

## **Canada as a global leader in advanced electrified rail technology**

Submitted by Bob Oliver, P.Eng., CEO of Tech-K.O., Inc. on behalf of Hydrogenics for consideration by the House of Commons Standing Committee on Finance as part of the 2017 Pre-Budget consultation.

August 5, 2016

### **Executive Summary**

On June 3, 2016, the House of Commons Standing Committee on Finance issued an open invitation to Canadians to participate in the pre-budget consultation process. This submission has been prepared to address the interest of the Committee regarding federal actions that would assist Canada's businesses meet their expansion, innovation and prosperity goals, and thereby contribute to economic growth in the country.

Specifically, the focus of this submission is on the opportunity for Canadian industry to grow its exports, globally, based on competitive advantages that it already has in clean, decarbonizing technologies. The Government of Canada can play an instrumental role in catalyzing international demand for Canadian clean-tech in the commuter rail sector, thereby generating wealth and new employment throughout the country. This would fulfill key objectives of the government's innovation, jobs and climate change leadership agenda.

The recommended action for the federal government is to stage a world-class demonstration of *wireless electrified* commuter rail, similar to systems that Hydrogenics – a Canadian clean-tech company headquartered in Ontario – is already developing for use in Europe. The budget for such a demonstration would range from \$30 to \$35 million, and would involve industry, academia and government, as well as a host commuter rail operator. OC Transpo's Trillium Line is under consideration as an ideal venue for the demonstration, due to its international visibility and the favourable configuration of its light rail coaches, which serve an urban population.

Strategically designed, this demonstration of wireless electrified commuter rail could generate unique systems designs, operational experience, valuable patents and intellectual property. In possession of these assets, Canada would be positioned as a global leader in advanced electrified railway technology, benefiting from the export of technology and know-how, and directly enabling the decarbonization of a major, expanding mode of transportation.

Tech-K.O., Inc. and Hydrogenics appreciate the opportunity to participate in the Committee's pre-budget consultation, and to appear at the invitation of the Committee. This document presents a narrative description of the opportunity, which is believed to align closely with the interests of the Committee and of the Government of Canada in the context of supporting the success of the nation's growing clean-tech industries.

## **A narrative introduction to Canada’s leadership opportunity in wireless electrification of commuter rail systems (also known as “hydrail”)**

Consider a hypothetical scenario: It’s 2040, a little more than 20 years into the future. Many positive transformations to our industry, our economy, and our society, are in full swing. Clean technologies are maturing and are rapidly displacing carbon-intensive systems of the past. Greenhouse gas emissions have plateaued, globally, and a sustained downward trend has taken hold. These transformations are creating new value and employment, and are generating tremendous wealth for the nations and regions engaged in developing and exporting the products and services that are fundamentally driving change.

The seeds for these transformations were planted in our time now – today – by leaders who knew that the time had come to switch tracks, and then implemented policies for change and revitalization.

At this point in the future, hydrogen fuel cell-powered rail service – or *hydrail*, a form of electrified rail that obviates the need for overhead contact wires – is a dominant trend sweeping the transportation sector. Around the world, it is not a question of *if* but *when* the existing stock of diesel-powered locomotives and self-propelled coaches will turn over and be replaced by modern hydrail systems.

Why is this happening? In a word: decarbonization. Developed nations around the world are delivering on the Paris Agreement, signed in 2016, to prevent a catastrophic warming of our world. They are targeting energy production and transportation as priority sectors, because they represent the majority of their greenhouse gas emissions inventories.

Hydrail is a key driver, because it helps reduce emissions in both of these sectors, simultaneously. Here’s how:

First, *Power-to-Gas* is growing as an effective and versatile form of grid-scale electrical energy storage. To decarbonize energy production, cost-competitive renewable power sources, such as solar and wind, as well as nuclear power, which are virtually emissions-free, are favoured for electricity generation. But nuclear reactors generate power at one constant level, while passive renewables generate power variably. Should the combined output of these sources exceed the system-wide demand for power, the excess generating capacity can be converted into some suitable form stored energy, and banked for use at a later time.

This additional electricity is used for *electrolysis* – the simple separation of water into oxygen and hydrogen gas. Currently, more than 30 Power-to-Gas projects have launched throughout Europe, providing ‘grid services’ that are instrumental to accommodating the high levels of renewable power that countries like Germany are striving to achieve and deliver, reliably, to users. Ten of these rely on turnkey systems built by Canada-based Hydrogenics, and half of these are among the largest installed to-date, capable of operating at 1 MW or higher.<sup>1</sup>

Second, this installed base of Power-to-Gas is *creating the hydrogen to power electric trains*. The wheels on all modern locomotives are actually powered by electric motors. But the electricity usually comes from diesel-combustion generators onboard. By replacing the diesel generators with fuel cells that convert hydrogen gas into water and electricity, the locomotives effectively become wirelessly electrified, zero-carbon, zero-emissions vehicles. Or, as it is popularly known, “hydrail.”

Thus, hydrail's effectiveness in advancing the decarbonization of both energy production *and* transportation sectors, specifically commuter rail, makes it a solution in high demand in our bright, future-looking scenario.

Furthermore, hydrail is expected to leave other forms of rail electrification behind. The only rail systems that are not slated for electrification with hydrogen fuel cells are those already electrified using overhead power lines. Overhead contact systems rely on extensive catenary infrastructure, which is very expensive to build and thus represents a substantial, sunk cost. Once built, the only economic sense is to continue to run these systems for as long as possible.

This can be unfortunate, because running electric trains with overhead contact systems draws power directly from the grid. If this coincides with other demands for grid power, then it contributes to the conditions of peak demand, and all of the problems that go with it. By contrast, a hydrail system, working in conjunction with Power-to-Gas, can draw power from the grid during periods when demand is low, storing it for later use and working to enhance the economics and the efficiency of the electricity system, overall.

While the scenario described above is an optimistic vision of the future, its origins are *real*. The hydrail revolution has already begun. In late-2014, four German states (Lower Saxony, North Rhine-Westphalia, Baden-Württemberg and Hesse) communicated their interest in purchasing 40 fuel cell-powered trains, provided that they:

- would be in service on regional lines in Germany by 2020,
- conformed with the existing diesel-powered articulated railcar platform in use, but in which the diesel powerpacks were replaced by some combination of hydrogen storage, fuel cells and battery system, and
- performed equivalently to electric multiple units, which would be their only other low-carbon option.

The Federal Ministry for Transport and Digital Infrastructure in Germany later announced supporting funding for the initiative, to the tune of about €8 million.

Alstom – a French multinational and one of the world's largest manufacturers of high-speed trains, tramways and track work – responded with a commitment to meet the terms. Alstom was prepared to begin manufacture at their competence centre for regional trains in Salzgitter, but needed a proven fuel cell provider with which to partner in the development.

In May 2015, Alstom announced the outcome of its rigorous technical scan and selection process: Canada's own Hydrogenics. The deal, valued at more than €50 million, will see the delivery of at least 200 engine systems based on Hydrogenics' HD series fuel cell power modules.<sup>ii</sup>

So, Canada is currently at the centre of a potential global transformation in rail transportation, with Hydrogenics working in exclusive partnership with Alstom to deploy the world's first hydrogen fuel cell-powered commuter rail service in Germany. But to solidify its leadership position, an anchoring initiative here in North America is needed.

In response to this need, **a high-profile demonstration pilot of the technology in Canada is recommended.** Combined, these projects could help Canadian industry set the specifications and define the platform for wireless electrification/hydrail, worldwide, for the next several decades. The associated contribution to the Canadian economy realized through new exports over this period would range in the billions of dollars.

The particulars of the demonstration pilot are available upon request. Notionally, a three-year demonstration hosted on a centrally located, active commuter light rail line, such as the OC Transpo Trillium Line in Ottawa, involving railway and public transit sector stakeholders and academic partners, would require a budget in the range of **\$30-35 million, inclusive of capital and operating expenses.** The involvement and leadership of the Government of Canada would greatly contribute to the success of an initiative of this scale and strategic importance.

In conclusion, Canada is currently regarded as a leader in clean hydrogen technologies, including Power-to-Gas and fuel cell systems. That leadership has led the country to occupy a pivotal position at the beginning of the wirelessly electrified commuter rail future. But Canada is not alone in this sector, and other, larger interests will compete for its growth potential. That is why a commitment to a high-profile, world-class demonstration of hydrail technology is a commitment to Canada, and to becoming the leader on climate change and clean technology we wish to be.

### **About the author**

Bob Oliver works with technology developers to promote practical solutions for decarbonizing transportation energy use in Canada.

### **About Hydrogenics**

Hydrogenics is a worldwide leader designing, manufacturing, building and installing industrial and commercial Hydrogen Systems around the globe with over 60 years of experience. It offers world leading expertise for a range of applications, including:

- Hydrogen generators for Industrial processes and fueling stations
- Hydrogen fuel cells for electric vehicles, such as urban transit buses, commercial fleets, utility vehicles and electric lift trucks
- Fuel cell installations for freestanding electrical power plants and UPS systems (uninterruptible power supply)
- Hydrogenics is pioneering "Power-to-Gas" the world's most innovative way to store and transport energy

Hydrogenics Corporate headquarters are located in Mississauga, Canada. Hydrogenics is a publicly listed company on the NASDAQ (stock symbol HYGs) and the TSX (stock symbol HYG).

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<sup>i</sup> <http://www.hydrogenics.com/hydrogen-products-solutions/energy-storage-fueling-solutions/power-to-gas>

<sup>ii</sup> <http://www.hydrogenics.com/about-the-company/news-updates/2015/05/27/hydrogenics-and-alstom-transport-sign-agreement-to-develop-and-commercialize-hydrogen-powered-commuter-trains-in-europe>