HALIFAX

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Item No. 11.1
Environment and Sustainability Standing Committee
February 4, 2021
March 4, 2021

TO: Chair and Members of the Environment & Sustainability Standing Committee

SUBMITTED BY: ***Original Signed***

Kelly Denty, Executive Director, Planning and Development

Original Signed

Jacques Dubé, Chief Administrative Officer

DATE: **January 26, 2021**

SUBJECT: **Hydrogen and Decarbonizing Halifax**

INFORMATION REPORT

ORIGIN

On December 4, 2019, the following motion of the Environment and Sustainability Standing Committee, regarding Item No.13.1 was put and passed:

"THAT the Environment and Sustainability Standing Committee request a staff report on the feasibility of initiating programs to implement a Hydrogen Economy in the municipality. This report should consider and include consultations with researchers and engineers at Dalhousie University, hydrogen fuel cell companies such as Ballard Power, examinations of actions taken in other municipalities and jurisdictions in Canada and internationally, potential adoption of systems to allow fuel cell buses and ferries, and hydrogen as an alternative to fossil fuels for home and business, heat and cooling, and electricity generation."

LEGISLATIVE AUTHORITY

Halifax Regional Municipality Charter, Section 34(3): "The Council shall provide direction on the administration, plans, policies, and programs of the Municipality to the Chief Administrative Officer."

BACKGROUND

HalifACT: Acting on Climate Together is the Municipality's long-term climate action plan to reduce emissions and help communities adapt to a changing climate. This plan[1] aligns with the Climate Emergency that was declared by Halifax Regional Council on January 29, 2019, which emphasized that climate change is a serious and urgent threat to our community. The plan was unanimously approved by Halifax Regional Council in June of 2020 and outlines a suite of actions that are necessary to meet the aggressive carbon reductions outlined in the plan. As shown in Figure 1, key actions for reducing emissions in the Municipality include:

- Achieving net-zero construction for all new residential and non-residential buildings;
- Retrofitting all existing buildings to be climate resilient and net-zero;
- Exponentially increasing onsite and utility-scale renewable energy generation; and
- Decarbonizing transportation.

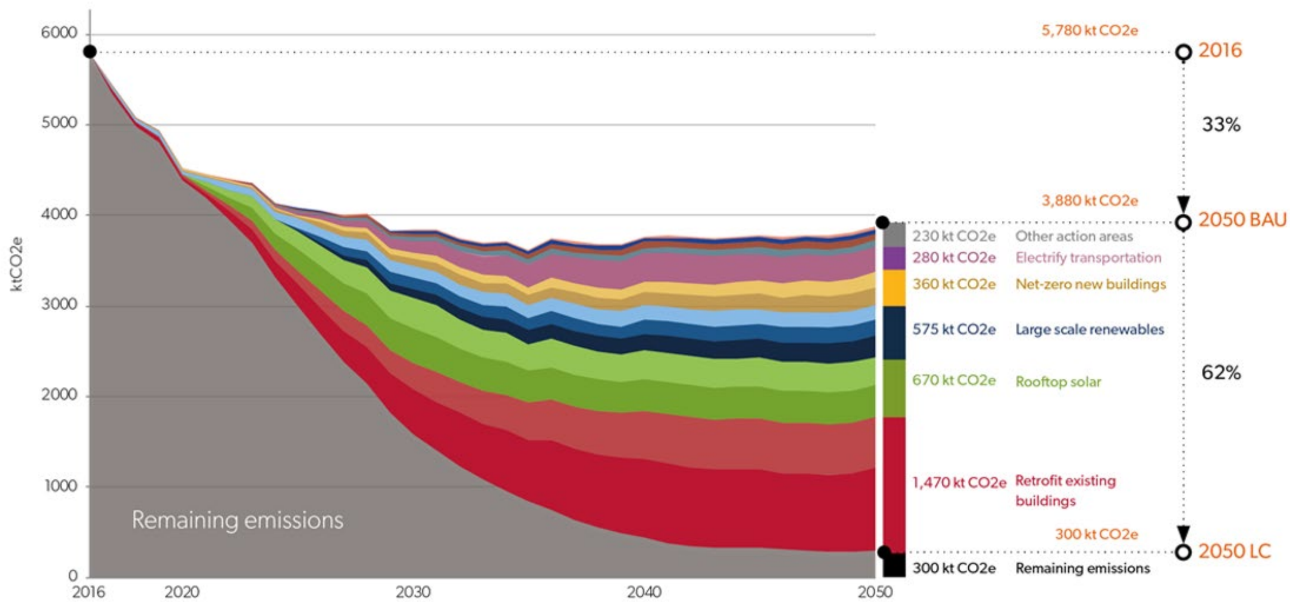

Figure 1: Wedge diagram of actions for the low carbon pathway

While the actions identified in the plan are ambitious and all-encompassing, full implementation will not achieve the net-zero emission target by 2050. In 2050, 5% or 300 ktCO2e (thousand tonnes of carbon dioxide equivalent) will remain, mostly through natural gas consumption. To mitigate these remaining emissions, new and evolving technologies like hydrogen need to be considered and supported.

[1] HalifACT – Acting on Climate Together, Halifax Regional Council Package https://www.halifax.ca/sites/default/files/documents/city-hall/regional-council/200623rc916.pdf

DISCUSSION

Hydrogen is the most abundant element in the universe and is a dense energy carrier, meaning it can deliver and store 2 to 3 times more energy when compared to other liquid hydrocarbons. While dense, there are no major safety concerns beyond those commonly associated with similar concentrated fossil fuels. In fact, due to how light hydrogen gas is and how quickly it disperses in air, it is difficult to ignite. There are no end-use emissions associated with hydrogen use, although emissions are generated through its production and are commonly classified by the following three colours:

Grey Hydrogen: refers to the production of hydrogen via steam reforming. Steam reforming is the most common method for hydrogen production in which high-temperature steam is used to produce hydrogen from a methane source, typically natural gas.[2] Steam reforming is the least costly method of hydrogen production.

Blue Hydrogen: refers to the production of hydrogen via steam reforming but unlike grey hydrogen, the emissions associated with this process are captured and sequestered.

Green Hydrogen: refers to the production of hydrogen via electrolysis, with the required electricity generated through renewables. Electrolysis is a process that takes place in an electrolyser and uses electricity to split water into hydrogen and oxygen. At this time, electrolysis powered by renewables is the most expensive way to produce hydrogen, but the only means of production without carbon emissions.

Today, 95% of hydrogen is produced through steam reforming which has high emission content and requires an input of fossil fuels. To ensure a sustainable, low carbon future, hydrogen must be produced via electrolysis powered by renewables.

Hydrogen Applications and Barriers

In the context of HalifACT, green hydrogen is viewed as a potential tool for decarbonizing heavy transport, natural gas heating applications and the electricity grid.

Heavy Transport

Decarbonizing transportation and shifting travel modes to public transit and active transportation will be fundamental in achieving the targets of HalifACT. The 2016 baseline report outlined that the transportation sector contributed to 19.3% of emissions in the municipality, with heavy transport making up 7.5% of this, or 1.45% of community-wide emissions. Research by Canadian Energy Systems Analysis Research suggests that early adopters of hydrogen will be heavy-duty trucks, buses, local delivery vehicles and trains.

Fuel cell electric vehicles (FCEV) use a fuel cell that generates electricity via an electrochemical reaction that combines hydrogen and oxygen. This reaction does not produce any tail-pipe emissions and the only by-products are heat and water.[3] FCEVs have many benefits to the heavy transport industry when compared to battery electric, such as long ranges and short refuelling times. Most FCEVs have a range of 800 km and the refuelling experience is like that of traditional diesel or gas refuelling. Fueling stations, while similar in price to Direct Current Fast Charging, require much less space since extra electrical equipment like transformers is not needed.

A jurisdictional scan of hydrogen uses in the transportation sector found that some provinces, states and countries have started to adopt FCEVs and roll out hydrogen fueling infrastructure. In Canada, British Columbia (BC) currently has three public hydrogen fueling stations with three more scheduled to open by

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[2] US DOE- Office of Energy Efficiency and Renewable. "Hydrogen Production: Natural Gas Reforming" https://www.energy.gov/eere/fuelcells/hydrogen-production-natural-gas-reforming
[3] Fuel Cell & Hydrogen Energy Association. "Fuel cell basics" http://www.fchea.org/fuelcells

the end of 2021.[4] BC is also home to the headquarters of Ballard Power Systems, a world-renowned manufacturer and developer of fuel cell solutions. In Alberta, a group called the Alberta Zero Emissions Truck Electrification Collaboration recently launched a demonstration project that features two long range fuel cell electric hybrid transport trucks that operate between Edmonton and Calgary. The trucks have a range of 700 km and are fueled by blue hydrogen.[5] This demonstration project is scheduled to run until mid-2022 and is the first time a vehicle of this size (64 tonnes, B-train tractor trailer) with a range of 700 kilometres will be built and tested in the world. It is anticipated that by the end of the project, the trucks will have travelled more than 500,000 kilometres and carried 20 million tonne-kilometres of freight.[6] With respect to public transit, San Francisco will soon be testing one of the first hydrogen-powered ferries in North America and as of May 1, 2020, the state of California has 42 fuel cell buses in operation and 18 retail hydrogen stations in development.[7]

In 2019, Halifax Transit conducted an alternative fuel study to examine the feasibility of various fuels for the future transit fleet, including hydrogen fuel cell technology. While the final report has not yet been released, it was found that there are many benefits to this technology, which will likely become more viable as advances are made and the technology matures. One key benefit, as mentioned above, is the available range between refueling, making it comparable with the current diesel fleet, reducing the need for major route structure changes. Hydrogen also provides service resiliency during power outages, which is more difficult with all-battery electric. Unfortunately, the barriers of availability and cost outweigh the associated benefits. Currently, there is no green source of hydrogen fuel available in Nova Scotia and the emissions associated with transport would negate the benefits. While the cost of hydrogen was found to be comparable to diesel, the cost of FCEV buses is nearly double that of battery electric, and four times that of traditional diesel. Finally, as more jurisdictions across Canada are making the transition to battery electric buses, the lack of vendor support for hydrogen fuel cell buses makes for an even more difficult transition.

Heating

The 2016 baseline report showed that 70% of community-wide emissions come from existing commercial and residential buildings, dominated primarily by space heating. While electricity use for heating is on the rise and will likely be dominant as more buildings are retrofitted and electrified, emissions associated with natural gas heating applications are expected to remain static under the HalifACT analysis and will need to be offset in some manner to achieve net-zero emissions by 2050.

To achieve net-zero emissions by 2050, green hydrogen is viewed as potential option to replacing natural gas for space heating. This is currently being investigated in the European Union (EU) as the best, if not only, choice for large scale decarbonization of their natural gas grid. In 2019, Fuel Cells and Hydrogen 2 Joint Undertaking released a Hydrogen Roadmap,[8] outlining the potential of hydrogen in the EU. In the EU, natural gas is the primary fuel used for heating buildings and therefore it has an extensive, widespread natural gas grid. Most studies have indicated that the existing network can accommodate up to 20% mix by volume of hydrogen without any major modifications to existing appliances or piping systems. This amount of blending has been tested in some areas of the EU via demonstration projects like that of HyDeploy project at Keele University in the United Kingdom[9] and the Gestion des Réseaux par l'injection d'Hydrogène pour Décarboner project in France[10]. Unfortunately, for the EU transition to 100% hydrogen, significant upgrades of the grid are required as the existing infrastructure is far too corrosive and porous to accommodate this volume of hydrogen. Fortunately, as the natural gas grid in Nova Scotia is relatively new

[4] BC Gov News. "Province invests in hydrogen to help transition to cleaner energy" https://news.gov.bc.ca/releases/2020EMPR0046-001696#
[5] Emissions Reduction Alberta. "Alberta Zero Emissions Truck Electrification Collaboration (AZTEK)" https://www.eralberta.ca/projects/details/alberta-zero-emissions-truck-electrification-collaboration-azetec/
[6] Canadian Energy Systems Analysis Research. "$15-million project to test hydrogen fuel in Alberta's freight transportation sector" https://www.cesarnet.ca/blog/15-million-project-test-hydrogen-fuel-alberta-s-freight-transportation-sector
[7] California Fuel Cell Partnership. "By The Numbers" https://cafcp.org/by_the_numbers
[8] Hydrogen Roadmap Eurpose. https://www.fch.europa.eu/sites/default/files/Hydrogen%20Roadmap%20Europe_Report.pdf
[9] HyDeploy. "Hydrogen is vita to tackling climate change" https://hydeploy.co.uk/
[10] Energie. The GRHYD demonstration project" https://www.engie.com/en/businesses/gas/hydrogen/power-to-gas/the-grhyd-demonstration-project

and primarily made of non-corrosive, non-porous, polyethylene piping, the transition to 100% hydrogen is more feasible. Additionally, as our gas grid is still being expanded, there is potential to future proof and plan for 100% hydrogen.

In 2019, 187,000 GJ (Giga-joules) of natural gas was consumed in the municipality's corporate facilities. As most of the municipal natural gas boilers are relatively new, it is not currently cost effective to switch to fully electric, so alternate avenues for decarbonizing must be explored like integrating green hydrogen into the natural gas grid as discussed. In September, the Municipality provided a letter to Heritage Gas in support of their Investing in Canada Infrastructure Program Climate Change Mitigation Sub-Stream application. The proposed project consists of an electrolysis plant that is powered by 4MW (mega-watt) of wind energy. The project would be located within the municipality and produce 40,000 GJ of green hydrogen annually. Should they be successful, the Municipality will consider purchasing some of the produced hydrogen to reduce emissions associated with corporate space heating.

Electrical Grid

Through HalifACT, a key action is to actively support, advocate and partner with Nova Scotia Power, the Province and others to decarbonize the provincial electricity grid. It is recommended that this be done with the integration of both rooftop and utility scale renewables. Nova Scotia Power has a regulatory target of 40% electricity generation through renewables by 2020 and they have been actively planning for future integration via the Integrated Resource Plan (IRP). Through the IRP analysis, it was found that wind is the lowest-cost domestic source of renewables, however the capacity that can be installed is expected to be limited due to the intermittency of the resource and the nature of our winter peaking electricity demand in Nova Scotia. To provide seasonal reliability and further decarbonize the grid with local resources, hydrogen is viewed as a potentially viable option. Unlike batteries, hydrogen can be stored for a very long time, so it is suggested that the excess of wind and solar electricity generated during off-peak periods be used to produce hydrogen via electrolysis and stored. When needed during the winter peak, this stored hydrogen can then be converted back to electricity through a fuel cell or hydrogen turbine, negating the need to fire up additional fossil fuel electricity generators.

Hydrogen in the Maritimes

The applications outlined above are fully supported by the recently released report, *A Feasibility Study of Hydrogen Production, Storage, Distribution and Use in the Maritimes*[11]*.* The study was conducted by Zen and the Art of Clean Energy Solutions in partnership with the Nova Scotia Offshore Energy Research Association, Heritage Gas Limited, the Nova Scotia Department of Energy & Mines and others. This study aligns closely with the National Hydrogen Strategy for Canada[12], save for the recommended hydrogen production method.

With input from various stakeholders, the Municipality included, the study looked at what role hydrogen can play in supporting the region's broad energy policy objectives. The study found that hydrogen has the potential to deliver up to 22% of the region's energy by 2050, reducing emissions by 21%. Due to the region's rich wind potential and relatively high cost and emission intensity of natural gas, production of hydrogen via renewable electrolysis is considered the most promising long-term solution. In Nova Scotia, it is expected that by 2030 it will be feasible to produce hydrogen through a grid mix of 40% wind. The business case will continue to improve when compared to fossil fuel generated electricity as the cost of renewables decreases and the percentage of wind power and cost of carbon increases. As the sector continues to grow, there will be significant opportunity for new and existing skilled technicians and trade persons to participate in the hydrogen supply chain. As the Maritimes has a long history of resource extraction and heavy industry, embracing hydrogen can support a just transition for many in these sectors as we pursue a low carbon future.

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[11] OREA. "Net-Zero Future: A Feasibility Study of Hydrogen Production, Storage, Distribution and Use in The Maritimes" https://oera.ca/hydrogenstudy

[12] Natural Resources Canada. "Hydrogen Strategy for Canada" https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

To meet the targets set out through HalifACT, all new and existing tools and technologies must be considered. To support the adoption of hydrogen, the Municipality can play a partnership role in demonstration projects like that of the aforementioned 4MW electrolysis plant and become an end user through the blending with natural gas at our facilities. As community-wide retrofit programs are developed, hydrogen-based applications like heating equipment, fuel cell electric vehicles and the associated fueling infrastructure can be supported. To further support its adoption, the Municipality can work with NSP and the province to advocate for decarbonizing the electric grid and implementing a zero-emission vehicle mandate. Finally, the Municipality will continue to be an active participant with industry, academia and the provincial government to ensure that hydrogen realizes its full potential as we shift to a low carbon future.

FINANCIAL IMPLICATIONS

There are no financial implications associated with this report.

COMMUNITY ENGAGEMENT

To inform this report, interviews were conducted with Heritage Gas, Ballard Power Systems, Planetary Hydrogen and representatives of Dalhousie University.

ATTACHMENTS

None.

A copy of this report can be obtained online at halifax.ca or by contacting the Office of the Municipal Clerk at 902.490.4210.

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