The Evolving Hydrogen Landscape in Canada & Alberta

Building to a Net-Zero Future

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National Hydrogen Strategy released late-2020

Climate Context

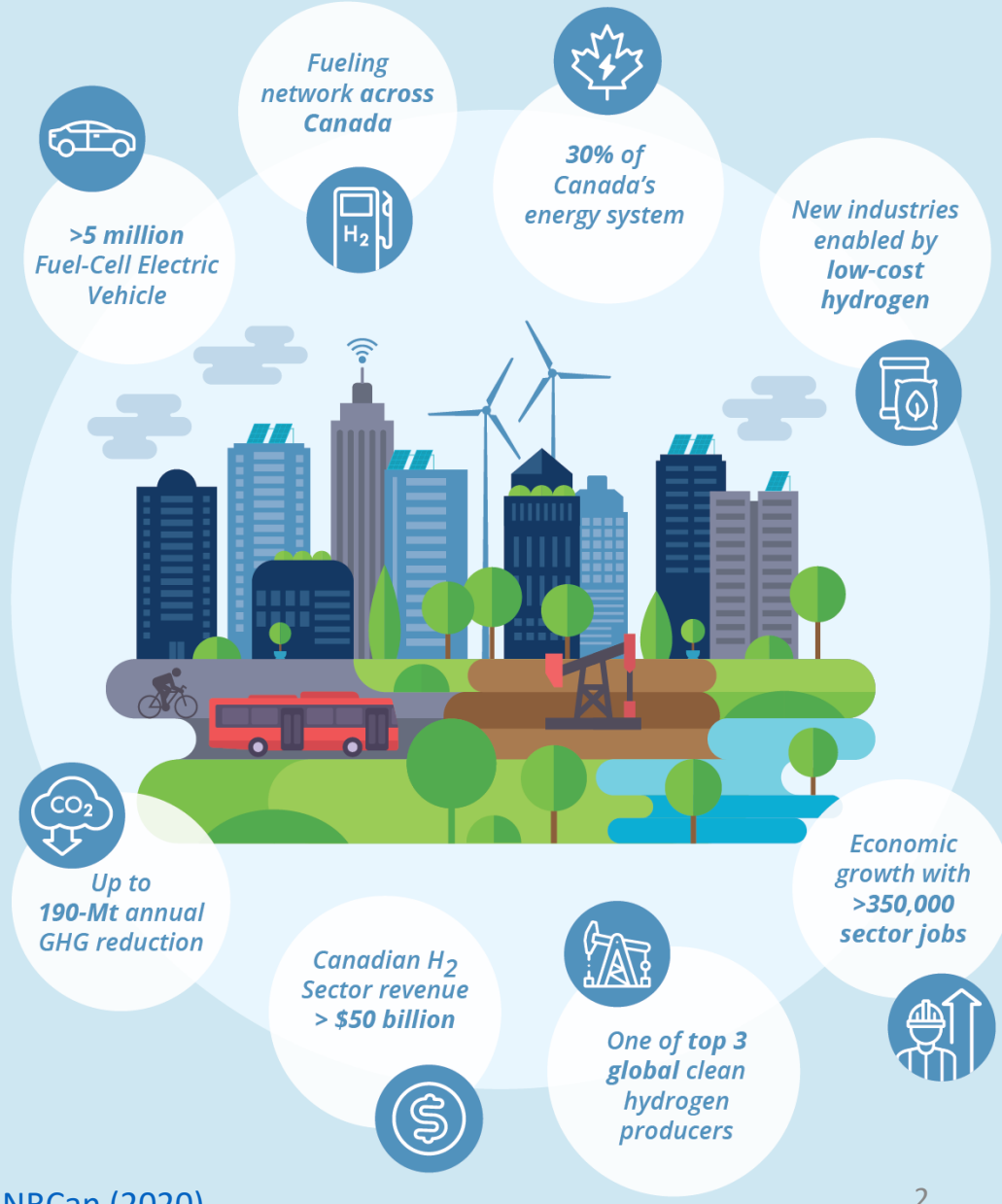
- Domestic targets of 40-45% below 2005 in 2030; net-zero by 2050
- Targets in *Canadian Net-Zero Emissions Accountability Act*
- Federal government sets a carbon price backstop; provinces have the option to implement equivalent pricing schemes

Hydrogen Targets

- 4 MtH_2/y in 2030 growing to 20 MtH_2/y in 2050
- 30% of total final energy demand in Canada
- Avoidance of "up to" 190 $MtCO_2e/y$

Recommendations

- Total of 32 across eight pillars
- Important focus on regional "blueprints" or hubs



NRCan (2020)

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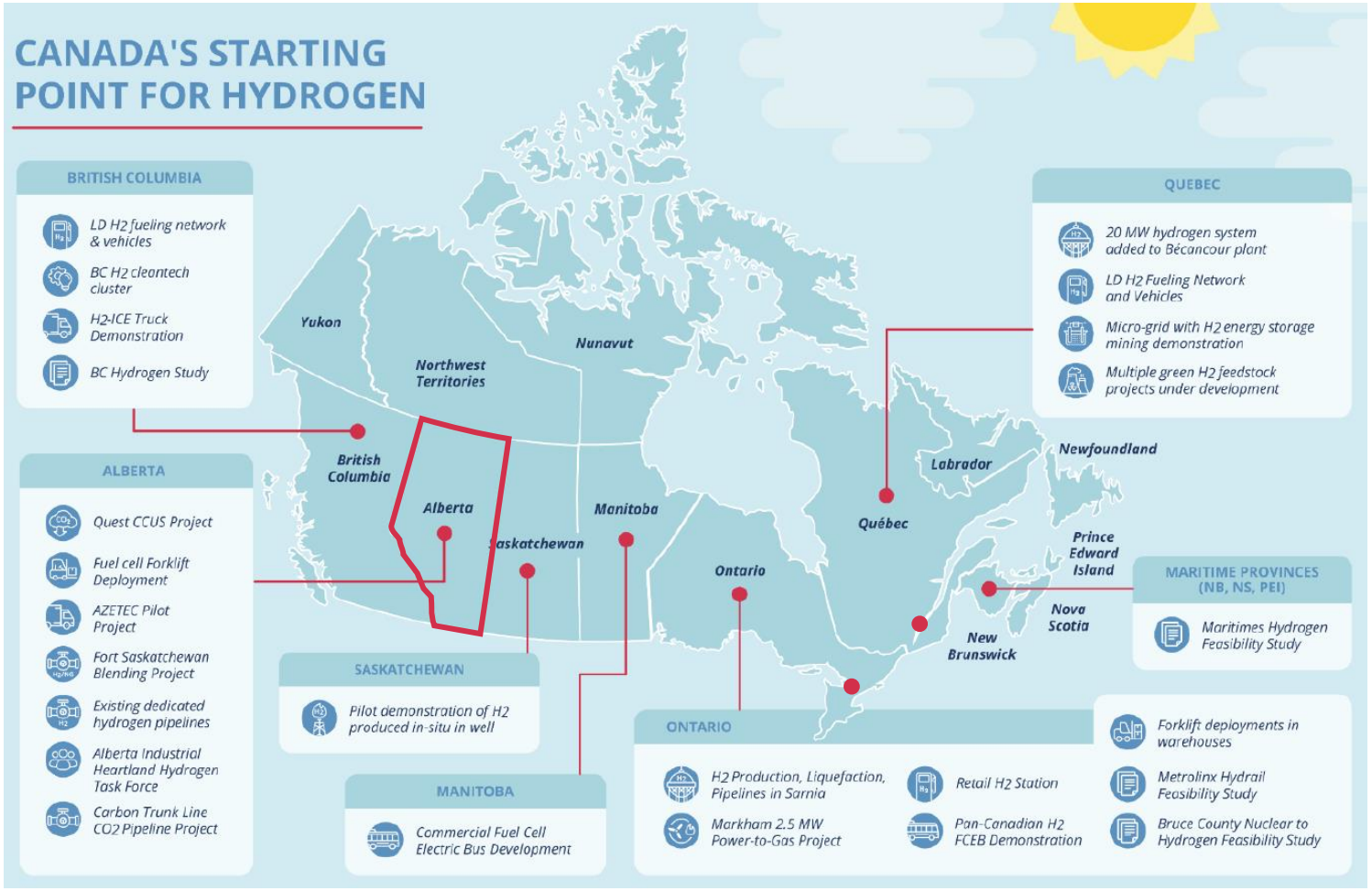


NRCan (2020)

Canada's hydrogen mix will likely be "teal"

Quebec, Ontario and Manitoba

- Generally low-CO_2 grids, with large hydroelectric resources
- Low prospectivity CO_2 storage resources

Alberta and Saskatchewan

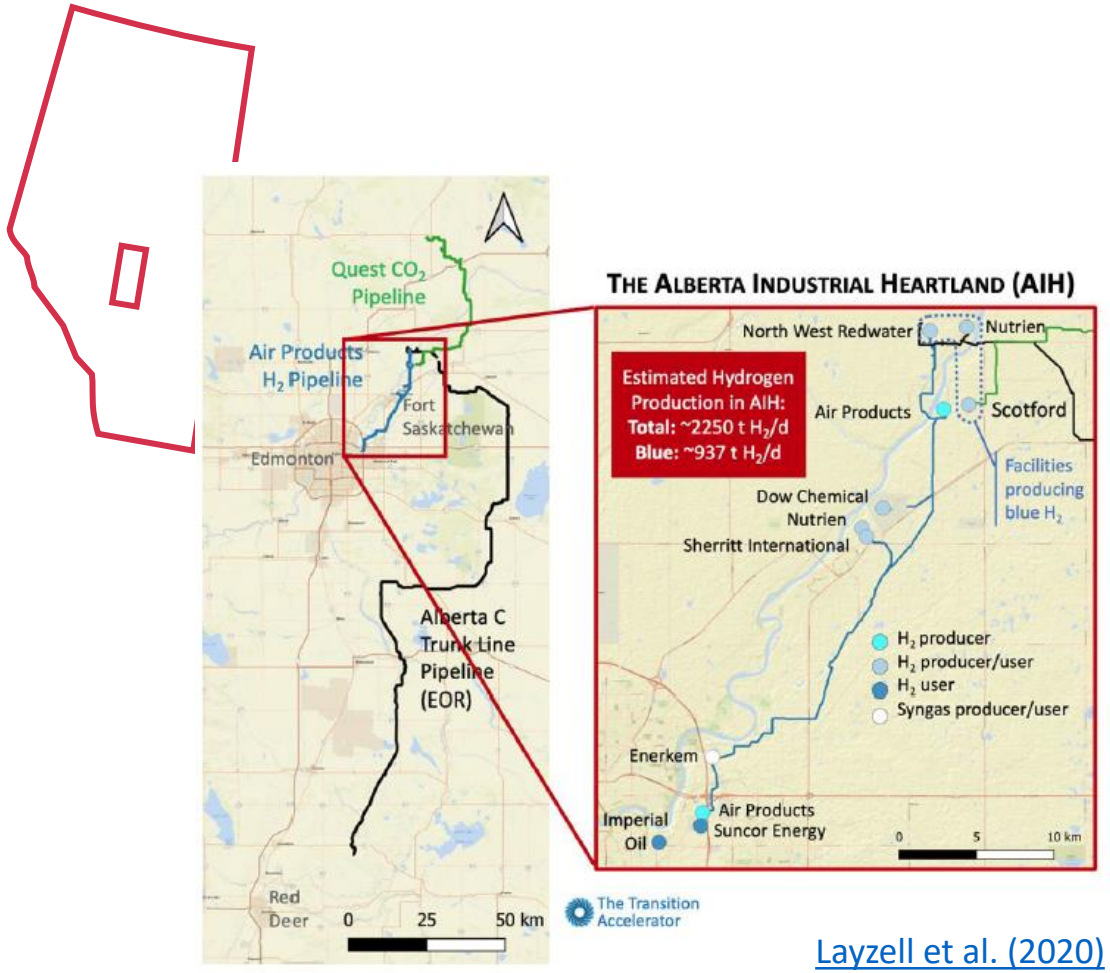
- High-CO_2 grid today, strong variable renewable potentials
- Large natural gas and emerging CO_2 storage reserves

British Columbia

- Relatively low-CO_2 grid, with large hydroelectric resources
- Large gas and CO_2 storage resources, but geographically isolated from major centres

Current Alberta hydrogen market is large

- 5,400 tH_2/d primarily from natural gas (SMR) for upgrading of heavy oil, refining of fuels, fertilizers, etc.
- Current demand anchored near Edmonton (“Alberta Industrial Heartland”) and Fort McMurray
- “Blue” hydrogen from the Shell Quest Project (400 tH_2/d) and the NWR Sturgeon Refinery (60 tH_2/d)
- Merchant plants and existing pipeline (12-16”) in AIH delivers H_2 to various users



Layzell et al. (2020)

Potential future demand for “low-carbon” hydrogen?

Alberta Industrial Heartland

1,300 tH_2/d	of existing “grey” hydrogen
600 tH_2/d	to displace diesel (and gasoline) for heavy duty vehicle fleets in Edmonton region
1,500 tH_2/d	for commercial and residential heating (highly variable demand)

Layzell et al. (2020)

Fort McMurray

2,000 tH_2/d	of existing “grey” hydrogen
100’s of tH_2/d	to displace diesel for oil sands mine trucks
15,000 tH_2/d	to displace natural gas for oil sands process heat (steam assisted gravity drainage, surface mining, etc.)

Unknown export potential as H_2, NH_3, and synthetic (non-fossil) hydrocarbons…

Many caveats to these estimates!

Multiple projects announced in Alberta

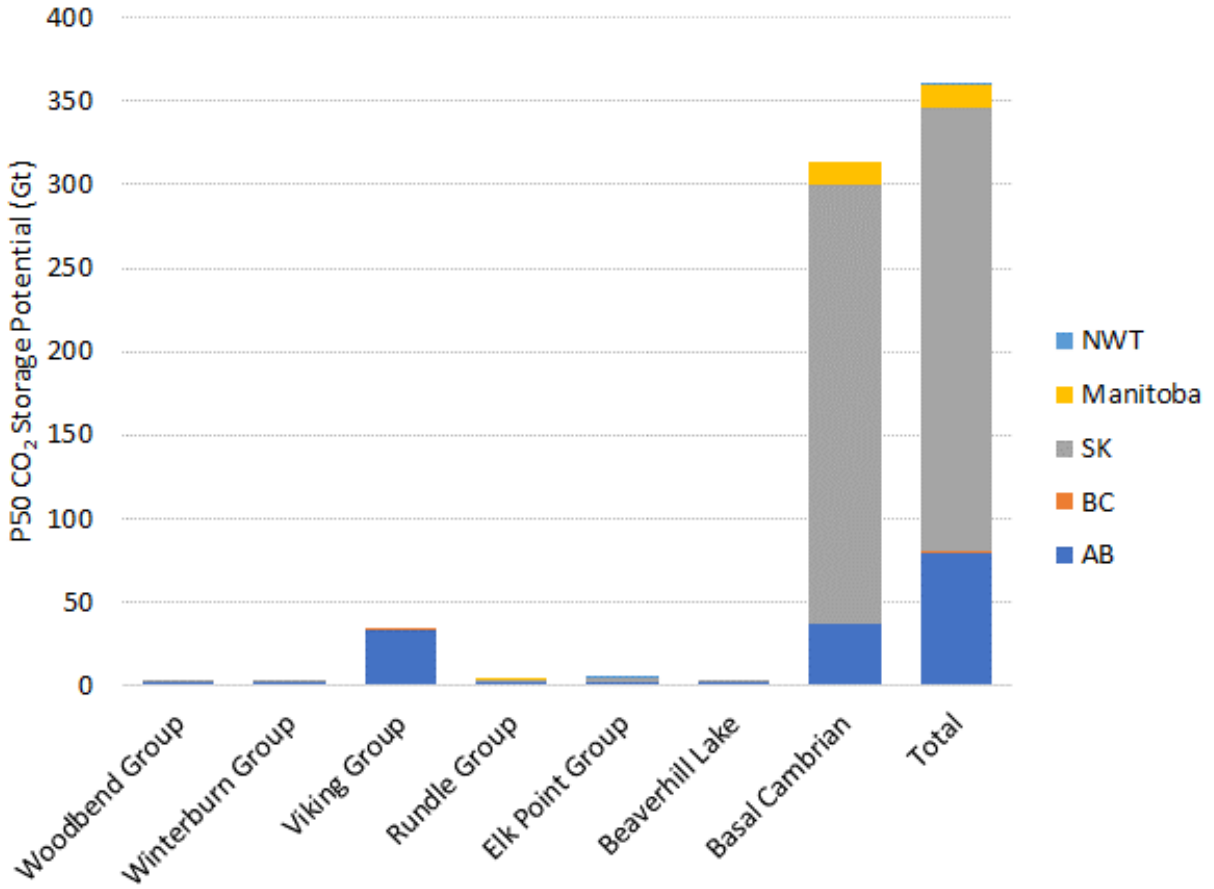
Proponents	Location	Capacity (tH_2/d)	H_2 Market(s)	Technology	Status
Suncor & ATCO	AIH	850	65% Refining 20% Gas grid 15% TBD	TBD 90% Capture	Proposed FID 2024
Air Products	AIH	1,500	Merchant 30 t/d LH_2	Haldor-Topsoe ATR H_2-Fired Cogen 95% Capture	Sanctioned* Operation 2024
Shell Polaris	AIH	Unknown	Existing Refinery	SMR Unknown capture level	Proposed FID 2023
Mitsubishi & Shell	AIH	500	Export to Japan (NH_3)	SMR Unknown capture level	Proposed#

* "…approved by Air Products' Board of Directors, subject to final completion of the agreements contemplated in signed Memorandums of Understanding between Air Products and Canadian authorities, and with appropriate permit approvals."

\# "…build and start-up the low-carbon hydrogen facility… towards the latter half of this decade…"

Western Canada is well positioned for CO_2 storage

- Ample storage resource in assessed formations, but additional work needed to develop capacity
- Law governing subsurface access is clear; post-closure liability sorted; Alberta Energy Regulator has needed tools
- Recent government moves have created uncertainty, but these will hopefully be resolved soon



Data: 2017 PCOR Atlas

Where does Alberta go from here?

1. Acknowledge that H_2 is, primarily, a response to climate change that requires a focus on the cradle-to-gate life cycle impacts of H_2 production
2. Through continued development of hubs, continue develop regional options where H_2 makes most climate and economic sense
3. Invest in CO_2 storage to enable accelerated deployment in Alberta
4. Anticipate that “green” H_2 will, eventually, be economically competitive and may be preferred by some importers
5. Acknowledge that for hydrogen success, government will play a large role – individual players don’t have incentives to drive system change

Questions?

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