long range FCEV trucks for freight service between Calgary and Edmonton, including fueling stations.[33]

Lastly, the Roadmap notes the prospects for export of hydrogen to national and international markets. Because of the absence of dedicated long-distance pipeline access to international markets, transportation of hydrogen by rail in the form of ammonia is the most realistic shipping mode for the export of hydrogen produced in Alberta. The potential for development of pipelines will be an important consideration for the future success of hydrogen.

v. Alberta's Hydrogen Future

In the last section, the Roadmap considers the future of hydrogen development using two scenarios: (1) an incremental future, and (2) a transformative future. As suggested by the name, the incremental future scenario involves a slow uptake of hydrogen use and development in the province based on current policy and regulations. In the transformative future scenario, hydrogen is quickly integrated into the province's energy systems, encouraging. It is noteworthy that the Roadmap, and by extension the Province, does not forcefully address which scenario is more likely. The resulting impression is that market forces will determine the scenario realized, with the Province prepared to assist where and as it can. In so doing, the Roadmap lays bare the issue of investment – will there be sufficient confidence to attract private investment in hydrogen generally, and Alberta hydrogen specifically, to propel it forward?

b. Canada - National Hydrogen Strategy

A year before the release of the Alberta Hydrogen Roadmap, the Federal Government published a national strategy entitled, "Hydrogen Strategy for Canada – Seizing the Opportunities for

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[33] See <https://eralberta.ca/projects/details/alberta-zero-emissions-truck-electrification-collaboration-azetec/>

Hydrogen" (the "**Strategy**").[34] This December 2020 document describes the benefits of hydrogen including the fact that hydrogen is carbon free at the point of use, can be produced from many diverse kinds of feedstock, and is incredibly energy dense (i.e., gives off more energy per measure than comparable fuels like gasoline). To facilitate future hydrogen development, the Strategy establishes an action plan consisting of eight pillars. In this section we provide an analysis of the National Hydrogen Strategy, including the eight pillars, and comment on recent discussion of hydrogen by the Canada Energy Regulator ("CER").

i. Hydrogen Strategy for Canada

The Strategy identifies hydrogen as a significant means of helping Canada reach net zero by 2050, and identifies the need to build new hydrogen supply and distribution infrastructure while fostering uptake among end users. To achieve these strategic goals, the Strategy envisions three phases of development. The first phase, scheduled for 2020 to 2025, is dedicated to organizing and understanding the current state of hydrogen development in Canada. A second phase, slated for 2025 to 2030, is focused on growth and diversification. The final phase, between 2030 and 2050, is identified as a period of rapid expansion of hydrogen use and production.

In the Strategy, the Government of Canada identifies a number of targeted end users for hydrogen, including fuel for transportation, primarily in the form of hydrogen fuel cell vehicles (i.e., medium, and heavy-duty trucks), rail, shipping, and aviation. A further targeted end use is power generation. Export is identified as a longer term end use for Canada's hydrogen development, premised on the view that global demand for hydrogen will surge by the year 2050 to an estimated $2.5 trillion dollars per year.

For hydrogen development to succeed, the Strategy identifies a number of challenges that need to be addressed from an economic and technological standpoint. Notably, the need to price carbon to ensure cost competitiveness of hydrogen compared to conventional energy sources. The result would be to favour hydrogen production using renewable sources, whilst increasing the cost of production using fossil fuels, such as natural gas. This would have a clear negative impact to the Alberta strategy which calls for near total production of hydrogen through natural gas processes.

A number of regulations and policies will be required to facilitate the advancement of hydrogen development, including regulations associated with carbon pricing, and vehicle emissions. Further, the Strategy states that the "patchwork" nature of Canada's current regulatory framework for hydrogen is in need of reform aimed primarily at harmonization of standards and codes across Canadian jurisdictions.

The eight pillars outlined in the Strategy, intended to inform development of concrete action steps to create a robust hydrogen economy in Canada, are as follows:

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[34] Natural Resources Canada, "Hydrogen Strategy for Canada: Seizing the Opportunities for Hydrogen: A Call to Action", Catalogue No M134-65/2020E-PDF (Natural Resources Canada, 2020)

1. ***Strategic Partnerships*** - *Strategically use existing and new partnerships to collaborate and map out the future of hydrogen in Canada.*
2. ***De-Risking of Investments*** - *Establish funding programs, long-term policies, and business models to encourage industry and governments to invest in growing the hydrogen economy.*
3. ***Innovation*** - *Take action to support further R&D, develop research priorities, and foster collaboration between stakeholders to ensure Canada maintains its competitive edge and global leadership in hydrogen and fuel cell technologies.*
4. ***Codes and Standards*** - *Modernize existing and develop new codes and standards to keep pace with this rapidly changing industry and remove barriers to deployment, domestically and internationally*
5. ***Enabling Policies and Regulation*** - *Ensure hydrogen is integrated into clean energy roadmaps and strategies at all levels of government and incentivize its application.*
6. ***Awareness*** - *Lead at the national level to ensure individuals, communities, and the private sector are aware of hydrogen's safety, uses, and benefits during a time of rapidly developing technologies.*
7. ***Regional Blueprints*** - *Implement a collaborative, multi-level, government effort to facilitate the development of regional hydrogen blueprints to identify specific opportunities and plans for hydrogen production and end use.*
8. ***International Markets*** - *Work with our international partners to ensure the global push for clean fuels includes hydrogen so Canadian industries thrive at home and abroad.*

ii. Canada Energy Regulator

In its 2021 publication, *Canada's Energy Future*, the CER for the first time dedicated a section to hydrogen supply and demand.[35] Focus was predominantly on the prospects of hydrogen use as an energy carrier with production by methods that emit little or no CO_2. In the section titled "Evolving Policies Scenario," the CER considered a future in which total hydrogen demand reaches 4.7 megatonnes (MT), by 2050, accounting for 6% of total end-use energy demand. In these projections, industrial use of hydrogen would make up 60% of all hydrogen consumption by 2050. The transportation sector would account for 15% of hydrogen demand, mostly displacing diesel in long distance freight trucking and marine transportation, and 10% of hydrogen would be used in the residential and commercial sectors, where it would be blended into the natural gas stream and used for space and water heating.[36]

The CER does not view hydrogen as being produced for anything other than to meet local demand, with no interprovincial or international trade.[37] Further, in *Canada's Energy Future,* the

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[35] See, "Canada's Energy Future 2021", Canada Energy Regulator, online: < https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2021/index.html>

[36] *Ibid*

[37] *Ibid*

CER discussed "Key Uncertainties" for hydrogen development, which include infrastructure, trade, declines in production technology and carbon intensity.

c. Other Canadian Jurisdictions

In addition to Alberta and the Government of Canada, the provinces of British Columbia and Ontario are in the process of developing policies to guide and foster hydrogen development. We will analyze and evaluate the distinct hydrogen policy in each province in the following section.

i. British Columbia

British Columbia's Hydrogen Strategy ("**BC Strategy**") is ambitious: it contains a sixty-three point hydrogen plan which adopts the colour-based shorthand for describing emission levels for production (i.e., green for zero emissions, blue for CCUS, and grey for production of hydrogen with no emissions capture.). The BC Strategy emphasizes the opportunities for BC hydrogen development from an economic perspective, specifically in relation to the leading export markets of China, South Korea, Japan, and California, which together are expected to represent nearly half of total global demand for hydrogen by 2050.[38]

The BC Strategy provides a more detailed description of the regulatory regime required to promote hydrogen development in British Columbia than the Alberta Hydrogen Roadmap. For example, if the hydrogen in question is produced from fossil fuels, the BC Strategy provides that the BC Oil and Gas Commission will be the entity with regulatory control over its production, storage, and transportation. Further, amendments to the *Water Sustainability Act* are suggested *vis-à-vis* producing hydrogen from water (i.e., making hydrogen production an authorized industrial water use). Finally, the BC Strategy addresses the application of carbon-intensity targets for different hydrogen production pathways and calls for consultation with various stakeholders to implement the strategy.[39]

ii. Ontario

Although Ontario's hydrogen strategy has yet to be formally written, the Ontario government has signaled an intention to move towards hydrogen production by releasing the Ontario Low Carbon Hydrogen Strategy Discussion Paper ("**Discussion Paper").**[40] The Discussion Paper outlines an approach to the issue of hydrogen production different from that proposed in British Columbia or at the federal level. Ontario's motivation appears to be primarily economic and secondarily

[38] See, "B.C. Hydrogen Strategy: A sustainable pathway for B.C.'s energy transition", online < https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/electricity/bc-hydro-review/bc_hydrogen_strategy_final.pdf>

[39] *Ibid.*

[40] See, "Ontario Low-Carbon Hydrogen Strategy - DISCUSSION PAPER", online < https://prod-environmental-registry.s3.amazonaws.com/2020-11/Ontario%20Low-Carbon%20Hydrogen%20Strategy%20-%20discussion%20paper%20(November%202020).pdf>

environmental, with a focus on creating jobs in a potential new growth sector and the objective to build a "new hydrogen economy in the province…while reducing greenhouse gas emissions."[41]

Whatever its underlying political motivations, Ontario has commenced a period of public consultation that remains ongoing as of the date of this paper. It remains to be seen, therefore, whether public input helps to re-focus or perhaps re-engage the Ontario government's enthusiasm for hydrogen development.

d. International

We conclude our review of the current policy landscape by considering the international scene. We briefly comment on each of the European Union, Japan, China, and United States. These jurisdictions have been selected because they were among the first to craft hydrogen policy, in the case of the European Union and Japan, or are large markets that may drive hydrogen scale and progress, as in the case of China and the United States.

i. European Union

The European Union, ("**EU**"), released a Hydrogen Strategy ("**EU Strategy**") in June 2020 and, in some respects, the EU Strategy is more realistic than the policies advanced in Canada and discussed above.[42] The EU Strategy considers the limited role of hydrogen in the overall EU energy mix at present, the emissions concerns associated with current production methods, and the need to achieve larger scale and fully decarbonized production for hydrogen to contribute to "climate neutrality" and thus be of value to the EU generally. Some of the motivation behind the EU's seemingly cautious approach comes from the current realities surrounding hydrogen production in Europe; natural gas is more expensive and less readily available, making it harder to produce hydrogen from natural gas. Further, CCUS capability is less developed in Europe and, consequently, it appears the EU elected to focus on green hydrogen (produced from renewables) in place of blue or grey hydrogen.

Despite the identified challenges, the EU Strategy indicates Europe is keen to see hydrogen development grow. While the current trajectory would see Europe largely decarbonize its energy needs through replacement with renewables (i.e., wind and solar), hydrogen could serve as an important bridging measure. Europe can achieve this goal by utilizing hydrogen to store renewable power for future use as clean burning feedstock or employing hydrogen in locations that are not well served by renewables. Lastly, hydrogen is seen as an important means of decarbonization in hard to decarbonize sectors such as long-haul trucking.[43]

The EU Hydrogen Strategy highlights that support (i.e., regulatory reform and financial) is likely required for some time to enable renewable hydrogen to become cost-effective on the scale envisaged. To this end, the EU Hydrogen Strategy seeks amendments to the EU Emission Trading System ("**ETS**") to incentivize the production of renewable and low-carbon hydrogen. Finally, the

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[41] *Ibid* at pg. 3

[42] See "COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS - A hydrogen strategy for a climate-neutral Europe", online < https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf>

[43] *Ibid*

EU Hydrogen Strategy foresees: (i) a common low-carbon threshold/standard which would be defined relative to the existing ETS benchmark for hydrogen production, and (ii) comprehensive terminology and certification for renewable and low-carbon hydrogen; thus, introducing a certificate of origin for hydrogen and enabling the trading of green hydrogen.[44]

ii. Japan

In many respects, Japan has been a leader on the hydrogen front, having advanced its equivalent of a hydrogen strategy in 2014 with the Basic Hydrogen Strategy. Japan's objective was set out in a succinct manner in the April 2014 Strategic Energy Plan approved by the Japanese Cabinet, which stated that "it is essential for Japan to formulate a road map toward the realization of a hydrogen society".[45]

Japan's embrace of hydrogen development and willingness to pursue technological advancement in this area may arise from geographic insecurity; as an island nation with little to no hydrocarbon resources, hydrogen is a stable form of energy that can be produced locally and would provide energy security, industrial competitiveness and reduce emissions. Further, given Japan's seismic history, hydrogen is an alternative clean energy option that is not nuclear.[46]

iii. China

China is uniquely poised to be both the largest hydrogen producer (producing twenty-five million tonnes in 2020) and the largest hydrogen consumer in the world.[47] As the majority of hydrogen produced in China is "grey" hydrogen, the separation process undertaken to isolate the hydrogen results in a significant amount of emissions.

Currently, a large share of hydrogen produced in China is utilized in hydrogen powered vehicles arising from an enormous effort over the last decade to develop hydrogen technology for application to personal vehicles. Hydrogen fuel cells, a key component of hydrogen powered vehicles, and hydrogen refueling stations are necessary infrastructure required to support the implementation and viability of hydrogen fuel cell vehicles in China.[48]

China does not have a well-defined legislative framework for hydrogen projects across various sectors. This creates a number of gaps and uncertainties, which need to be addressed before the hydrogen economy can flourish. The policy basis for the development of hydrogen energy utilization in China is mainly founded on national industrial planning policies and local pilot regulations. The draft Energy Law of the People's Republic of China, issued in April 2020, highlighted various energy sources. However, unlike other secondary energy sources such as electrical power, thermal power and refined product oil, hydrogen was not listed separately, but

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44 *Ibid*

45 See, "Strategic Road Map for Hydrogen and Fuel Cells", online <https://www.meti.go.jp/english/press/2014/0624_04.html>

46 *Ibid.*

47 Vera Zhang, "Hydrogen Law and Regulation in China," CMS Expert Guide to Hydrogen Energy Law, November 24, 2021. 1-13.

48 *Ibid.*

was only categorized as among "other new energy sources." Therefore, the importance and potential of hydrogen is yet to be fully reflected in China's legislation.[49]

iv. United States

In 2020, the United States Department of Energy ("**DOE**") developed a comprehensive Hydrogen Program Plan ("**Program**") to promote hydrogen as a viable form of energy in the United States. The Program serves as a definitive statement of federal policy that outlines the United States' plan to accelerate research, development and deployment of hydrogen related technologies nationwide .[50]

The Program does not explicitly frame its hydrogen policy around the need to combat climate change or to promote cleaner hydrogen over the more prevalent grey hydrogen. But rather, the Program primarily focuses on terms such as "low carbon" or "carbon neutral" in relation to the DOE's objectives and does not categorize hydrogen based on colour.

With respect to the regulatory regime in the United States, the current divergence between federal and individual state laws is an obstacle to the regulation of hydrogen. On the federal level, the Energy Policy Act 2005[51] ("**EPA Act**") governs energy production in the United States, including forms of renewable energy. While the EPA regulates at the federal level, in contrast, the states California and Texas have implemented their own specific policy and regulations with respect to hydrogen.[52]

4. Regulatory Framework

In this section, we examine the regulatory framework within which hydrogen is produced and distributed. We commence by considering the regulatory regime in Alberta. We focus on the broad categories of facilities and distribution, noting the way in which existing legislation and regulators incorporate hydrogen. We will then examine the Government of Canada's regulatory structure and implications for hydrogen development at the national level.

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49 *Ibid*

50 The Program updates and expands upon previous versions including the 'Hydrogen Posture Plan' and the DOE 'Hydrogen and Fuel Cells Program Plan' and provides a coordinated high-level summary of hydrogen related activities across the DOE. The DOE liaises with the Office of Energy Efficiency & Renewable Energy, the Office of Fossil Energy, the Office of Nuclear Energy, the Office of Electricity and the Office of Science. See pages 1 -2, 38 -40 which provide an in depth outline of the responsibilities each office as part of the DOE Hydrogen Program. https://www.hydrogen.energy.gov/pdfs/hydrogen-program-plan-2020.pdf

51 Energy Policy Act, 42 USC 13201 et seq. (2005)

52 With respect to hydrogen development, California is a promising example when it comes to FCEV's. As of September 2021, the majority of the FCEV's in the United States were located in California and California ranked alongside nations including Germany, Japan and South Korea on deployment of hydrogen refueling infrastructure. Through developing policies to boost the market, developing relationships with industry via public-private partnerships and by earmarking money for hydrogen development, California has positioned itself to be a leader in the hydrogen field. Likewise, Texas has potential to become a substantial player in the hydrogen development field. Due to the size and geography of Texas, the state has the capacity to host renewable energy infrastructure such as wind turbines and solar panels. As Texas' is the largest producer of hydrogen in the United States, there exists the possibility of using the excess renewable energy generated by wind and solar to generate green hydrogen as contemplated by DOE's H2@Scale initiative. Lastly, Texas has approximately 1,600 miles of established dedicated hydrogen transport pipelines with room for expansion and three hydrogen specific underground storage fields which can be utilized for hydrogen development.

a. Alberta Regime

Currently, Alberta's regulatory framework does not expressly provide for the licensing of hydrogen *per se*. Rather, each proposed project is assessed based on the specific processes, feedstock and methods being employed in order to determine which approvals and authorizations are required. Consequently, the method of production is the driving factor in determining the regulatory approach to be navigated on a project by project basis.[53]

In most cases, the process for hydrogen development closely mirrors that of petrochemical facilities. The first regulatory hurdle is often consideration of whether an environmental impact assessment ("**EIA**") is required, either federally or provincially. An EIA is a process of information gathering and consideration aimed at examining the effects of a proposed project on the environment. Under Alberta's *Environmental Protection and Enhancement Act*[54], ("**EPEA**"), a project is required to undergo an EIA if it is listed in the *Environmental Assessment (Mandatory and Exempted Activities) Regulation* ("**Regulation**").[55]

Currently, the Regulation does not expressly address hydrogen production as being either a mandatory activity requiring an EIA or an exempted activity. However, under section 43 of EPEA, a "Director" may order that an EIA be carried out where they are "of the opinion that the potential environmental impacts of a proposed activity warrant further consideration under the environmental assessment process". Consequently, a determination as to whether a hydrogen project will trigger an EIA depends on the particulars of the project and any determination by the Director, as designated under EPEA.[56] As a result, it is difficult to say with confidence whether hydrogen projects as a whole are more or less likely to require an EIA. In addition to the provincial process, a project may be subject to federal environmental impact assessment requirements. These are discussed further under the next sub-heading.

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[53] See for example Alberta Energy and Utilities Board, decision 2000-30 Shell Canada Limited Cogeneration Plant and Hydrogen Pipeline Fort Saskatchewan Area; other Alberta projects include the Northwest Refinery, the Nutrien fertilizer plant, and the pending Air Products facility to be constructed by 2024.

[54] *Environmental Protection and Enhancement Act*, RSA 2000, c E-12

[55] Environmental Assessment (Mandatory and Exempted Activities) Regulation, Alta Reg 111/1993

[56] Section 44:

Initial review by Director

44(1) Where a proponent or a proposed activity is referred to the Director under section 41, where the Director gives a notice under section 43 or where a proponent on the proponent's own initiative consults with the Director in respect of the application of this Division to a proposed activity, the Director shall,

(a) if the proposed activity is a mandatory activity, direct the proponent by order in writing to prepare and submit an environmental impact assessment report in accordance with this Division, or

(b) if the proposed activity is not a mandatory activity,

(i) make a decision that the potential environmental impacts of the proposed activity warrant further consideration under the environmental assessment process and require that further assessment of the proposed activity be undertaken, or

(ii) make a decision that further assessment of the proposed activity is not required and, if it is an activity for which an approval or registration is required, advise the proponent that it may apply for the approval or registration.

Further authorizations and approvals under EPEA may be required, in addition to approvals under the *Water Act*[57]. Certain hydrogen production may require large amounts of water be diverted to a project. Diversion licences, depending on location, can be difficult to obtain owing to limited quantities of water and high degree of competition for water resources between industry and municipalities which may inhibit the creation of hydrogen "industrial clusters" as proposed in the Alberta Roadmap.

Depending on the type of hydrogen project, approvals or authorizations under the *Public Lands Act*, the *Historical Resources Act*, from Nav Canada, and from Alberta Transportation may be required. In each context, a proponent is dealing with a different regulator and process. Further, municipal development permits will likely be required. Throughout all these processes, proponents may also be required to undertake consultation with indigenous groups under the direction of the Aboriginal Consultation Office, depending on the location and specifics of the project.

The primary regulator overseeing hydrogen projects would be Alberta Environment and Parks ("**AEP**"), as administrator of EPEA. However, should a project fall more closely in line with oil and gas production methods and distribution, then the legislative requirements associated with the oil and gas industry, such as the *Pipeline Act* and *Oil and Gas Conservation Act*, can be expected to have application. In this context, the primary regulator would be the Alberta Energy Regulator ("**AER**"). In theory, a proponent might prefer this outcome, as the AER Integrated Decisions Approach creates a single application and regulatory "window" for applications under EPEA, *Water Act, Public Lands Act* and *Directive 056-Energy Development Applications and Schedules*.[58] In practice, the AER's application process is often lengthy. Finally, where hydrogen is being used in a power generation context, or in a utility context such as blending with natural gas, regulatory oversight by the Alberta Utilities Commission ("**AUC**") would be expected.

b. Federal Considerations

Under the Government of Canada's regulatory regime, the production and distribution of hydrogen is potentially impacted in three ways. The first is the potential for a hydrogen production facility to trigger a federal impact assessment. The second is through regulation by the CER. Third, it is anticipated that the Government of Canada may choose to regulate ancillary matters in support of making hydrogen a more cost effective means of decarbonizing. We analyze the above mentioned aspects in the paragraphs below.

i. Federal Impact Assessment

Under the *Impact Assessment Act*[59], ("**IAA**") an impact assessment is required for projects identified in the *Physical Activities Regulations*[60], often referred to as the "Project List." This includes projects above a certain size or new projects in National Parks or Protected Areas. Further, even if a project is not on the Project List, under section 9 of the IAA the federal Minister

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[57] *Water Act*, RSA 2000, c W-3,

[58] Concurrent applications, as required, under the *Historical Resources Act*, Nav Canada, and Alberta Transportation would still be processed separately

[59] *Impact Assessment Act*, SC 2019, c 28, s 1 ("**IAA**")

[60] Physical Activities Regulations, SOR/2019-285

of Environment and Climate Change ("**ECCC**") may designate the project as requiring an impact assessment if in his/her opinion it may cause adverse effects within federal jurisdiction or adverse direct or incidental effects, or if public concerns related to those effects warrant the designation of the project. Before making such an order, the Minister may consider adverse impacts that a physical activity may have on the rights of the Indigenous peoples of Canada as have been recognized and affirmed by section 35 of the Constitution Act, 1982.[61]

Currently the Project List does not expressly address hydrogen. However, a hydrogen project may be sufficiently incidental to a designated project as to trigger review. For example, section 30 of the Project List states that fossil fuel-fired power generating facilities, with production capacity of 200 MW of more, are designated projects. Conceivably, a generation facility using a natural gas and hydrogen blend, or even pure hydrogen, could be captured under this requirement.

Proponents will be familiar with the requirement to submit documents (a "Project Description") to the Impact Assessment Agency of Canada ("**IAAC**") during the planning phase of a project. Based on the Project Description, the Minister will decide whether the proposed project is a designated project or not. If an impact assessment is mandated, the assessment may be carried out by IAAC or be referred to a review panel. In either case, once the impact assessment is completed, the Minister of ECCC (or the Governor in Council if referred by the Minister) must make a decision whether the project is in the public interest based on the impact assessment report, which may include the Minister issuing a decision statement with enforceable conditions.

ii. Role of the CER

The Canada Energy Regulator will likely play a significant part in the process of regulatory approval of hydrogen distribution in Canada, as the CER is the federal entity that regulates pipelines, energy development, and interprovincial/international trade of energy and trade on behalf of the public. The CER's mandate requires consideration of economic, environmental, and social matters. The CER's work is primarily, but not limited to, pipeline oversight and power line projects that cross provincial and national boundaries.[62] In these areas of responsibility, the CER could have oversight or responsibility for hydrogen distribution insofar as it relates to the need for and creation of dedicated pure hydrogen pipelines.

iii. Regulation of ancillary matters

A significant aspect of the federal regulatory regime is focused less on direct hydrogen production and distribution and more on exercising the federal government's broad powers to achieve certain policy outcomes. For example, as recently affirmed by the Supreme Court of Canada, the federal government is able to set national standards for greenhouse gas pricing across all points of consumption, which standards may enable hydrogen to better compete with current sources of energy from a cost perspective.[63] This dynamic is exemplified in the pending *Clean Fuel Standard,* a proposed regulation to be established under the *Canadian Environmental Protection Act, 1999.*[64]

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61 IAA, sec. 9(2)

62 *Supra* note 35

63 See *References re Greenhouse Gas Pollution Pricing Act*, 2021 SCC 11

64 *Canadian Environmental Protection Act*, *1999* (S.C. 1999, c. 33)

The *Clean Fuel Standard* aims to drive investment to leading clean fuel sectors such as biofuels and hydrogen. Indeed the Canadian Hydrogen Fuel Cell Association, in an open letter to the federal government, has identified such measures as imperative to stimulate the widespread use and development of hydrogen across Canada.[65]

iv. Conclusions on the Regulatory Regime

As we have seen, the development of hydrogen projects does not fall under a defined standalone regulatory regime, such as exists for oil and gas development. Rather, various parts of a hydrogen project are typically permitted, authorized or approved under existing legislation and regulation.

Legally, the federal government is unlikely to have significant regulatory oversight of hydrogen outside of the potential for IAA review, or involvement of the CER as circumstances warrant. This is because of the constitutional division of power as set out in the *Constitution Act, 1867.*[66] The provinces have generally held control over and responsibility for resource and industrial development. A review of the heads of power set out in the *Constitution,* make this clear, including section 92 and the provincial autonomy over matters of natural resources, property and those matters of a local and private nature.[67]

In Alberta, the aforementioned regime can lead to challenges with legal interpretation. For example, under *EPEA* many of the proposed types of hydrogen production facilities discussed herein would likely satisfy the definition of gas processing plant or petrochemical plant as provided for in the *Activities Designated Regulation,* under EPEA.[68]And yet projects such as the Air Products hydrogen facility in Edmonton have been approved as chemical manufacturing plants. Under the *Activities Designated Regulation,* such a plant is defined as, "a plant that manufactures organic or inorganic chemicals, but does not include an oil refinery, a sugar refinery, **a gas processing plant**, a **petrochemical manufacturing plant**, a food processing plant or a plant that only blends or packages chemical".[69] Further such inconsistencies have been canvassed in the paper *Pathways to Net-Zero: Opportunities for Canada in a Changing Energy Sector*, where in the author notes:

> Indeed, even if blue hydrogen facilities are not sweet gas processing facilities under the EPEA, they arguably fit within the definition of "processing plant" for licensing purposes under the Oil and Gas Conservation Act, which illustrates some of the internal inconsistency present in even sophisticated regulatory schemes. Processing plants under the OGCA are plants "for the extraction from gas of hydrogen sulphide, helium, ethane, natural gas liquids or other substances, but [this definition] does not include a well head separator, treater or dehydrator" and require approval from the AER. It is not clear that the process of steam methane reforming to produce hydrogen is

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[65] Letter is available, online < http://www.chfca.ca/resources/governmentrelations/>

[66] *Constitution Act, 1867,* 30 & 31 Vict, c 3.

[67] *Supra,* at section 92.

[68] Activities Designation Regulation, Alta Reg 276/2003

[69] *Supra,* at section 2(2)(g).

> equivalent to extracting substances from a natural gas stream, but there are conceptual similarities.[70]

As new methods of hydrogen production take hold, it will be an increasing legal challenge to properly situate the projects within the confines of the legislation and regulations drafted, presumably, without hydrogen in mind. And while this may pose challenges to lawyers and regulatory professionals, as is addressed in the next section, the need for wholescale reform (i.e., a separate hydrogen regulatory process), is not advocated for herein.

5. Future Prospects - Emerging Issues and need for reform

In this section, we evaluate the emerging issues facing hydrogen development and regulation in Alberta. We consider the issue of "clean" hydrogen and the implications of the ambiguity in both definition and approach. We then analyze ways in which the existing legislative and regulatory regimes are used to address hydrogen development and whether regulatory reform is required. Lastly, we discuss the prospects for hydrogen development.

a. What is "clean" hydrogen?

It is striking how the Alberta Roadmap carefully avoids using the terms, grey, blue or green hydrogen.[71] As set out above, these terms are used in much of the literature on hydrogen and relate to the carbon intensity associated with a particular production method.[72] Grey hydrogen refers to methods resulting in high carbon emissions, while green refers to methods which result in nearly zero carbon emissions. While not expressly stated in the Roadmap, what Alberta envisions is a production chain of mostly blue hydrogen; natural gas processes coupled with CCUS. When announcing the Roadmap, Associate Minister of Natural Gas and Electricity Dale Nally, stated, "[w]e are agnostic to the colour of hydrogen, as long as it's clean hydrogen… it will be industry that decides the colour of the hydrogen".[73]

In addition to avoiding the widely adopted terms used to denote carbon intensity, the Roadmap is at times both ambiguous and even defensive on the issue of carbon intensity associated with natural gas based production. This is exemplified by statements calling for the development of emissions standards for hydrogen production that are "science-based,"[74] and which take into consideration the entire reduction in emissions profile associated with any given hydrogen energy

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[70] Brendan Downey et al, Pathways to Net-Zero: Opportunities for Canada in a Changing Energy Sector, 2021 59-2 Alberta Law Review 225.

[71] In addition, reference is sometimes seen to "pink" hydrogen. This term denotes hydrogen production associated with nuclear power

[72] Carbon Intensity is described in the Federal Hydrogen Strategy, at page 59, as follows, "the Carbon Intensity (CI) of hydrogen production is a method for comparing the end-to end lifecycle GHG emissions of hydrogen as it moves from primary energy source/feedstock to delivered energy commodity"

[73] Chris Varcoe, "Hydrogen has the potential to be Alberta's next oilsands in importance", Calgary Herald, November 5, 2021

[74] *Supra* note 22, at pg. 27 "Alberta will collaborate with other governments and international partners to support the development of science-based carbon intensity thresholds for hydrogen production. This collaboration will be important to establish carbon intensity threshold targets, definitions, and measurement and reporting standards."

stream. In other places, the Roadmap arguably moves from ambiguity into a more defensive posture, such as in the following statement:

> An **emerging narrative against natural gas-based hydrogen production** can disrupt Alberta's efforts to build a clean hydrogen economy. As Canadian and global carbon intensity benchmarks and Guarantee of Origin schemes are proposed and developed, Alberta needs to **actively inform their development with data grounded in robust analysis and science**.[75] (emphasis added)

Such statements can lead one to question whether the provincial approach fully addresses the issue of carbon intensity associated with natural gas hydrogen production and what it might mean more broadly for hydrogen development in Alberta.

There appears to be a significant difference in policy approach between Alberta and the federal government. As set out above, Alberta's Roadmap has taken an ambiguous and defensive stance on the issue of carbon intensity. Conversely, the federal Hydrogen Strategy advocates for a clearer policy goal supported by rigorous assessment. For example, the Hydrogen Strategy notes that carbon intensity for hydrogen produced from natural gas includes "upstream emissions required to recover the gas" in addition to "emissions released during SMR or ATR process".[76] Further, the federal government seems poised to move towards a carbon intensity (referred to as CI) threshold and certification process for clean hydrogen which is more aligned with those seen in Europe, as opposed to Alberta's as yet undefined "science based" position:

> It will be important for Canada to develop and adopt **national definitions** and standards for 'clean' hydrogen, whereby CI thresholds are established and can be independently certified. Hydrogen's decarbonization benefits will only be realized **if Canada adopts low CI hydrogen**, and any government investment in the development of new supply in Canada needs to reflect this. It is recommended that Canada coordinate efforts underway internationally, to facilitate trade in the longer term as well as benefit from extensive efforts that have already been initiated to quantitatively define and measure hydrogen CI from a range of pathways. For example, the European Commission has initiated a pilot program called CertifHy to develop an EU-wide Guarantee of Origin scheme for green and low carbon hydrogen that considers both the origin of the hydrogen and its greenhouse gas (GHG) intensity. **The recommended threshold for GHG intensity is set at 60% below the intensity of hydrogen produced from natural gas**, currently set at 36.4 gCO_{2e}/MJ.[77]
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> (emphasis added)

The Alberta Roadmap relies on CCUS as a response to the issue of carbon intensity associated with hydrogen production and as the means of making natural gas production viable from an

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[75] *Supra* note 22, at pg. 48

[76] *Supra* note 34

[77] *Supra* note 34.

emissions standpoint. However, the history of CCUS in Alberta would suggest that such a position has risk. Indeed, CCUS has experienced difficulties in appeasing climate wary investors and end-users; CCUS applications in other industries suggest that success is limited, costly, and often undervalued by the intended audiences.[78] That said, hydrogen production and associated CCUS can be distinguished from previous uses, such as in oil and gas development. For example, hydrogen production with CCUS at the point of production results in a zero emissions source of energy at the point of consumption (i.e., hydrogen in a fuel cell powered car does not emit CO_2). By contrast, CCUS used in conjunction with the production of oil and gas does not result in gasoline that burns clean when consumed in an automobile, even if it has reduced the carbon generated during production.

Despite the mitigative effects of CCUS, the Roadmap acknowledges what the federal Hydrogen Strategy makes explicit - when applied to current international standards for "clean" hydrogen, existing methods of production in Alberta likely fall short. Even with CCUS, hydrogen production methods such as SMR still result in more carbon emissions than what is permissible for a "clean" hydrogen designation under certain metrics and approaches currently in use (i.e., CertifHY). Moreover, it appears that even the Alberta government is uncertain about the net-benefits on emissions reduction that is to be obtained by hydrogen. This point is exemplified by the following paragraph found in the executive summary of the Roadmap:

> Adoption of clean hydrogen in Alberta has the potential to reduce GHG emissions. Modelling conducted for the Hydrogen Roadmap shows that under a 2030 scenario where hydrogen is widely integrated into Alberta's energy systems at a large scale, the province could reduce GHG emissions by 14 million tonnes per year. **This represents a reduction of five per cent of Alberta's 2019 emissions**.[79] (emphasis added)

When considered against the level of investment and development that is associated with the 2030 scenario, a mere 5% reduction over 2019 emissions levels seems a modest return on investment.

A position of "agnostic" indifference on the issue of emissions is understandable but ultimately unsustainable. The Alberta Roadmap is clearly focused on the production of blue hydrogen, and the associated creation of a new and sustained market for Alberta's natural gas, something that Alberta is keen to realize. However, at present, blue hydrogen is a solution with many caveats, including the willingness to develop this form of hydrogen and the risk associated with the market, both domestically and internationally, accepting anything less than fully decarbonized production as "clean."

By refusing to engage with this issue squarely, and failing to layout a more concrete plan, the Alberta Roadmap leaves something to be desired. Furthermore, questions remain about whether the Roadmap has accurately assessed the long-term prospects of hydrogen production using fossil fuels coupled with CCUS and whether such an assessment would in fact support broad

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[78] Graham Thomson, "Carbon capture and storage: Hasn't Alberta learned its lesson?", CBC News Edmonton, online: <https://www.cbc.ca/news/canada/edmonton/carbon-capture-storage-lesson-1.5377626>; See also Graham Thomson, "Pipe Dream The failure of Alberta's carbon-capture experiment", Alberta Views, July 1, 2015, online: <https://albertaviews.ca/pipe-dream/>

[79] Alberta Hydrogen Roadmap: Executive Summary Ministry of Energy, at pg. 9

development. Given the carbon intensity issues associated with current production methods, and absent significant technological advances to address same, the fact is that fossil fuel production, while economically viable today, may not be so in the near term. At a certain point, the economics may switch to favour production by renewable energy means. The federal Hydrogen Strategy notes the following:

> By 2030, the cost of SMR+CCUS hydrogen is expected to be in the range of ~$1.00 - $2.00/kg-$H_2$ when produced at scale (>100 tons per day - TPD) in Canada based on studies out of Alberta and British Columbia, while the cost of electrolysis from dedicated renewables shows potential to be in the $3.20/kg-$H_2$ range in that timeframe.
>
> BloombergNEF predicts the global levelized cost of hydrogen from large renewable energy powered projects will be cost competitive with low carbon hydrogen from natural gas via SMR w/CCUS by 2030. Their study shows that by 2050, renewable hydrogen could be produced for less than a dollar per kilogram. This may not be directly applicable to Canada, but the general trend of renewable hydrogen costs coming down over time is valid and warrants further study regionally in Canada. [80]

An alternative approach for the Government of Alberta to adopt would be to realistically emphasize the role of blue hydrogen production as an interim measure, akin to the position taken by the EU. That is, to view the use of natural gas produced hydrogen for what is – an imperfect solution but one which has positive aspects and which over time and with further technological advancement may play an increasing role in the energy transformation. To a national and international audience such an approach is more realistic, and arguably more acceptable, than the current position which appears to suggest CCUS is the ultimate answer to blue hydrogen's emissions problem now and in the future, or that aggressive standards such as CertifHY may not be tenable targets for near term development of hydrogen resources in Canada.

b. Minimal Regulatory Reforms

Alberta does not have a dedicated regulatory framework for hydrogen and has instead relied so far on an "amalgam of existing environmental and oil and gas statutes and regulations that do not always apply perfectly".[81] As hydrogen is similar to hydrocarbons in its current production processes, transportation and uses, development to date has fallen under the regulatory regime designed for the most analogous process or use. This raises the following questions: to what degree are changes to existing legislation and regulatory oversight needed? Is the current approach sustainable (i.e., requiring nothing more than minor amendments to existing legislation), or are the number and extent of changes anticipated sufficient as to warrant wholesale legislative reform (i.e., the creation of a *Hydrogen Act)*.[82]

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[80] *Supra* note 35, at pg. 58

[81] Brendan Downey et al, "Pathways to Net-Zero: Opportunities for Canada in a Changing Energy Sector", 2021 59-2 Alberta Law Review 225, 2021

[82] *Ibid*; Wherein it is stated that effective regulation would be better served by creating clear paths for hydrogen regulation in the form of simple legislation that directs all such projects to one regulator, such as the AER or AUC. Certainty in regulatory process would also be beneficial for investment confidence

We are of the view that minor amendments to existing legislation are sufficient at this time. Uncertainty regarding the future of hydrogen development over the coming years[83], coupled with the ability of existing legislation to adequately oversee hydrogen development, albeit with minor legislative amendments, all support such a position. In the following paragraphs we address some of the legislative amendments that should be pursed within the existing regulatory framework regarding hydrogen.

i. Blending hydrogen and natural gas

For context, blending natural gas and hydrogen has an immediate effect of reducing green-house-gases (because the hydrogen component of such a blend does not emit GHG when burned). A number of pilot projects have been undertaken including the Enbridge Gas Inc. City of Markham Hydrogen blending project and the ATCO Fort Saskatchewan Hydrogen Blending Project. Both have proposed modest levels of blending; Enbridge proposes 2% hydrogen by volume and ATCO has indicated an objective of 5% hydrogen by volume.

Blending presents immediate regulatory challenges. For example, in a regulated utility context, how are the costs associated with the blending process to be allocated, including not only costs to utilities but potential costs to consumers who may have to consume more blended gas to achieve the same level of heating owing to the fact that hydrogen burns at 1/3 the heating power of natural gas.[84] Other impacts to consider include issues of safety and reliability in the delivery of blended hydrogen through existing infrastructure systems, whether uniform standards are needed for blending, and practical matters such as the impact of hydrogen blending on appliances in homes and businesses.[85]

At the direction of the provincial Minister of Energy, the AUC seeks to address some of these issues in *Proceeding 27256 – Hydrogen Inquiry*. Bulletin 2022-05, announcing the inquiry, limited the focus to matters relating to hydrogen blending in natural gas distribution systems, and identified the following "key issues":

- Legislation
- Delivery of services to municipal and rural natural gas consumers
- Safety

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[83] *Supra* note 8

[84] In a recently published article, "Canadian Energy Regulators and New Technology: The Transition to a Low Carbon Economy," (2021) 9:2 Energy Regulation Quarterly 7, Gordon Kaiser discusses how Canadian energy regulators have historically been reluctant to fund new technology through rates, which has served as an obstacle to innovation in the energy sector. Kaiser identifies measures that have been adopted by various energy regulators in response to this challenge, which include: pilot programs to introduce new technologies for test periods, for example, the pilot program approved by the Ontario Energy Board to study the effects of hydrogen blending in the natural gas distribution system; collaborative platforms between industry actors and regulators such as the Ontario Energy Board's Innovation Sandbox initiative; rate-payer funded innovation funds; and amendments to the regulators' statutory objectives "to facilitate innovation in the electricity sector." Amendments go a step further in providing regulatory certainty: the Amendments constitute explicit legislative directions that permit gas utilities to acquire and supply specific types of hydrogen, and to recover specified costs of such undertakings. It will be interesting to see if other provinces introduce similar legislative changes.

[85] Jay Lalach & Adriana Da Silva Bellini, "How About Some Clean, Green Hydrogen With that Natural Gas", June 2021, online: <gowlingwlg.com/en/insights-resources/articles/2021/clean-green-hydrogen-with-that-natural-gas/>

- Factors to consider when assessing hydrogen projects and costs
- Rate impacts related to capital and commodity cost treatment
- Other issues

Expressly excluded from the scope of the inquiry were:

- Pure hydrogen distribution systems
- Emissions targets that should be established
- Blending in the context of high pressure pipelines

One prudent change would be for the AUC to allow utilities to recover some portion of the costs incurred to bring about blending, thereby encouraging ongoing expansion of blended gas and development of hydrogen. In May 2021, the British Columbia government adopted such an approach with significant amendments to the *Greenhouse Gas Reduction Regulation*.[86] These amendments paved the way for regulated gas utilities to produce, buy and distribute specified types of hydrogen as part of their offerings.[87] Pursuant to B.C.'s *Clean Energy Act*, under which the amendment regulation is made, hydrogen was listed as a "prescribed undertaking." The *Clean Energy Act* authorized rate recovery (to a set amount) to participate in "prescribed undertakings," in effect assisting in covering the cost expenditures associated with GHG reducing initiatives. To ensure the implementation of "clean" hydrogen use, cost recovery is limited to distribution of green hydrogen (i.e., derived from using renewable electricity) or "waste hydrogen" produced by the utility.[88]

ii. Definition of "gas"

A secondary, and far more prosaic, area in need of reform involves changes to the definition of "gas" under certain legislation. These amendments would need to account for the fact hydrogen is not a hydrocarbon; definitions of "gas" which largely contemplate natural gas could potentially fail to capture hydrogen as a result. For example, under the *Gas Utilities Act*, "gas" is currently defined as:

> (e) "gas" means all natural gas both before and after it has been subjected to any treatment or process by absorption, purification, scrubbing or otherwise, and includes all fluid hydrocarbons not defined by clause (i) as oil.

Amendments to the definitions of "gas" also need to be alive to and adequately address the possibility of hydrogen production from both blended and renewable sources. Similar changes, across other pieces of legislation are also needed to ensure the hydrogen produced through both existing and future means is captured and thus regulated as appropriate.

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[86] The Regulation is made pursuant to the *Clean Energy Act*, SBC 2010, c 22

[87] Eric Bremermann et al., "British Columbia Reduces Regulatory Barriers to Hydrogen Investment", Energy Regulation Quarterly, Vol 9, Issue 3 2021

[88] *Ibid*

iii. Guarantees of Origin

Active steps should be taken to address the issue of accounting for production methods associated with hydrogen production. As discussed above, the language of "guarantees of origin" is often used in this context. In the EU, proposals call for comprehensive terminology and certification for renewable and low-carbon hydrogen. A certification program is also called for that could even facilitate trading of green hydrogen.

It would be prudent for Alberta to take leadership in the development of a domestic means of accounting for and classifying hydrogen based production methods. This would require the Alberta government to do two things. First, tracking and better understanding of how hydrogen production and uses are impacting the overall energy mix from an emissions standpoint (i.e., is hydrogen in fact driving down emissions?).[89] Second, by obtaining and publishing such results, the government would allow the market to function better by creating consistency across all producers and for consumers who can, as appropriate, charge or pay a premium for certified lower carbon hydrogen. A simple regulation, perhaps under the auspices of the AER, could achieve this objective.

iv. CCUS

Lastly, the Alberta government needs to ensure that the current CCUS regime is robust, given the importance of CCUS in the blue hydrogen production process.[90] To this end, it would be prudent for the government of Alberta to consider and update the findings of the *Carbon Capture & Storage: Summary Report of the Regulatory Framework Assessment*, released in 2013.[91] Further, and to the extent possible, the government needs to address the uncertainty surrounding availability and quantity of pore space for CCUS.[92] While the recent focus on "hubs" suggests a scaling up of CCUS, the concurrent announcement by the federal government that Canadian oil and gas producers must reduce emissions by 42% by 2030 is adding demand to the already ambitious industry objectives of zero emissions from oilsands production by 2050.[93] On that basis, viable pore space may be in greater demand sooner than previously thought. At present, most pore space and proposed "hubs" are associated with oil and gas development.[94] As a result there is potential risk that blue hydrogen producers, who require access to CCUS, may be left with limited options. These producers could, in theory, negotiate access to CCUS "hubs," but this could be tricky and expensive for late entrants. Alberta would be well served by taking steps to address concerns regarding access, in addition to the litany of others matters such as monitoring and liability, to give all participants greater certainty in CCUS.

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89 *Supra* note 10

90 https://www.pembina.org/reports/alberta-hydrogen-strategy-comments.pdf

91 https://open.alberta.ca/dataset/9781460105641; see also https://ablawg.ca/2021/12/07/province-of-alberta-issues-a-request-for-full-project-proposals-for-carbon-sequestration-hubs/

92 https://thenarwhal.ca/carbon-capture-explainer/

93 JWP April 1, 2022, Alberta Advances six carbon capture proposal for further study

94 Current, and proposed projects are by Shell, Enbridge, Suncor, Pembina Pipeline, TC Energy among others.

c. Prospect for hydrogen development

Although hydrogen development is an attractive way to reduce carbon emissions while transitioning to a net zero world, its ultimate success rests on factors unique to the different jurisdictions analyzed above. Three central themes emerge: diversification, energy security and policy direction.

i. Diversification to ensure future economic prosperity

Globally, there has been a shift from fossil fuels toward new technology and green forms of energy to combat the challenges posed by climate change. In an effort to diversify energy production and reduce carbon emissions, many countries have identified areas where hydrogen can be incorporated into their economies as a viable way to achieve transition to clean energy. However, the ultimate success of hydrogen as an energy source may rest on a country's willingness to reorient policy goals to meet a changing world. Further, the transition to clean forms of energy worldwide may be accelerated due to the disruption caused by conflict and the economic consequences that follow when a nation or province (i.e. Alberta) primarily uses fossil fuels for energy. Therefore, in order to weather the deleterious economic effects related to unpredictable world events, by diversifying a nation's energy economy using hydrogen as an alternative source of energy, the result may be economic stability in the long term.

ii. Energy Security

Until recently, with the advent of new technology and green forms of energy, a nation's energy security would likely be dependent on the availability of fossil fuels – coal, oil and natural gas. In contrast to Canada and the United States, the EU and Japan are two jurisdictions that do not have large quantities of carbon based energy at their disposal. In response, the EU and Japan were on the forefront of hydrogen development, as evidenced by the early release of hydrogen strategies and detailed policy frameworks with realistic targets for hydrogen development. By developing hydrogen for use as a fuel and for residential or commercial heating, both Japan and the EU can reduce dependency on other nations to meet their energy requirements. Thus, achieving economic self-sufficiency and energy security was likely an important driving force behind the creation of policy in the EU and Japan. Both the EU and Japan's aim to achieve energy security seems prescient in light of the current global energy crisis.

iii. Policy Direction:

When attempting to predict whether hydrogen development policy and regulatory regimes (or reform) will ultimately be successful, an important consideration to take into account is policy direction. Through employing a comparative analysis of hydrogen policy in Canada, the EU, Japan, the United States and China, some conclusions can be drawn. In particular, the policies of British Columbia, the EU and Japan appear to have many similarities despite being separate jurisdictions and economies with differing needs. Yet translated through the policy in relation to hydrogen development comes a willingness to encourage transition to clean energy, to create specific action plans to achieve this goal and have an overarching vision of where this industry evolves to in the future.

If Alberta, British Columbia and Ontario (as well as the other provinces) continue to develop divergent hydrogen strategies and implement different regulatory regimes, Canada may end up in a similar situation as the United States – where there is a gap between federal and state level hydrogen regulation and economic policy. That being said, in recent years the federal government has taken steps to create national energy policy to target climate change which may provide a consistent policy across Canada in some regards.

6. Conclusion

At the outset, we noted that hydrogen is being touted as a means of balancing the tension of needing to decarbonize while still making use of existing resources (i.e., natural gas). And while this is true, as we have shown in this paper, hydrogen development has inherent limitations. While some of the limitations may be temporary, and capable of resolution through advances in technology and other means, questions remain about the viability and attractiveness of hydrogen over the long term.

Governmental policies across Canada are aligned on the role of hydrogen as a significant tool in achieving decarbonization but differ on some of the more technical aspects of regulating same. Further, existing legislation can, with minor amendments, seemingly address hydrogen development as currently unfolding. As hydrogen development is scaled-up and new production methods brought online, further consideration of the ability of existing regulatory and legislative regimes to adapt to hydrogen will be need. Further, government policies offer a somewhat overly optimistic view of the current state of hydrogen and its long-term prospects, which is especially evident in the Alberta Roadmap. However, the optimism is not without foundation because Hydrogen can be an important part of the energy transition. Therefore, policy and regulation should serve to further the development of hydrogen rather than limit it through excessive or minimalist oversight.