Ontario Low Carbon Hydrogen Strategy

Discussion Paper

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Congratulations on this important document and thank you for the opportunity to comment. Ontario's hydrogen strategy needs to be anchored to Ontario's unique socio-economic and geographic attributes. The strategy also needs to reflect Ontario's place within a pan-Canadian (and global) energy transition.

Scale and pace of an economy-wide energy transition

Many governments are advocating for 'net-zero' carbon energy system by 2050, however the necessary scale and speed of this transition is under-estimated. For example, the province's transportation, land-use, and economic development plans are woefully inadequate to meet the target. Municipalities and planning agencies need to ensure today that new buildings can be heated without fossil fuels and accessed through zero carbon-emission transportation systems within the decade. None have yet acted on this commitment. The potential impact of hydrogen production on Ontario's electricity system is a powerful example of the potential scale of change. The Transition Accelerator highlights that the national strategy places hydrogen demand at 3000 PJ/yr in a net zero carbon future. Assuming 40 percent of this demand is in Ontario the province will need 8.5 Mt H2/yr. To produce this from electricity (assuming 82% efficient electrolysis) would require 407 TWhr/yr, or 2.7 times the current generation (not including increased electrification of transportation and building heating).

Ontario's shift away from 'surplus low-carbon' electricity

Much is made in the report of Ontario's 'low-carbon electricity'. True, the carbon intensity of Ontario's electricity is today a world-leading 50 gCO2e/KWh. No mention is made in the report however of the 2025 closure of Pickering NGS and loss of 3000 MW of low-carbon nuclear-generated electricity. This loss in generation will be offset mainly with natural gas. Beginning 2025 the carbon intensity of Ontario's 'low-carbon electricity' is likely to quadruple (to more than 200 gCO2e/kWh – hydrogen generated from this electricity would have the approximate carbon intensity of 'grey hydrogen'). This will not be offset by the small modular (nuclear) reactor, SMR, proposed at Darlington NGS (~100 MW), especially as overall electricity demand will increase as fossil fuels are phased out.

The strategy suggests that Ontario has, and will continue to have, surplus off-peak electricity, and that this might be used for hydrogen generation by electrolysis. With Pickering NGS closing and the soon-to-be commissioned Lake Erie Connector (bi-directional 1000 MW transmission line), Ontario will likely not

have surplus electricity for hydrogen production. Policies and public discourse needs to reflect these circumstances. Of course, any off-peak electricity might be available would be an excellent source for electrolytic production of hydrogen (as supported by local economics; most 'surplus' electricity at night would provide EV charging).

The report states that 'Ontario is committed to reducing electricity rates for all consumers which will benefit hydrogen production.' This policy needs greater techno-economic analysis considering that today's electricity in Ontario is highly subsidized (about $5.6 billion per year of the cost of electricity is borne through general revenues, i.e. not reflected in prices). With Ontario's current deficit, and considerable and growing debt, there is no financial stability in today's electricity prices (e.g. tomorrow's taxpayers and children cannot be asked to pay today's consumption indefinitely). This budgetary shortfall will be further exacerbated as Ontario's electricity generation shifts away from nuclear power (generated at Pickering NGS and as Darlington and Bruce reactors are temporarily offline for refurbishment) to natural gas (adding more than $2 billion per year in electricity costs from the carbon tax at $170/t CO2).

Integration within a genuine long term *energy* strategy

The release of the hydrogen strategy by the Ministry of the Environment, Conservation and Parks may be expedient, however this also raises questions of policy integration. Hydrogen is an energy carrier, requiring generation and transportation prior to use. Ontario's Ministry of Energy has typically served as a Ministry of *Electricity* (e.g. more than 95% of Ontario's long term energy plans are devoted to electricity – mostly about price). Within the Canadian federation, provinces have sole oversight of electricity while natural gas and liquid fuels are mostly regulated federally, with prices generally more market-based. Hydrogen has the potential to disrupt this convention.

Will the province of Ontario (and presumably hydro-rich provinces such as QC, NL and BC) encourage the private sector to generate hydrogen from (subsidized) provincial-grid electricity for sale into sectors such as transportation and industrial processes? Will Ontario seek adjudication if hydrogen is generated in Alberta (through steam methane reforming) and piped to Ontario? Will the government of Canada impose minimum hydrogen content in nationally piped natural gas, endeavoring to maximize returns on capital-intensive pipeline networks (mostly owned by private agents), requiring modifications to household appliances, or will the Government and a relatively high (>$200/t) carbon tax bring about a faster transition away from natural gas, stranding pipeline assets?

Any Ontario hydrogen strategy needs active involvement of various ministries, including, but not limited to: Finance (e.g. continued provision of $6 Bn electricity price subsidy, loss of gasoline tax); Transportation (hydrogen corridor, shift in HD trucking); Energy (oversight and long-term contracting of electricity generation); Government and Consumer Services (TSSA fuel technicians and pipeline regulation); Infrastructure (Metrolinx and GO hydrail); Health (air quality benefits through clean fuels); Municipal Affairs and Housing (changes to land use planning and building codes).

Linking with rest of Canada and a de-carbonization strategy

Ontario's hydrogen strategy needs to be an integral part of the province's de-carbonization plan (with costed and prioritized programs). Ontario's de-carbonization plans need be fully consistent with, and supporting the Government of Canada's similar plans. Ontario can take a leadership role in developing

this shared vision, however it cannot proceed in isolation as Canada's federalism requires a consistent provincial approach, structured within an international framework, e.g. the Paris Agreement.

More than 80 percent of economic growth for the remainder of this century will take place outside OECD countries (Canada, and especially Ontario's traditional trading partners). Economic development strategies, such as this one, need to also target the regions of Asia, Latin America and Africa.

'Energy strategies' in Ontario typically have a disproportionately large emphasis on electricity (about 30 percent of the province's energy use). Transportation is the largest energy demand, and largest source of GHG emissions (and NOx and particulate pollution), however the province has traditionally not availed policy instruments such as congestion charging, HOV lanes, and surface transit systems on 400-series highways.

Similarly the province has an aggressive support program for natural gas delivery in rural and agricultural communities (responding to voter requests for price relief). A systems analysis is needed as carbon taxes and a switch to hydrogen may well remove any price support (while actually increasing overall GHG emissions and air pollution).

Vaccine development and distribution in response to COVID-19 provides lessons for a large scale energy transition as proposed in the hydrogen strategy. The speed and comprehensiveness of vaccine development was unprecedented and a scientific triumph. Vaccine distribution, especially in federal countries like Canada, Germany and the US, however is problematic as political frictions intensify. This is similar with mandating face-masks and the pace and scale of 'lock-downs'.

Transitioning energy systems is on a similar large-scale to the response to COVID-19; comparable challenges should be anticipated. These include: inter-governmental friction (e.g. between Ontario and federal government, provinces of AB and QC); significant influence and agitation from existing stakeholders (e.g. urging preservation of status quo over systemic change with new entrants); resistance to change; local manifestation of geo-political issues; urban-rural tensions; low willingness to pay; a small but influential group of 'deniers'; political (or cultural) precedence over scientific facts.

Prioritizing action

A key priority for hydrogen development in Ontario is clear: start with use in Class 8 trucks along 400-series highways (beginning with the Highway 401 and ETR 407, and broadening to buses). Complementary aspects to the this first priority include: (i) a review of underground storage in the sedimentary basin of SE Ontario; (ii) hydrogen supply node (initially with steam methane) in Sarnia; (iii) targeted research nodes; (iv) expansion of hydrogen for HD trucks to the Great Lakes Region (establish a reciprocal trucking agreement with QC and the US states bordering the Great Lakes); (vi) review the role of hydrogen in rail transportation – starting with Metrolinx and Via route between Toronto and Montreal; (v) as hydrogen demand grows beyond the cost-effective ability of Sarnia to supply (with low-carbon supply, i.e. below 100g/kWh equivalency) expand supply through three possible means – renewables and electrolysis, nuclear power and electrolysis (e.g. Cu-Cl cycle), through natural gas and UGS, e.g. from Alberta.

Ontario Low Carbon Hydrogen Strategy

Recommendations

Decision making support

- Ontario should pursue a 'color blind' approach to hydrogen and 'simply' specify hydrogen by carbon intensity (LCA production). The report should be commended for suggesting this.
- The Government of Ontario should designate Sarnia as an initial regional deployment HUB consistent with the Mayor's petition and the Government of Canada's Hydrogen Strategy recommendations. A second Oshawa HUB for low-carbon hydrogen generation is also warranted.
- The Government of Ontario should support a Durham-York Strategic Energy Alliance as they pilot residential applications of hydrogen and low-carbon transportation.
- The Government of Ontario should support municipalities to shift toward time of use charging for at least delivery vehicles on local roads (fees should be differentiated by levels of emissions and GVW - this will help drive a market for hydrogen, along with EVs).
- Ontario should anchor a Great Lakes Region approach to hydrogen (with consistent standards and transmission for the provinces of QC, ON and states of IL, IN, MI, MN, NY, OH, PN, WI).

Scale and speed of the transition

- Ontario (i.e. Min of Energy) should analyze the techno-economic aspects of hydrogen supply from Alberta and Saskatchewan (steam methane reforming with UGS) at the 5, 10 and 30 year time horizon. This study needs to include feasibility analysis of hydrogen supply by hydro-power in QC and NL and possible co-generation with nuclear plants in Ontario.
- Hydrogen has the potential to disrupt Ontario's overall energy system – not only the more traditional electricity sector as the province traditional oversees. More than 15 percent of Ontario's economy will be fundamentally shifted. A clear publicly vetted discussion document is needed, as this likely represents the largest social, economic and possibly environmental change the province will see this century. The Ministries of Finance and Energy should jointly oversee the preparation of this report (with publicly vetted terms of reference and a non-partisan advisory committee). The Government of Canada and at least the provinces of Quebec and Alberta should be invited to be part of the process.

Ontario's opportunities (supply, demand, storage and transmission)

- Strategic pilot (phase one) priorities for Ontario are: (i) 'hydrogen highway' (starting with Windsor – Quebec City corridor HD trucking – minimum target of 30% GHG reduction – to avail federal funds, strategic deployment of fueling stations for commercial and municipal fleets); (ii) expanded electrolysis facilities, e.g. Markham District Energy and transmission in existing natural gas pipelines; (iii) low-carbon surface transit on existing 400-series and Trans Canada Highways.

- Strategic research priorities for Ontario are: (i) underground storage of hydrogen in salt-domes; (ii) hydrogen applications in remote communities (storage in Precambrian bedrock, generation through intermittent renewables); (iii) alternative generation through industrial-grade heat, (e.g. nuclear and cement plants and CuCl cycle); (iv) hydrogen fueled aircraft; (v) electrolytic generation from variable renewables; (vi) fuel cells. The Ministry of Colleges and Universities should partner with NRCan (and NSERC) to call for 5-to-10 year partnered research proposals in these areas. Ontario universities should establish 3 to 5 research centers to address specific research questions related to the hydrogen transition.
- Ontario's research and manufacturing capacity should be supported to develop hydrogen powered aircraft (in addition to surface vehicles). International markets, such as Africa, should be identified early. Work with Ontario's remote communities should be viewed in context with similar small communities in low-income countries.

Policy and regulatory barriers

- TSSA should be commended for launching Canada's first hydrogen fuel technician licensing. The program should be partnered with at least one southern and one northern Ontario college.
- Similar to gasoline and natural gas, hydrogen is dangerous. As hydrogen takes a larger role in Ontario communities, accidents will happen. These can be minimized, but planning is needed now for the eventuality (if not in Ontario, elsewhere). The province will need to engender trust and ask local governments to help with building this trust.
- The Government of Ontario should support Ontario Tech University plans to establish a Graduate Diploma in hydrogen energy systems (consistent with the Government of Canada's recommendation).
- The Government of Ontario should prepare a discussion document for municipalities and the land development community outlining the changes envisaged as part of the shift to a net-zero carbon society by 2050 (significant growth of potentially stranded assets is occurring – and the rate of change is woefully under-estimated).

Hydrogen in context

- The COVID-19 pandemic is providing important lessons. For example, the federal model of Canada is limited by inter- and intra-provincial governance issues. Local (regional) optimization and partisan policy development limits optimum policy solutions and in-practice service delivery, e.g. vaccine distribution and consistent health data across Canada. Canada's new energy strategy, of which hydrogen will be a large part, is in danger of being sub-optimized. Having this occur in the energy sector will be extremely detrimental to the province and the country. Easily, a sub-optimum solution in the energy sector could cost more than 10 percent of GDP (i.e. failing to work together smartly could cost more than the current health care or education budgets). To guard against this, the Government of Ontario should establish an advisory committee that reports to the Legislature annually for the next 15 years on the success of the energy transition (with full knowledge and support of the Government of Canada and fellow provinces).

- As a non-emitting energy carrier hydrogen will play an important role in overall sustainability, e.g. as captured through the Sustainable Development Goals (SDGs). As some 900 million people do not have access to electricity and 2.6 billion cook with unsafe fuels, Ontario's energy transition, and the role of hydrogen, needs to reflect our place in the world and urgent global priorities. In partnership with the Government of Canada, Ontario can do much to help with sustainability at home and globally. Ontario – with Canadian partners – should establish a long-term partnership with 3-5 larger cities in low-income countries to help better understand and support their energy transition (minimum ten year involvement).
- The Government of Ontario should support the transition to low-carbon practices in the steel and cement industries, and while doing so should ask the Government of Canada to support their efforts through carbon-adjusted border tariffs.
- Work needs to begin now with first-responders in terms of training for emergency response to building and vehicle accidents involving hydrogen (Ontario Fire Marshal, MTO and Ontario Trades programs). Education and training is also needed for the insurance industry and secondary vehicle servicing, e.g. towing and mechanics.

Integrating Ontario's and Canada's Hydrogen Strategies

In December, 2020 the Government of Canada (NRCan) released Hydrogen Strategy for Canada, Seizing the Opportunities for Hydrogen (A Call to Action). The 141 page report is summarized through 32 recommendations covering eight 'pillars' (see attachment). Following are recommendations for the governments of Canada and Ontario to integrate recommendations.

Strategic Partnerships

- Support establishment of the Durham-York Strategic Energy Alliance (senior representatives from NRCan and the Ministries of Energy; Transportation; and Environment, Conservation and Parks; TSSA; OPG; GM).
- Through low-carbon vehicles (buses and vans – H_2 and EV) provide a surface-transit route along major highways (Ontario – 400-series highways, GOC – TransCanada Hwy).

De-Risking Investments

- Using the planned residential developments in York-Durham Regions, (approximately 65,000 new homes) provide a 'safe space' for hydrogen applications in appliances, transmission and space-heating.
- Support a regional deployment HUB in Sarnia, ON (production and use).
- Provide support to the steel trade associations (with a focus on Hamilton, Nanticoke and Sault Ste Marie) – include border tariff adjustments. Industry to provide costed timeline to net zero emissions by 2050 (with at least 25% reduction by 2030).
- Provide support to cement industry; include border tariff adjustments. Industry to provide costed timeline to net zero emissions by 2050 (with at least 25% reduction by 2030).

Innovation

- Provide shared support to academic, government and private sector research facilities, including, but not limited to: U of Waterloo ('hydrogen freeway' and underground storage); U of Windsor (wind generation of H2 and UGS); Ontario Tech (CuCl generation, hydrail, nuclear generation); Carleton (public policy); Canadian Nuclear Laboratories; Nuclear Innovation Institute (with Bruce Power).
- Establish life cycle approach to carbon intensity in hydrogen generation (with globally accepted equivalencies for UG storage and nuclear generation).
- By 2022, Province of Ontario to set carbon intensity targets for electricity and hydrogen generated and used in the province (consistent with national framework).

Codes and Standards

- Support harmonized codes and standards. Support and participate in an inter-provincial working group and international standard and certification program (carbon intensity of hydrogen generation, transmission, and phased blending ratios with natural gas).

Enabling Policies and Regulations

- Support low-carbon transition of municipal and Canada Post fleets (buses, trucks and waste collection vehicles).
- Encourage municipalities to shift toward pay-per-use of local roads by delivery vehicles (with preferential pricing for lower emissions).

Awareness

- Support Ontario Tech University's proposal to develop a Graduate Diploma in hydrogen energy systems – coordinated with the Hydrogen Technologist training with TSSA (and colleges).

Regional Blueprints

- Establish a hydrogen HUB in Sarnia and pilot-zone at Durham-York Regions.
- Identify at least four academic research centers, i.e. Waterloo, Ontario Tech, Windsor, Carleton.

International Markets

- Consistently message carbon intensity of hydrogen generated (and used) in Canada
- Establish the 'hydrogen highway' from Windsor to Quebec City (and beyond) as a flagship project for international recognition.