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Comments on the discussion paper for an Ontario Low-Carbon Hydrogen Strategy – ERO 019-2709

Summary

We appreciate the Province's interest in exploring hydrogen as a way to reduce greenhouse gas emissions and improve air quality, while creating opportunities for economic growth. Strategic deployment of renewable hydrogen technology could make a small impact on Ontario's ability to meet its 2030 climate target and fill a niche role along a pathway to zero emissions.

However, we have concerns about moving forward with a hydrogen strategy in the absence of a credible climate plan,[1] a long-term energy planning process,[2] or a clear assessment of hydrogen's potential, limitations, and costs in Ontario. These elements are necessary in order to assess the role hydrogen can play in reducing emissions in Ontario, eventually to net-zero.

A credible hydrogen strategy must ensure that hydrogen is used cost-effectively alongside other proven low carbon technologies which are currently more widely available and cheaper to implement. Many of these technologies, like electric heat pumps and electric vehicles, have not yet seen the level of support promised in the Made-In-Ontario Environment Plan. Deploying these more established low carbon technologies where they are most effective is essentially picking the low-hanging fruit in Ontario's pathway to meeting its emission reduction target and should be done first, while hydrogen is a specialized tool best used for hard-to-reach areas.

Hydrogen has a high energy density, but involves a more complex and costlier production process than electricity. For these reasons hydrogen is best suited to reduce emissions in hard-to-decarbonize sectors with few alternatives and where electrification isn't an option, such as the production of steel and cement, and potentially with heavy-duty transport and maritime shipping. For example, there are cost-effective solutions available now to decarbonize space and water heating, including energy efficiency and electric heat pumps; and electricity can effectively power passenger vehicles at much lower cost and be implemented more quickly than hydrogen. Ontario's hydrogen strategy must include a credible analysis of hydrogen's greenhouse gas reduction potential and relative costs alongside these existing technologies, and use this analysis to guide deployment in areas where there aren't already cost-effective, ready to deploy low carbon technologies.

[1] https://www.cbc.ca/news/canada/toronto/auditor-general-report-2019-1.5383961
[2] https://ero.ontario.ca/notice/019-2149

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Ontario's hydrogen strategy should prioritize hydrogen's ability to help shift our economy away from carbon intensive fossil fuels like natural gas. A focus on blending small amounts of hydrogen into existing natural gas supply for space heating does little to build the infrastructure needed to truly decarbonize Ontario's energy sources, and distracts from hydrogen's much greater potential to move hard-to-decarbonize sectors to net-zero.

Renewable or "green" hydrogen can be made entirely in Ontario from on-site solar, wind, or hydro power. This form of hydrogen has much greater potential for job creation than hydrogen made from imported natural gas. Québec is aiming to capitalize on its abundant hydroelectricity to produce 'green' hydrogen, where it sees a growing market.

However, significant work is needed before Ontario can establish a renewable hydrogen industry as strong as Quebec's. Ontario's electricity grid is lower in carbon emissions than many other jurisdictions, but it is not entirely renewable or emissions free. More than half of our electricity comes from nuclear power, and a small but increasing amount comes from natural gas, a fossil fuel. Neither of these sources fits the widely accepted definition of "green" hydrogen. The Province will need to expand zero-carbon renewable sources of electricity like wind, solar, and hydro power in order to build a hydrogen industry around the production of green, renewable hydrogen, which will be in increasing demand as economies around the world decarbonize.

As noted in the proposal, hydrogen has the potential to improve air quality in addition to helping meet climate change goals. Renewable hydrogen is the only type of hydrogen which can achieve the Province's stated goal of improving air quality alongside reducing greenhouse gas emissions. Burning natural gas to produce hydrogen, even using carbon capture and storage technology, releases pollutants like nitrogen oxides which are harmful to human health.

The Ministry of Environment, Conservation and Parks has asked for input to help shape Ontario's hydrogen strategy. We offer the following general guidance on the goals, ideas and vision outlined in the discussion paper.

Vision Statement

The discussion paper proposes the following Vision Statement:

Leverage our existing strengths to develop Ontario's hydrogen economy, creating local jobs and attracting investment while reducing greenhouse gas emissions

We support these goals, but would suggest refining the statement as follows:

Leverage our existing strengths to develop Ontario's hydrogen economy, creating local jobs and attracting investment while reducing greenhouse gas emissions, reducing reliance on imported fossil fuels, and decarbonizing Ontario's energy sources.

The hydrogen strategy should support this vision statement with clear, credible, and transparent targets for greenhouse gas emissions reductions which include timelines. We suggest estimating the potential greenhouse gas emissions impact of the strategy on

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Ontario's 2030 target as well as a net-zero by 2050 target, in recognition that much of the potential for hydrogen to reduce emissions will be realized after 2030.

The strategy's action items and their estimated ability to reduce greenhouse gas emissions should be supported by modelling from the Ministry of the Environment, Conservation and Parks, and this modelling should be presented as part of the strategy in order to increase accountability and transparency. Any estimates for emissions reductions should be contextualized alongside other priorities in Ontario's Environment Plan.

Ontario's hydrogen strategy must also form part of a broader long-term energy planning process which incorporates Ontario's greenhouse gas emission reduction targets alongside other factors like electricity affordability, health outcomes, and economic potential. In fall 2020, Ontario revoked their existing energy planning process with no accompanying plan for a new energy planning process[3]. Before finalizing a hydrogen strategy (or other specific energy strategies), Ontario must first decide how to proceed with its broader energy priorities and planning process. Charting a course on hydrogen without this crucial plan in place could mean wasting time on a strategy that doesn't align with Ontario's priorities or misallocates resources towards suboptimal technologies.

Defining green/renewable hydrogen

Ontario's discussion paper identifies three types of hydrogen and defines them as follows:

Green hydrogen *is made using low carbon sources like electricity from Ontario's grid or renewable organic material (i.e. biomass).*

Blue hydrogen *is made from natural gas with carbon capture use and storage (CCUS).*

Grey hydrogen *is made from natural gas.*

This definition of green hydrogen differs from the currently accepted definition, used by the IEA and in Canada's recently released hydrogen strategy, where "green" hydrogen is made by extracting hydrogen from water using electrolysis powered by renewable (not simply low carbon) electricity.[4] This type of hydrogen has the greatest potential to reduce greenhouse gas emissions and fight climate change.

It is generally assumed that the renewable electricity fueling green hydrogen production emits no greenhouse gas emissions. Hydrogen produced from Ontario's electricity grid is certainly low-carbon, but not produced with exclusively renewable electricity. Even after eliminating coal, producing electricity in Ontario usually generates between three and five million tonnes of greenhouse gas emissions every year.[5] This is because natural gas, a fossil fuel, contributes to Ontario's electricity supply.[6] The amount of natural gas in

[3] https://ero.ontario.ca/notice/019-2149
[4] https://www.iea.org/reports/the-future-of-hydrogen
[5] https://www.ieso.ca/en/Powering-Tomorrow/Data/The-IESOs-Annual-Planning-Outlook-in-Six-Graphs
[6] https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-ontario.html

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Ontario's electricity supply is projected to increase in the next decade, meaning Ontario's electricity will become more carbon-intensive.[7]

Nuclear power provides more than half of Ontario's electricity supply.[8] If Ontario is following hydrogen colour scheme definitions, hydrogen produced through electrolysis powered by nuclear energy is generally considered "pink" hydrogen, not green.[9] Although nuclear power can be zero-carbon, it is not widely considered to be "renewable" due to its reliance on a rare type of uranium (not a renewable resource). Nuclear waste created by power plants in Ontario is also hazardous and problematic to store.

Hydrogen produced from Ontario's electricity grid therefore can't be considered "renewable" or "green" under the currently accepted definition. In order to compete with fully renewable green hydrogen produced in other jurisdictions, Ontario would need to either remove nuclear and natural gas-fired electricity from the grid or exclusively use wind, solar, and hydroelectricity for hydrogen production.

Ontario's opportunity in renewable hydrogen

There is an opportunity for Ontario to become a global leader in the renewable hydrogen industry. Canada is among a small group of countries with the highest potential for exporting clean hydrogen, thanks to plenty of access to water (required for electrolysis) and a clean power system, and Ontario's grid is one of the cleanest in the country. But a focus on fossil hydrogen risks squandering this opportunity.

The creation of renewable electrolysis-derived hydrogen provides a ready mechanism to allow for more efficient use of Ontario's existing renewable energy resources. The discussion paper suggests that "producing hydrogen from excess wind and solar electricity using electrolyzers presents an opportunity to store that energy over days, weeks or even months. This could help improve the reliability and affordability of Ontario's electricity system." This method would generate green, renewable hydrogen, but the amount of hydrogen produced would depend on the availability of excess electricity from wind and solar, and would not be able to increase to meet growing demand. Increased demand could also risk diverting renewable power generation from the grid for hydrogen production. Lastly, if storing surplus energy is the goal, battery technology is far more advanced than electrolyzers when paired with the above-mentioned renewables, and would be a much more cost-effective, efficient storage method.[10]

To produce and market "green" hydrogen in Ontario, an investment would need to be made in expanding Ontario's supply of renewables like wind, solar, and hydro power to use exclusively to produce green hydrogen. However, Ontario's policies in the last two years have drastically curtailed investment in new renewable sources of electricity, holding back the potential for green hydrogen production. In 2018, the provincial

[7] https://www.ieso.ca/en/Powering-Tomorrow/Data/The-IESOs-Annual-Planning-Outlook-in-Six-Graphs
[8] https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-ontario.html
[9] https://www.enapter.com/hydrogen-clearing-up-the-colours
[10] https://www.iea.org/articles/batteries-and-hydrogen-technology-keys-for-a-clean-energy-future

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government abruptly cancelled more than 750 renewable energy contracts, and in 2019 Ontario's Minister of Environment, Conservation and Parks intervened to cancel an in-progress wind power project. His efforts were later overturned by the court as "unreasonable" and "procedurally unfair."[11] Ontario's hostile approach to renewable energy expansion is inconsistent with the expression of interest in building a strong hydrogen industry. This will need to be addressed if Ontario is serious about creating a credible hydrogen strategy.

Renewable hydrogen is a smart long-term investment

Ontario should build a hydrogen strategy to last. That means investing in the production of renewable hydrogen from the start, and capitalizing on the steadily decreasing costs of renewable hydrogen compared to fossil-based hydrogen.

Although "blue" hydrogen made from natural gas is currently cheaper to produce, it's a less attractive long-term investment than green hydrogen. According to Wood Mackenzie analysts, the cost of renewable hydrogen will drop by up to 64% until 2040, while the cost of blue hydrogen will rise 59% over the same period, mostly due to natural gas prices.[12]

Hydro-Québec is aiming to position Quebec as the ideal location to produce so-called 'green' hydrogen, capitalizing on its abundant hydroelectricity. This shift towards green hydrogen is part of a larger global trend. According to the Financial Post, "by the early-2040s, green hydrogen production could be the single largest use of electricity, exceeding industrial electricity use. And lots of renewable power will be required to meet that demand."[13]

The European Commission estimates that blue hydrogen would cost €2 a kilograms at today's prices, and renewable hydrogen €2.50-€5.50/kg, compared to €1.50/kg for existing grey hydrogen.[14] However, there is widespread optimism about renewable hydrogen's ability to compete. New analysis by Morgan Stanley says plummeting renewable energy prices, as well as ongoing reductions in the costs of electrolyzer technology, could push renewable hydrogen to be more cost competitive than even unabated fossil hydrogen by 2023.[15] Canada's carbon pricing regime would further improve the economics of renewable hydrogen.

The prices of the renewable energy sources that power green hydrogen are falling quickly, and are now the lowest cost sources of new power in many parts of the world.[16] Renewables have undercut conventional power generation in the past decade. Since 2009, the cost of unsubsidized solar power in the U.S. has fallen 90% and wind is down 70%.[17]

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[11] https://www.cbc.ca/news/canada/ottawa/north-stormont-wind-farm-court-bats-1.5569590
[12] https://www.woodmac.com/press-releases/green-hydrogen-costs-to-fall-by-up-to-64-by-2040/
[13] https://financialpost.com/technology/green-or-blue-quebec-eyes-overtaking-alberta-to-emerge-as-canadas-hydrogen-hub
[14] https://www.thefifthestate.com.au/energy-lead/energy/hydrogen-for-homes-is-a-terrible-idea-we-should-fight-it/
[15] https://ieefa.org/morgan-stanley-green-hydrogen-could-be-economically-competitive-by-2023/
[16] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf
[17] https://www.lazard.com/media/451419/lazards-levelized-cost-of-energy-version-140.pdf

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Another key factor is the rollout of electrolyzers used to produce the renewable hydrogen, which have already fallen in price by 60% over the past decade. According to the European Commission, prices are expected to halve in 2030 compared to today with economies of scale. In China production costs are already 80% lower than in Europe and North America.[18]

The costs of blue hydrogen are harder to gauge as they depend on the cost of adding CCS to conventional production. Though the cost of CCS is also highly uncertain, current estimates place it at about a 30% cost increase.[19] Furthermore, fossil (blue and grey) hydrogen technologies are expected to have limited cost reduction potential relative to the expected cost reductions for electrolysis.[20] While most of the technologies used for fossil hydrogen are already mature technologies, there is still a lot of potential for innovation and cost reduction in the renewable hydrogen process, as large-scale electrolysis is a novel field of application.[21] Focusing on current metrics to dismiss green hydrogen's prospects is highly risky. Both cost trends and capacity deployment lessons from other sectors point to a future competitive environment very different from today.[22]

Both the European Commission and German government are clear in setting out renewable hydrogen as the only sustainable hydrogen source. The EU envisions installing at least six gigawatts of green hydrogen by 2024 and at least 40 gigawatts by 2030. This would be followed by the large-scale deployment of new hydrogen technology out to 2050.[23] France announced €2 billion over two years for green hydrogen as part of a stimulus package, with a further €5.2 billion to be invested by 2030.[24] Lacking sufficient cheap renewables, European nations will turn to imports. Germany has earmarked funds to create partnerships with countries where green hydrogen can be efficiently produced.[25]

If Ontario is to compete and succeed in the global hydrogen economy, we must harness our competitive advantages and focus on the long-term with a plan to produce, use, and export the world's cleanest hydrogen and its related technologies.

Prioritizing applications for green/renewable hydrogen in Ontario

While electrification plays the leading role in carbon reduction pathways identified by the Intergovernmental Panel on Climate Change (IPCC)[26], it cannot currently decarbonize some sectors. Hydrogen has the potential to reduce emissions in hard to decarbonize

[18] https://www.carbonbrief.org/in-depth-qa-does-the-world-need-hydrogen-to-solve-climate-change
[19] https://www.e3g.org/wp-content/uploads/E3G_Renewable_and_decarbonised_gas_Options_for_a_zero-emissions_society.pdf
[20] www.imperial.ac.uk/sustainable-gas-institute/research-themes/white-paper-series/white-paper-3-a-greener-gas-grid-what-are-the-options/
[21] https://www.e3g.org/news/a-global-green-hydrogen-market-made-in-germany/
[22] https://www.petroleum-economist.com/articles/low-carbon-energy/renewables/2020/green-hydrogen-can-be-cost-competitive
[23] https://ec.europa.eu/energy/sites/ener/files/hydrogen__strategy.pdf ; https://www.renews.biz/61529/eu-unveils-40gw-greenhydrogen-vision/
[24] https://www.reuters.com/article/us-france-economy/france-unleashes-100-billion-eurostimulus-to-revive-economy-idU
[25] https://www.carbonbrief.org/in-depth-qa-does-the-world-need-hydrogen-to-solve-climate-change
[26] https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter2_Low_Res.pdf

sectors where electrification isn't an option, such as the production of steel and cement as well as heavy-duty transport and maritime shipping.

However, hydrogen is and will continue to be a scarce resource during the growth of this emerging clean energy sector. Even a niche application of hydrogen would require a dramatic scaling up of its production and use, which will take time. There is also the risk that renewable power generation is diverted from the grid for the production of hydrogen. In addition, hydrogen faces technical and economic challenges compared with other zero-carbon competitors. Its use should be prioritized for the sectors most difficult to electrify or decarbonize.

Furthermore, to the extent that any public resources are available for hydrogen development, they should be reserved for renewable hydrogen for the hardest-to-decarbonize sectors that do not have viable decarbonization alternatives. Ontario should not be providing any form of financial support for the development of fossil-fuel derived hydrogen, especially considering these fossil fuels must be imported. Support for research and development of natural gas for the production of hydrogen, as well as for infrastructure, falls under the international definitions for fossil fuel subsidies.

Hydrogen blending is not a suitable alternative for space/water heating

Cost-effective solutions exist right now to decarbonize space and water heating for buildings, including energy efficiency and electric heat pumps. Hydrogen should only be considered where these solutions fall short.

Ontario's approach has so far supported the injection of hydrogen into the gas grid for space and water heating. However, hydrogen blending is highly ineffective, expensive, and speculative in comparison to alternatives measures to decarbonize space and water heating.

The energy conversion losses associated with hydrogen means that at least 2-3 times more green electricity is required to decarbonize space and water heating via hydrogen versus electric heat pumps. Existing infrastructure is also not equipped to handle more than a very low percentage (up to 6%) of hydrogen blended into fossil gas. Hydrogen is a much smaller molecule than fossil gas and will cause dangerous leaks at higher concentrations. It also burns very differently, and will cause explosions and fires if too much is blended into the system. The Ontario Energy Board recently approved a project to test blending of hydrogen into pipelines, but noted that there is "apparent limited potential of hydrogen blending" and "there was general agreement by intervenors that hydrogen is an expensive fuel source compared to natural gas, could be dangerous at high concentration levels, and cannot make a significant reduction to the carbon emission levels in gas delivery."[27]

[27] http://www.rds.oeb.ca/HPECMWebDrawer/Record/691859/File/document

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In addition, hydrogen blending is extremely expensive in comparison to alternatives. Whereas hydrogen blending will cost in the range of $4,000 to $5,000 per tonne, energy efficiency saves money, often over $100 per tonne.[28]

Blending a negligible volume of hydrogen into carbon emitting fossil gas is a dangerous distraction from realistic measures to decarbonize space and water heating. This application would divert hydrogen from other uses where it is actually needed, and would merely extend Ontario's reliance on fossil gas.

Conclusion

Environmental Defence supports a hydrogen strategy that is developed and implemented alongside Ontario's existing commitments from the Made-In-Ontario Environment Plan, and part of a robust long-term energy planning process. This strategy could help reduce greenhouse gas emissions, improve energy resilience, and build a strong hydrogen economy in Ontario.

[28] http://www.rds.oeb.ca/HPECMWebDrawer/Record/686135/File/document

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