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Canada

RE: Ontario Low-Carbon Hydrogen Strategy - Discussion Paper (ERO 019-2709)

Dear Mr. Bishop,

Thank you for providing the opportunity for public consultation on the development of Ontario's hydrogen strategy. As a member of the rail transportation industry and avid proponent of innovative, sustainable transportation infrastructure development, DB Engineering & Consulting GmbH (Canadian branch; headquartered in Toronto) respectfully submits the following commentary on how we foresee the rail sector and hydrogen market forging a strong, renewable and financially dependable economic sector in Ontario.

National Resources Canada expects the global hydrogen market to be valued at over $11 trillion[i] by 2050 including a $50 billion domestic hydrogen sector, export projections of $100 billion and 350,000+ domestic high-paying jobs. Ontario had a head-start in the Hydrogen sector thanks, in part, to Ontario-based industry-leading innovation (e.g., Hydrogenics). An Ontario-specific strategy is required to maintain our lead in the market, both at the national and global scales, and secure Ontario as a major player in the global hydrogen market.

Major factors in Ontario's reasoning for adopting a hydrogen strategy include the need for a reduction in greenhouse gas emissions and stimulus to the local economy. The development of a rail-specific hydrogen strategy within the overall Ontario Hydrogen Strategy has the potential to significantly bolster each of those goals and maintain Ontario's place as a leader in Canada's hydrogen industry.

Overview of the Rail Industry in Canada

Generating an average of $10 billion per year nationally,[1] the rail industry has the potential to provide significant contributions towards both of those goals as demonstrated by some key facts from 2018:

- Railways in Canada invested $2.38 billion to support growth and service enhancements;[2]
- 3,100+ locomotives moved over 328 million tonnes of goods[3] of which 45.2 million tonnes was destined for Ontario;[ii,4,5]
- Ontario was home to over 27% of Canada's operational track (approximately 17,100 km);[6] and,
- 4.5 million VIA Rail passengers travelled through the Québec City-Windsor rail corridor, Canada's busiest rail corridor (3/4 of which is within Ontario), representing a 9.3% increase in ridership through the corridor from 2017.[7]

[i] All monetary values referenced in this letter are made in Canadian dollars.
[ii] Composed of transported commodities and intermodal tonnage.

Economic Benefits

Canada's rail sector is developing an appetite for cleaner, more efficient operations as demonstrated by the propulsion system criteria in Metrolinx's GO Expansion Program, by Canadian Pacific Rail's plans to develop a hydrogen-powered line-haul locomotive (a locomotive capable of pulling freight trains), and in Canadian Nationals emissions reduction targets.

The rail industry is dependent on diesel fuel. It collectively consumes hundreds of millions of litres of diesel fuel in Ontario each year, and billions of litres per year across the nation (2.16 billion litres in total in 2018).[8] With the cost of diesel fuel increasing (2018 saw a 27% increase[3] in diesel fuel costs from 2017 to 92 cents/L in 2018), the pressure of looming emissions targets, and a need for fuel diversification for industry resilience, alternative fuel sources are likely to continue gaining interest. Given Ontario's potential for cost-effective low-carbon hydrogen production, the provision of hydrogen as a fuel source for the rail industry serves as a lucrative potential market.

In 2018, diesel fuel costs for Canadian rail operators averaged 92 cents/litre (equivalent to approximately $3.50/kg hydrogen). Low-emissions hydrogen is already being sold on the open market at $3.50/kg,[9] and could cost as little as $1.50/kg by 2050 per the Federal Hydrogen Strategy. Additionally, studies, pilot demonstrations, and in-service vehicle data have shown that hydrogen-powered trains require 20% - 50% less energy than their diesel-powered counterparts for the same service (typically closer to 50%), meaning they require less fuel overall. Purchasing less fuel at a comparatively lower price would result in significant operating cost savings for railways. However, the fuel cost savings do not address the infrastructure, storage and distribution costs associated with hydrogen fuel.

The hydrogen sector is still in the early stages of development and the costs associated with implementation of various aspects of the sector (e.g. power system acquisition and maintenance, hydrogen storage and distribution) are high. A large-scale project and investments in the hydrogen supply chain are needed to support the sector's development, spur innovation and production, and stimulate the hydrogen economy within Ontario which would decrease the cost of the logistics associated with the hydrogen sector and open it up to other industries. The rail industry's adoption of hydrogen fuel could likely provide that initial large stimulus given the industry's higher price tolerance compared to the average consumer. However, significant research, development and implementation efforts are still required, which should be addressed through the provincial hydrogen strategy.

Development of ambitious rail-based emissions reduction goals in conjunction with incentive programs relating to hydrogen technology development and implementation for rail would prioritize Ontario as a locale for hydrogen-based rail innovation and implementation. California has implemented this approach[10] and is seeing increased technological development. Should Ontario implement similar measures, there is a potential to stimulate hydrogen-based infrastructure expenditures within Ontario through progressive upgrading of infrastructure to develop Ontario's hydrogen sector. This would support hydrogen fuel production, lower hydrogen pricing and further hydrogen's palatability to other industries where the development-stage pricing is prohibitive to their entry into the market. It would also add a variety of Ontario-based jobs (lower-skilled and high-skilled) throughout the hydrogen supply chain and in the rail sector.

Environmental Benefits

Diesel fuel, the primary fuel source for Canadian railways, emits greenhouse gases (GHGs) and air pollutants including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), oxides of

nitrogen (NO_x), particulate matter (PM), carbon monoxide (CO), hydrocarbons and sulfur dioxide (SO_2).[11] The rail industry's fuel consumption in Ontario[8] is shown in Figure 1.

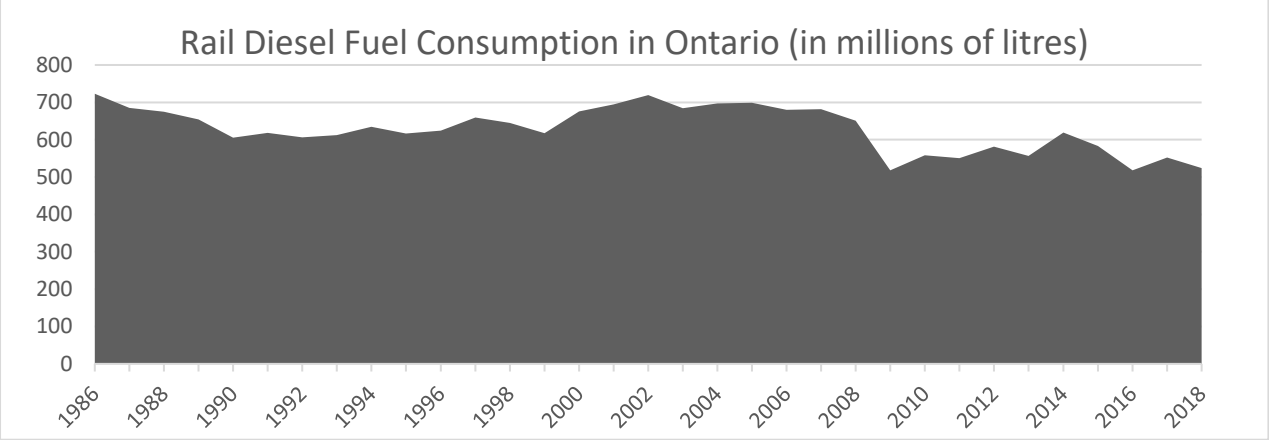

Figure 1. Rail industry diesel fuel consumption in Ontario, by year (in millions of litres).

Since 1990, the rail industry has achieved a reduction in GHG emission intensity of 43.5%.[11] Rail transport emissions constituted approximately 1.05% of Canada's CO_2-equivalent emissions in 2017, [12] which amounted to approximately:[11]

- 6,428,840 tonnes of greenhouse gases;
- 79,550 tonnes of nitrous oxides;
- 1,650 tonnes of particulate matter;
- 15,180 tonnes of carbon monoxide;
- 3,380 tonnes of hydrocarbons; and,
- 53,090 tonnes of sulphur dioxide.

Keeping in mind that roughly 27% of Canada's track is within Ontario, and the majority of freight and passenger rail movements occur within the Québec City – Windsor Corridor which is home to over 90% of Ontario's population, the emissions are still too high. The rail industry collectively consumed 314.5 million litres of diesel fuel within the Québec City – Windsor Corridor in 2017 alone, accounting for over 14% of the national railway GHG and NO_x emissions.[11]

Canadian railway's corporate strategies and participation in numerous climate initiatives suggest they are striving to reduce emissions. The 2019 signing of the 4th Memorandum of Understanding for reducing locomotive emissions in Canada, signed by the Railway Association of Canada and the Federal Government furthers the momentum.

Government pushes for emission reduction/elimination in the rail industry have spurred innovation and spending in other areas of the world. In California, an executive order from the State Governor called for all off-road vehicles and equipment operations, including rail vehicles, to have zero-emissions by 2035.[13] As a result, the California Department of Transportation (CalTrans), which owns and operates the intercity passenger rail fleet, has developed a strategy to transition to zero-emissions rail vehicles by 2035. Following extensive studies on various options for achieving that goal,[iii] the State settled on hydrogen fuel cell and battery hybrid powertrains as the primary means of propulsion. Of note, Caltrans' high-powered intercity locomotives are very similar to most freight locomotives and to VIA Rail's newly purchased Siemens vehicles.

Given the similarities in service between CalTrans and VIA Rail's Québec City-Windsor route, it is possible hydrogen power could be the most economically achievable option for VIA Rail to meet its goal of having 80% of its fleet composed of zero-emissions vehicles by 2030.[14] Passenger trains of the size and class used by CalTrans and VIA Rail have not been developed with

[iii] Studies were carried out by DB Engineering & Consulting USA.

hydrogen-powered traction systems. Should Ontario participate in the development and/or implementation of this new type of hydrogen-powered vehicle, there is the potential for competition or collaboration with California in addition to the possibility of having a newly developed zero-emissions product that would gain international interest. This sort of endeavour would result in the development of a new workforce specializing in hydrogen rail technology.

Technology Development

The rail sector is making significant advances with hydrogen-fueled motive power technology.

Canadian Pacific has announced plans to develop a hydrogen-powered line-haul locomotive as part of its efforts to decarbonize freight transport.[15] The University of British Columbia is collaborating with Vancouver-based company Hydrogen in Motion and the Southern Railway of British Columbia to retrofit a diesel switcher locomotive[iv] with hydrogen fuel cells.[16]

Alstom's "Coradia iLint" hydrogen fuel cell powered vehicle has been operating in Germany for over 1.5 years and is now beginning trial operations along Austria's regional rail lines. The vehicle features fuel cells produced by Ontario-based Hydrogenics (now part of Cummins Inc.), low-noise production, zero emissions, a range of approximately 1,000 km, and can reach a top speed of 140 km/h.[17] It is the hydrogen equivalent of Alstom's diesel-powered Coradia Lint vehicle which currently serves Ottawa's Trillium Line.

Siemens and Deutsche Bahn are developing a regional rail vehicle which similarly boasts zero emissions, a targeted top speed of 160 km/h, range of 600 km, a refuelling time of 15 minutes and incorporates Canadian-based hydrogen fuel cell technology (Ballard Power Systems, based in British Columbia).[18] These trains will enter service on Deutsche Bahn's regional rail lines running between Tübingen, Horb and Pforzheim, Germany in 2024. Deutsche Bahn is also developing a specialized refuelling station and is modifying a maintenance facility to accommodate the trains.[18]

Orders for hydrogen-powered trains have been made worldwide, including in the United States where Stadler's "FLIRT H2" train (the hydrogen equivalent of the diesel-powered Stadler FLIRT trains recently ordered by the City of Ottawa) is set to enter service in San Bernardino County in 2024.[19] Deutsche Bahn is supporting the operator, San Bernardino County Transportation Authority (SBCTA), in this procurement.

European and Spanish manufacturers are converting electric multiple units (EMUs) to operate on hydrogen. A Scottish suburban rail vehicle is being converted to hydrogen power as a demonstration project for a November 2021 climate conference. Hydrogen-powered rail vehicles are also in existence or are in development in other parts of the world, including in the United States (TIG/M streetcars), China (CRRC streetcars and light rail vehicles (in operation)), South Korea (Hyundai Rotem regional trains), and Japan (JR East/Hitachi/Toyota regional trains). Many of the hydrogen rail vehicle programs worldwide are using Canadian fuel cell technology from Hydrogenics (Cummins Inc.) and Ballard Power Systems.

Conclusion

Given the influx of interest in hydrogen technology, the Canadian-based leaders in this sector are likely to continue growing while their competition also increases. Local support for all levels of this industry is needed to maintain our leadership in the development and export of hydrogen

[iv] A 'switcher locomotive' is used to move rail cars and freight around within a rail yard.

technology. We believe the rail industry can drive that support if a hydrogen strategy for rail is established as a priority in Ontario through appropriate government programs.

DB Engineering & Consulting is the global engineering and consulting arm of Deutsche Bahn AG – Europe's largest railway enterprise and the owner, operator and maintainer of Germany's extensive railway system which includes a line on which in-service hydrogen-powered trains are operating. We have Canadian- and internationally-based experts in rail vehicles, rail systems design, operations and maintenance, and alternative propulsion technologies including hydrogen fuel-cell propulsion. We have conducted hydrogen feasibility studies for multiple clients, including government agencies and railway operators in North America and globally. We are available to provide further information and analysis on hydrogen rail strategy and implementation at your request.

Sincerely,

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