Response to BC-LCFS Consultation- 1st Phase

For: **Michael J. Rensing, Ph.D.**
Director, Low Carbon Fuels
Electricity and Alternative Energy Division
British Columbia Ministry of Energy, Mines and Petroleum Resources

Date: January 5th, 2018

Subject: Comments to the British Columbia Low Carbon Fuels Compliance Pathway Assessment

Dear Michael,

We appreciate the opportunity that the BC Ministry of Energy, Mines and Petroleum Resources offers to provide comments on the **British Columbia Low Carbon Fuels Compliance Pathway Assessment.**

On behalf of Hydra Energy Corporation, I would like to submit comments divided in 2 categories:

- Comments to section 4 on Hydrogen and subsections 4.1, 4.2, and 4.3 of the discussion paper
- General comments

Comments to Section 4 on Hydrogen

Section 4.1 describes the current situation for hydrogen in British Columbia (B.C.). While the Hyundai Tucson is indeed the only hydrogen fuel cell vehicle available in B.C., Hydra Energy Corporation (Hydra) has introduced an extension of Hydrogen Internal Combustion Engine (HICE) technology to aftermarket Class 8 heavy-duty diesel trucks. There are two retrofitted prototype trucks approved by BC Safety: One is currently being tested on the road, and three additional trucks will be retrofitted during 2018. These trucks are being retrofitted with a dual fuel system intended to displace a minimum of 40% of diesel fuel, reducing emissions[2] while preserving vehicle performance, load capacity, and fuel efficiency[3].

HICE technology is an alternative to fuel cell technology more suitable to retrofit aftermarket vehicles, including heavy-duty internal combustion engine trucks[4]. Hydra's retrofitting system is lighter than fuel cell or battery options, meaning no loss in freight weight and greater reten[redacted] and performance necessary for

[1] Venkateswarlu Chintala, K.A. Subramanian, A comprehensive review on utilization of hydrogen in a compression ignition engine under dual fuel mode, In Renewable and Sustainable Energy Reviews, 2017, https://doi.org/10.1016/j.rser.2016.11.247.

[2] Saravanan, N. and Nagarajan, G., "Experimental Investigation on Performance and Emission Characteristics of Dual Fuel DI Diesel Engine with Hydrogen Fuel," SAE Technical Paper 2009-26-0032, 2009, https://doi.org/10.4271/2009-26-0032.

[3] Suzuki, Y. and Tsujimura, T., "The Combustion Improvements of Hydrogen / Diesel Dual Fuel Engine," SAE Technical Paper 2015-01-1939, 2015, https://doi.org/10.4271/2015-01-1939.

[4] Venkateswarlu Chintala, K.A. Subramanian, A comprehensive review on utilization of hydrogen in a compression ignition engine under dual fuel mode, In Renewable and Sustainable Energy Reviews, 2017, https://doi.org/10.1016/j.rser.2016.11.247.

hauling freight on B.C. highways year-round. In emergencies, retrofitting also allows vehicles to rely on its original fuel source, which helps to build industry confidence through the transition period.

Hydra, in addition to HTEC, is also planning the construction of a hydrogen fueling station to supply hydrogen to commercial truck fleets operating with Hydra's HICE technology.

Section 4.2 provides a good market outlook for hydrogen fuel cell vehicles, while this technology is a great alternative for new and light-duty vehicles, HICE technology used to retrofit aftermarket heavy-duty vehicles that can be fueled with low carbon intensity hydrogen, offers the opportunity to reduce approx. 40,000 tonnes of CO2e emissions annually from every regional operation[5]. Any heavy-duty diesel truck could be retrofitted using Hydra's technology.

In their first demonstration project, Hydra intends to retrofit at least 180 trucks to operate on hydrogen-diesel by the end of 2019. Additional similar projects would follow this demonstration.

As described in **Section 4.3**, Hydra Energy is one of the proponents looking at providing low carbon intensity hydrogen. The carbon intensity currently estimated by Hydra is of 9.5 g CO2/MJ[6]. Approximately 3 million kg. of hydrogen will be produced annually to power a fleet of 180 semi-trucks by the end of 2019.

General Comments

The current regulatory and economic environment reveals a gap in the transition between fossil fuel-driven vehicles and low (or zero) emissions vehicles: The large number of high carbon intensity heavy-duty vehicles on the road today have a viable remaining economic life of over a decade. The current regulatory focus on electric vehicles and fuel cell vehicles is not capable of bridging this gap, as they do not address the emissions of those heavy-duty vehicles that are on the road and will continue to be driven for years to come.

Retrofitting post-sale heavy duty vehicles offers a significant opportunity to reduce carbon emissions that is not currently being fully supported in the Canadian or British Columbian regulatory environment. Federal and provincial government policy changes can create a more balanced competitive environment that encourages technology inclusiveness and the adoption of clean technologies in these post-sale vehicles, plus capitalization on existing infrastructure.

By enabling a diverse and inclusive technology portfolio, the [redacted]vernment can motivate investment in niche solutions that help meet provincial emissions reductio[redacted]c niches that can be included as recognized technology solutions are vehicle retrofitting, waste hydrogen recapturing, and hydrogen internal combustion engines (HICE). Each of these technologies can be included within British Columbia's existing regulatory framework for allowances, exemptions, incentives, and other programs on the same terms as currently exist for other technologies, such as hydrogen fuel cells, batteries, LNG/CNG, and biodiesel.

While new fuel cell and battery technologies can be more easily applied to new vehicles, there are over 134 million internal combustion engine medium and heavy duty vehicles currently on the road in North America

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[5] Simon Fraser University, Fuel Cell Research Lab (FCReL), Life Cycle Analysis prepared for Hydra Energy, 2016

[6] Don O'Connor, (S&T)2 Consultants Inc., Carbon Intensity Calculation for Hydra Energy, 2018

only[7] [8]. And, by 2040, It's estimated that at least 46% of the over 100 million new vehicles being sold globally per year would still run on fossil fuels[9] [10]. Retrofitting such vehicles to dramatically reduce emissions has an enormous short and medium term potential as part of the transition to a low carbon economy. This solution also eliminates some of the trade-offs between price, weight, range and recharge time that breakthroughs in electric batteries and fuel cells would still face.

An ideal solution to all of these factors - filling the gap electric technologies do not cover - is to retrofit existing diesel semi-trucks to operate as dual fuel vehicles powered by low-carbon intensity hydrogen.

While replacing vehicle fleets altogether may be a long-term ambition, switchover of heavy-duty vehicles can begin immediately with combustion of alternative fuels. Such alternative fuel options, beyond electric and fuel cell vehicles, are needed to address current emissions from internal combustion engines and speed the transition of existing vehicle fleets to cleaner fuel options without requiring full-scale fleet replacement.

The Greenhouse Gas Reduction (Renewable & Low Carbon Fuel Requirements) Act sets out that its Renewable and Low Carbon Fuel Requirements Regulation determines an Energy Effectiveness Ratio (EER) for fuels classified as low carbon. In the case of hydrogen fuels, the EER is set for a fuel cell hydrogen vehicle, not a hydrogen internal combustion engine (HICE).

The Regulation can be revised to allow a separate Energy Effectiveness Ratio for hydrogen in HICEs. Similar considerations are recommended for adoption in the federal government's Clean Fuel Standard and complementary policy initiatives under development.

Additional Information

In support of the comments above, Hydra Energy Corporation will gladly provide additional information as desired. Please contact Laura Guzman, Director of Government Affairs and Partnerships, to respond to any needs or questions that may arise.

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[7] Statistics Canada, Vehicle registrations, 2016, 2017, http://www.statcan.gc.ca/daily-quotidien/170629/dq170629d-eng.htm
[8] America Trucking Associations, Industry Data, 2014, http://www.trucking.org/News_and_Information_Reports_Industry_Data.aspx
[9] Bloomberg New Energy Finance, Electric Vehicle Outlook 2017
[10] Simon Fraser University, EV Report Card 2016, https://sustainabletransport.ca/ev_report_card/