

MCLENNAN ROSS

Hydrogen Roadmap: Policy, Regulation & Prospects

Presented by: Michael Barbero & Kimberly Wasylenchuk



- 1. Introduction to Hydrogen
- 2. Policy Landscape
- 3. Regulatory Matters
- 4. Prospects



Introduction to Hydrogen

What is Hydrogen?

- One of the most abundant elements in the Universe
- Pure hydrogen not widely available on Earth
 – isolation process required
- Process of separating the H molecule from the H₂0 compound
- Practical considerations for hydrogen usage guide development



How is Hydrogen Made?

- Multiple ways to produce pure hydrogen from different feedstocks:
 - Water
 - Fossil Fuels
 - Nuclear power
 - Wind power
 - Solar power
 - Biomass



Hydrogen Uses

Industrial uses:

- Oil refining
- Ammonia production
- Methanol production
- Steel production
- Emerging uses:
 - Long-haul trucking using fuel cells
 - Commercial and residential heating using blended hydrogen and natural gas

Benefits of Hydrogen

- Hydrogen is a "clean fuel" with two byproducts: heat and water
- Hydrogen can be produced from a variety of methods:
 - Electrolysis (including via renewable energy)
 - Natural Gas (Steam Methane) Reforming
 - Gasification using coal or biomass

Challenges

- Hydrogen Storage
 - Mixing with Ammonia (NH₃)
 - Injection into underground caverns
- Storage poses technological and safety challenges
 - Compression required to increase density for storage of gaseous hydrogen
 - Large and costly storage tanks required
 - Risks related to storing liquified hydrogen
 - Vacuum insulated vessels required



Challenges

- Transportation of pure hydrogen via pipeline
 - Not undertaken on a large scale in Canada
- Blending Hydrogen with natural gas as cost effective alternative
 - Limited by volume due to hydrogen embrittlement
- To combat embrittlement, hydrogen transportation infrastructure requires high quality, non-porous materials i.e. stainless steel

Current Policy Landscape

Current Policy Landscape

- Canvass the policy landscape in three jurisdictions:
 - Alberta
 - British Columbia
 - Canada

*See paper for discussion on other jurisdictions, including EU, Japan, China and United States

Current Policy Landscape

Calgary

X

some parts of the Rockies

'Which thing to build?': Montem Resources weighs

coal mine versus hydrogen in Alberta

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Hydrogen coming fast and here to stay, city officials say

MEDICINE HAT NEWS



The utility and infrastructure division heard a presentation provided to a group of Alberta engineers and geophysicist

Varcoe: Hydrogen has the potential to be Alberta's next oilsands in importance

'This is an opportunity for Alberta to create generational wealth for the province. We have an opportunity to be a leader in clean, affordable energy,' said Associate Natural Gas Minister Dale Nally

Chris Varcoe · Calgary Herald Nov 05, 2021 • November 5, 2021 • 4 minute read • 🔲 79 Comments

Montem is considering government's extension of a pause on coal development in

C. Energy Minister Bruce Ralston tours Cellcentric's hydrogen fuel cell plant in Burnaby, August 202 Cellcentric is a German-based partnership of Mercedes Benz and Volvo, developing zero-emission heavy rucks (B.C. government photo)

B.C.'s hydrogen fuel project seeing big investor interest, Horgan says

Dedicated permit office aims to streamline development TOM FLETCHER / Mar. 31, 2022 10:50 a.m. / BUSINESS



- Alberta Hydrogen Roadmap
 - November 2021
 - Objective = set out a vision for a robust hydrogen industry
 - four (4) underlying rationales

Alberta Hydrogen Roadmap



Albertan

- 1. Alberta is home to large natural gas reserves.
- 2. Alberta has abundant CCUS.
- 3. Large and developing renewable sector.
- 4. The assets to produce low-cost hydrogen.

- Roadmap's five key considerations for hydrogen:
- 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.
- **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., in 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 to give rise to each scenario.

- A few observations:
 - Alberta hydrogen is about Alberta natural gas
 - 2020 Alberta Recovery Plan and Natural Gas Vision and Strategy
 - Impacts the overall document in certain ways, such as the lack of discussion on "green", "blue" and "grey" hydrogen



* Turquoise hydrogen is an emerging decarbonisation option.

https://www.weforum.org/agenda/2021/07/clean-energy-green-hydrogen/

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"[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"

Associate Minister of Natural Gas Dale Nally

Current Policy Landscape – British Columbia

- BC Hydrogen Strategy: A Sustainable Pathway for B.C. Energy Transition
- Contains 63 clearly articulated actions that will drive forward hydrogen development
- Incentive low emission hydrogen
- Encourage fuel cell vehicles

- Tangible legislative actions
- Clean Industry and Innovation rate, to offer discounted electricity for hydrogen production
- Amendments have been made to the Greenhouse Gas Reduction Regulation

Current Policy Landscape -Canada

- Strategic Partnerships –
- De-Risking of Investments –
- Innovation –
- Codes and Standards –



- Enabling Policies and Regulation –
- Awareness –
- Regional Blueprints –
- International Markets -



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Current Policy Landscape – Canada

- Commissioner of the Environment and Sustainable Development
- Critical of the assessment of benefit made by the government



'Unrealistic hydrogen assumptions mean Canada may struggle to hit 2030 emissions targets': federal watchdog

Environment commissioner issues scathing 38-page report into government's 'overly optimistic' and 'unfounded' clean H2 projections



Regulatory Matters

- No express legislative framework
- Covered by existing legislative schemes
- Production is key factor in determining regulatory process



Legislative Reform

 Alberta does not presently have a dedicated regulatory framework for hydrogen and has instead relied upon an "amalgam of existing environmental and oil and gas statutes and regulations that do not always apply perfectly"

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

• Minor amendments needed, not whole scale new legislation

• Gas Utilities Act

(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.



Blending of hydrogen with natural gas:

- immediate effect of reducing greenhouse-gas (i.e., the hydrogen aspect of such a blend does not emit GHG)
- Enbridge Gas Inc., City of Markham Hydrogen
- ATCO Fort Saskatchewan Hydrogen Blending Project
- AUC Proceeding 27256 Hydrogen Inquiry
- B.C. Greenhouse Gas Reduction Regulation

- "Science based" emissions standards to be developed???
- Consideration of entire emissions profile associated with a given hydrogen energy stream???

"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". (emphasis added)

CCUS F = MENJ SUBSCREEF SICN N



Opinion | Carbon captur Alberta learned its lesso

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Edmontor

Politicians tend to use CCS as a distractic says Graham Thomson



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Steve MacDonald of Emissions Reduction Alberta sp Cement's feasibility study into carbon capture and s



Pipe Dream The failure of Alberta's carbon-capture experiment

EY GRAHAM THOMSON JULY 1, 2015

Sometime later this year, a consortium of oll companies in Alberta vill, flip the svitch on a first-of-lits-kind climate change project in Canada. If it works, the Quest project will aptite and bury one million tomes of archon dioxide (CO2) emissions every year from Shell Canada's Socificd upgrader in Fort Saskatchewan. That's one million tomes a year for the west 25 years—roughly equivalent to pumping the weight of four Great Pyramids of Giza underground, or, as Shell likes to say, the equivalent of taking 175,000 greenhouse-gas-spewing cars off the road every year.

Steps to take:

- Carbon Capture & Storage: Summary Report of the Regulatory Framework Assessment, released in 2013
- availability and quantity of pore space for CCUS
- monitoring and liability



Prospects

International Hydrogen Policy

- European Union
 - Hydrogen Strategy June 2020
 - Considers role of hydrogen in EU energy mix
 - Focus on green hydrogen production
 - Support required to enable green hydrogen to become cost effective
- Japan
 - Early release of Basic Hydrogen Strategy 2014
 - Policy objective to formulate a road map toward realization of a hydrogen society



International Hydrogen Policy

• China

- Largest global hydrogen producer and consumer
- Majority of hydrogen produced is grey
- Large share of hydrogen produced used in vehicles
- No well-defined legislative framework

United States

- Department of Energy Hydrogen Program Plan
- Divergence of federal and state law an obstacle to hydrogen regulation
- Federal *Energy Policy Act* 2005
- California and Texas hydrogen policy

Prospects

- Success of hydrogen development rests on factors unique to the different jurisdictions analysed in the paper
- Three central themes emerge:
 - Diversification
 - Energy Security
 - Policy Direction



Diversification for future economic prosperity

- Global shift from fossil fuels toward new technology and green energy
- Success of hydrogen as an energy source may rest on willingness to reorient policy goals to meet a changing world
- Transition to clean energy may be accelerated by disruption caused by conflict and the economic consequences that follow
- Hydrogen as an alternative source of energy may achieve long term stability

Energy Security

- A nation's energy security may be dependent on the availability of fossil fuels
- EU and Japan: early release of hydrogen strategies and detailed policy frameworks
- Developing hydrogen as a fuel can reduce dependency on other nations to meet energy requirements.
- Achieving economic self-sufficiency and energy security was likely an important driving force behind the creation of policy in the EU and Japan



Policy Direction

- Policy direction important to determine success of hydrogen development regimes
- In the case of BC, the EU and Japan, translated through the policy is a willingness to encourage transition to clean energy
- Divergent policy in Alberta, Ontario and BC
- Creation of national energy policy to target climate change may provide some consistency in Canada

Conclusion

- Hydrogen development has inherent limitations
- Some limitations may be temporary or capable of resolution
- Other limitation may not be overcome thereby affecting the viability of hydrogen as an alternative energy source

Conclusion

- 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
- As hydrogen development scales up, the existing regulatory regime will need to be reassessed and adapt where needed
- Policy and regulation should further the development of hydrogen





