

A BLUEPRINT FOR HYDROGEN PRODUCTION CANADA

How Canada Can Go Green and Prosper

A New Crown
Corporation

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A Blueprint for Hydrogen Production in Canada

Introduction

In Canada, the installation of hydrogen production facilities, export infrastructure and distribution facilities lag significantly behind other nations: Japan, China, US, Russia, and Western Europe in particular.

Without immediate action Canada will become a follower in energy production and the associated technologies. When Canadians finally realize that hydrogen is the way of the future we will need to rely on foreign knowledge and expertise. There are more aggressive players who already see it's potential¹ but lack the certainty of demand that a Crown Corporation could provide.

In the past Canada could have claimed to be a leader in such fields as nuclear power generation, aeronautics and (naturally) ice hockey. Now I can't think of any discipline or sector that it can reasonably claim to be a world leader in. It is a competitor for top spot in the "most selfish culture" and "we don't care what others think" categories, but it is difficult to say that Canada is leading in those either.

The current government plan is guaranteed to fail in the long run (perhaps sooner). Outlined below is a plan designed to maximize returns and minimize negative effects through the transition from coal to hydrogen. First, I will make a case as to why hydrogen is the future of energy production; second, I will explain the need to form a Crown Corporation and, lastly, I will provide a starting point to build the industry.

Why Hydrogen?

Hydrogen lacks the drawbacks of all renewable energy sources and returns all the benefits of fossil fuels without many of the negative aspects.

The Necessity of a Crown Corporation

The Canadian market for hydrogen production is relatively small and a corporation having to undertake significant demand risk is unlikely to set up shop in Canada when there are far more lucrative options out there, so if Canada doesn't want to be last to the proverbial

“table” we must create the market ourselves as we don't have the capital structure or market size of our competitors. A Crown Corporation having all the governments' supports will be able to create sufficient domestic demand for hydrogen to positively impact Canadians lives. We can generate domestic demand in the following ways:

- Replacing all diesel generators with hydrogen fuel cell generators in all isolated communities (particularly the Arctic communities.)
- Blend Hydrogen with Natural gas for domestic use.
- Outfit all municipal buses with hydrogen fuel cells
- Create capital gains by exporting excess
- Create industry wide standards

Most of the wealth (our high standard of living) in Canada today is owed to Crown corporations such as Petro Canada (oil and gas), Cameco (uranium), Canadian National Railway, Telus and Bell Communications and the listⁱⁱ goes on. This also directly impacts our ability to assist other countries, which is something Canada is well known for, and the Federal government's wayward backing of the oil and gas industry will have a serious impact on Canada's ability to provide for its citizens never mind providing foreign aid.

Two Choices

1. Continue the 'steady as she goes' policies that have served Canadians well over time and could continue to do so in the short term.
However, times are changing and those unwilling to adapt will be left behind (I invite you to study any period of technological change in human history to see the truth of this statement).
They will degrade our environment, reputation, and future generations' standard of living. Currently, choice # 1 is the course of action advocated by all Canadian Political Parties (except Green) based on their actions.
2. Help me, and others who advocate prosperity for all in our efforts, to MAINTAIN and or improve human lives around the world by rising to the challenges presented by the energy transition.

“The future will belong to Canada but only if the people of Canada have faith in the destiny of Canada and work to make it all come true.”

Air Marshall Wilf Curtis:

“I ask you, ‘could we do better?’”

The answer is, yes, we could do better without breaking a sweat while improving the lives of Canadians, and in fact it is likely that if we do not transition to hydrogen our life in Canada will become much harder.

Locations of Electrolyzers

Where	Specifically	Why
Alberta	<ol style="list-style-type: none"> 1. At the head of the Trans-Mountain pipeline 2. Outside of Fort McMurray and Calgary 3. Head of the Keystone* Expansion 	<ul style="list-style-type: none"> • Power from Site C dam • Water from the N. Sask. River • Has access to the Pacific for export • Take advantage of new solar farms coming online in S. Alberta
British Columbia	<ol style="list-style-type: none"> 1. Two or more locations in the lower mainland 2. Northern B.C. (perhaps Kitimat) 	<ul style="list-style-type: none"> • Service the Vancouver Lower Mainland and export to Asia
Manitoba	<ol style="list-style-type: none"> 1. Outside Winnipeg 2. Close to Churchill 	<ul style="list-style-type: none"> • Service Northern communities and export to Europe or Asia
Newfoundland and Labrador	<ol style="list-style-type: none"> 1. Outside St. John's 2. Port Argentia 	Service Eastern Canada and export to Europe and Africa
Northwest Territories	service out of Northern AB, BC, SK, or MB	
Nunavut	service from Churchill	availability of clean energy
Prince Edward Island	Outside of Charlottetown	dependent on demand
Saskatchewan	Outside of Regina, Saskatoon, Prince Albert, and Uranium City	All of components necessary for hydrogen production in abundance
Yukon	service out of northern AB, BC, or MB	
** New Brunswick, Nova Scotia, Ontario, and Quebec installations should go wherever makes the most sense.		

Electrolyzers can and should be built in almost every major city in Canada where practicable (safety, environmental, economic considerations accounted for). They can and should also be built near the US border with consideration of their proximity to pipelines (especially the currently defunct Keystone Expansion Pipeline), I suspect construction of the Keystone Expansion would begin anew if it were designed to transport hydrogen instead of bitumen.

Now the port of Churchill, Manitoba may SEEM like an odd choice but for the following reasons it makes perfect sense:

- ✓ Plenty of green power
- ✓ Plenty of fresh water
- ✓ Four deep-water berths ⁱⁱⁱ
- ✓ Germany has already sent a minister to Canada^{iv}, indicating their interest in buying hydrogen from Canada when it is available.
- ✓ Most of the northern communities rely on diesel run generators for power: these generators should be replaced with hydrogen full cell generators because of the absorption^v effect of the soot they create.

The Cost of Start Up

Based on the electrolyzer recently purchased by the Province of Quebec^{vi}:

- ~ C\$ 200 million
90 MW Capacity
11,100 metric tonnes of hydrogen / year
88,000 metric tonnes of oxygen / year
- Using the statistics above and the ability to buy electrolyzers modularly, an average cost of \$1 billion per province (territory), \$15 billion.
- Pipeline upgrades - \$5 billion - as opposed to building new ^{vii} pg.23
- New Pipelines - \$5 billion
- Creation of Crown corporation - \$5 billion

Value for our tax dollars?

The Canadian Federal government has finally figured out that TMX will never make money for Canadians and yet they continue to link TMX to our national identity and insist that completion of the pipeline expansion is vital to our national interest. **Is it in our national interest to increase carbon emissions at an unprecedented rate to employ 500 people (at best) over the long term?**

What are we getting for \$30 Billion Dollars?

TMX ^{viii}	New Hydrogen Infrastructure ^{ix}
980 km (X2) of heavy oil pipeline with a limited life span	Upgraded pipelines to carry hydrogen
Approx. 200 long-term jobs with questionable longevity Short-term construction jobs lost (job finished)	Roughly the same number of short-term construction jobs (NEW) 350,000 or more long-term jobs
Three times the carbon emissions attributed to the current pipeline, Current emissions are roughly the same as the entire province of Quebec	Slowly declining carbon emissions Make a Paris agreement target?
Three times all types of environmental degradation	Improving environmental conditions
According to the Conference Board of Canada – a high probability the Southern Resident killer whales will not survive	Improved environmental conditions and stature on the world stage

At some point Canadians will still need to further subsidize oil sands production even in the absence of further supply disruptions far sooner than the government anticipates because:

- Every oil producer on the planet has been asked to increase production with no restrictions
- The supply chain will likely catch up to demand with 1 – 4 years
- High oil prices have pushed consumers toward alternatives
- Once they have changed over, consumers are not likely to return to inferior (dirty) tech.
- Currently, China has closer relations with Russia than Canada.
- Canada must discount its oil already ^x
- The cost of production is less almost everywhere else

It is very important to note that I do not advocate shutting down any oil and gas operations because their lifespan is limited and without subsidies will eventually die like the obsolete industries before them, that being understood, we should use the money to help fund the transition to hydrogen production. It should be noted that the expansion portion of the TMX should be abandoned until a three-person panel can determine whether it is worth the additional cost to convert the pipeline to carry hydrogen instead of building a larger electrolyzer in the Vancouver lower mainland.

Don't forget the past, learn from it, and move towards the future!

As of August 7, 2022, OPEC has agreed to increase production and as a result the price of WTI Crude settled below US\$ 90.00/ bbl. Looking at technical analysis, the trend is now down with support at the US\$ 70.00, 60.00, 40.00, and then US\$ 20.00 levels. Barring any more significant disruptive events (China attacks Taiwan) it is very likely the price of crude oil will continue to decline.

What is Canada going to do when aggregate demand for crude oil starts to fall? Will oil production decrease to maintain high prices? How long will Canadians subsidize oil sands production^{xi} when the price drops to \$US 60.00 and the oil sands production no longer profitable? When Russian oil is accepted in the West again, how low will it go? When will Canadian politicians adopt a perspective that is longer than four years (the next election)? Why are we competing at the bottom of the energy spectrum?

For those who are unaware, the Canadian Federal Government (specifically the Parliamentary Budget Office^{xii}) has recently reported that the Trans-Mountain Expansion project will never make money for Canadians.

It will be precisely as Air Marshall Curtis predicted back in the 1950's, the fate of Canada is in the hands of Canadians. If Canadians would like option 2 with their help, I will deliver it!

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I suggest that we minimize the effects these questions to the point where it does not affect our standard of living or abilities. I suggest that we join the race for cutting edge energy technology at the top rather than be dependent on others at the bottom.

Be Seeing You!
Rene

	Hydrogen	Natural Gas	Gasoline	No. 2 Diesel
physical state	compressed gas or liquid	compressed gas	liquid	liquid
flammability range in air	4.1%–74%	5.3%–15%	1.4%–7.6%	1.0%–6.0%
lower heating value (btu/lb)	52,217	20,263	18,676	18,394
boiling temperature (°F)	-423	-259	80–437	356–644
specific gravity (60°F)	0.07	0.424	0.72–0.78	0.85
energy content per gallon	gas: 6,500 Btu at 3,000 psi	gas: 33,000–38,000 Btu at 3,000 psi	109,000–125,000 Btu	128,000–130,000 Btu
autoignition temperature (°F)	1,085	900–1170	495	600
latent heat of vaporization (Btu/lb at 60°F)	192.1	219	150	100
freezing point (°F)	-435	-296	-40	-30 to -40

Source: U.S. DOE Office of Energy Efficiency and Renewable Energy; www.eere.energy.gov/afdc/pdfs/fueltable.pdf; www.eere.energy.gov/afdc/pdfs/afv_info.pdf

Conversion Factors

Pressure

- 1 bar = 0.1 megaPascal (MPa) = 14.5 lbf/square inch (PSI)
- 5,000 psi = 345 bars = 34.5 MPa
- 10,000 psi = 689 bar = 68.9 MPa

Volume

- 1 standard cubic foot = 28.3 liters
- [standard conditions are atmospheric pressure and 60°F (16°C)]

Mass

- 1 kilogram = 2.2 pounds

Energy

- 1 British thermal unit (Btu) = 1,055.05585262 joules (J)
- 1 calorie (cal) = 4.1868 joules (J)
- 1 kilowatthour (kWh) = 3.6 megajoules(MJ)

Temperature

- °C = (°F-32) x 5/9

Table 1

Tables

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