

City of Mississauga Corporate Report



<p>Date: September 22, 2020</p> <p>To: Chair and Members of General Committee</p> <p>From: Geoff Wright, P.Eng, MBA, Commissioner of Transportation and Works</p>	<p>Originator's files:</p> <hr/> <p>Meeting date: October 7, 2020</p>
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Subject

MiWay 2020 Hydrogen Fuel Cell Electric Bus Update

Recommendation

1. That the report "MiWay 2020 Hydrogen Fuel Cell Electric Bus Update" dated September 22, 2020 from the Commissioner of Transportation and Works be received.
2. That General Committee authorize City staff to engage with CUTRIC to restart the hydrogen fuel cell electric bus pilot project.
3. That the City staff request to participate in the Fuel Cell Electric Bus (FCEB) feasibility study, be approved.

Report Highlights

- MiWay, in partnership with CUTRIC, is exploring options to revive the Pan-Canadian Hydrogen Fuel Cell Demonstration and Integration Trial. The project's lifecycle will follow the same lifecycle of a typical bus, which is assumed to be 12 years.
- There are currently no dedicated hydrogen fuel cell electric bus pilots in Canada.
- The project will be coordinated in two high-level phases. **Phase 1** will be a feasibility study to understand local hydrogen fuel supply and storage, vehicle design and implementation logistics as well as statutory and regulatory requirements, economic and financial viability, and GHG reduction opportunities. **Phase 2** will involve CUTRIC working with the City and Provincial and Federal governments to secure the required funding for the project.
- Natural Resources Canada is developing a comprehensive strategy for hydrogen, which is expected to be released in 2020. The federal government has shared preliminary recommendations that include, but are not limited to, building strategic partnerships, developing new policies and regulations, providing investments in hydrogen pilots, and identifying high priority transit agencies and infrastructure deployments within each region to create regional hubs. Mississauga is well suited to become a hydrogen leader for our region.
- For Phase 2, a turn-key solution must be available, where the maintenance of the fueling

station, fuel delivery, and hydrogen-specific components of the bus are covered by a third-party vendor. The hydrogen buses will likely be operating out of the outdoor Malton garage, where infrastructure upgrades will be required.

Background

The purpose of this report is to provide an update to the “Fuel Cell Electric Bus Trial (Canadian Urban Transit Research and Innovation Consortium – CUTRIC)” report that was presented to Budget Committee on June 27, 2018. Since this report, there has been some advancement in the Fuel Cell Electric Bus (FCEB) landscape and Council-approved CUTRIC Pan-Canadian Hydrogen Fuel Cell Demonstration and Integration Trial.

In 2018, MiWay received Council approval to conduct a small scale hydrogen FCEB pilot. This project stalled due to the Provincial decision to cancel the Municipal Greenhouse Gas Challenge Fund and the Cap and Trade program, where \$4 million was allocated directly to this project. At the same time, the authorization to participate in this project was also subject to a project agreement with CRH Canada Group Inc. (CRH) for the supply and distribution of electrolyzed hydrogen fuel to MiWay facilities. CRH withdrew from the proposal due to the elimination of the Cap and Trade program, as offsets provided through that program were critical to the viability of the project for them. However, emerging legislation may revive CRH's interest in this project. For example, the forthcoming introduction of the Clean Fuel Standard may provide CRH with significant incentives to reduce its GHG emissions via hydrogen fuel production. When CRH dropped out of the pilot, not only did MiWay lose its source of hydrogen, but also the location for a hydrogen fueling station which was to be located at the CRH ready mix plant adjacent to the Central Parkway Transit Garage. MiWay has no space at Central Parkway for a fueling station on-site so a revived project would have to be located at our Malton satellite which means outdoor storage of buses.

MiWay is still a member of the CUTRIC Hydrogen Fuel Cell working group and is still working on the logistics and funding models with all stakeholders involved to revive the FCEB pilot project.

Present Status

There are currently no dedicated hydrogen fuel cell electric bus pilots in Canada. Indeed, there are few FCEBs operating in North America (see **Figure 1**). It is therefore difficult, if not impossible, to know how a FCEB would operate in MiWay's fleet, particularly with the winter climate conditions. A pilot project is therefore important and necessary for MiWay to examine the feasibility of introducing this low carbon technology into its fleet on a larger scale to meet the City's climate change targets. This hydrogen FCEB trial would be the first of this magnitude in Canada.

Note that there are many transit agencies that are currently conducting small scale *battery-electric bus (BEB)* trials. Through its membership in CUTRIC, MiWay will have access to the data from these pilots and will be able to apply any lessons learned to its own fleet. A FCEB pilot would therefore provide MiWay with the data necessary to determine a path forward (hydrogen or battery electric or a combination), as well as assist other Canadian transit providers with information they can use for their own fleets.

Figure 1: Global Hydrogen Fuel Cell Electric Bus Landscape (Credit: Ballard Blog, 2020)



As per the [Climate Change Action Plan \(CCAP\)](#) that was approved by Council in December 2019, MiWay is committed to helping the City reach its target of reducing Greenhouse Gas (GHG) emissions 40% by 2030. MiWay's GHG emissions account for roughly 70% of the City's total emissions. In order to meet the City's GHG target, MiWay cannot purchase any conventional diesel buses moving forward, and will be required to purchase hybrid-electric and electric buses with little to no emissions. The decarbonisation of the MiWay bus fleet needs to be a focal point in order to achieve the CCAP targets and for long-term strategic transformation.

MiWay is exploring both battery-electric and hydrogen electric opportunities for its bus fleet. Currently, MiWay is undertaking a Transit Electrification Study that will help inform BEB conversion opportunities. The study, which is expected to be completed by February 2021, aims to achieve three key objectives: (1) understand electric fleet capabilities; (2) identify electric fleet support and charging requirements; and (3) identify a garage phasing strategy. It is important to note that the scope of this study excludes hydrogen fuel cell electrification and is focused solely on BEBs. Therefore, a hydrogen fuel cell electrification feasibility study is required before deploying a pilot program. With both the Transit Electrification Study and the FCEB trial, MiWay

will better understand the pros and cons of both technologies. In theory, FCEBs are likely a better option for longer duration routes as they are lighter, can carry enough fuel, and can be refueled in a time comparable to diesel. Conversely, BEBs require regular on-route charging, or expensive and heavy batteries that take a long time to charge.

Comments

Hydrogen Fuel Cell Electric Bus Pilot Proposal

MiWay, in partnership with CUTRIC, are exploring options to revive the Pan-Canadian Hydrogen Fuel Cell Demonstration and Integration Trial. The project's lifecycle will follow the same lifecycle of a typical bus, which is assumed to be 12 years at a minimum. The project will be coordinated in two high-level phases.

Phase 1 – a feasibility study will be carried out to understand local hydrogen fuel supply and storage, vehicle design and implementation logistics as well as statutory and regulatory requirements (e.g. Clean Fuel Standards), economic and financial viability (including carbon pricing mechanisms), and GHG reduction opportunities. More specifically, the initial scope of the feasibility study will include the following:

- Conduct full fleet, block-based or vehicle-based modelling;
- Compare the total cost of ownership of FCEBs and diesel/biodiesel buses, considering the total cost of hydrogen fuel and the aggregate cost of the requisite number of FCEBs, along with fuelling infrastructure costs for MiWay;
- Analyze GHG emissions reductions by replacing diesel/biodiesel buses with FCEBs at MiWay, considering a well-to-wheel approach for all sources of fuel (steam methane reforming and electrolytic hydrogen);
- Assess current bus schedules and MiWay's fleet to optimize hydrogen fuelling times, considering MiWay's garage locations;
- Develop a fleet electrification roadmap using hydrogen fuel cell technology, with short term and long term recommendations on pathways toward zero-emissions. Minimize operational impacts and find the least costly solution based on energy consumption, fuel supply chains and the capital costs of infrastructure required;
- Modelling two (2) routes for two (2) models of electric low speed automated shuttles that have routes less than 3 kilometres in length (potentially on a dedicated laneway). The scope of this task is a federal funding requirement; and
- An analysis of the draft Clean Fuel Standard federal regulations and the opportunities it may create to stimulate a hydrogen economy.

The estimated cost of the feasibility study is up to \$175,000. To fund the feasibility study, CUTRIC is covering 75% of the costs, while the City of Mississauga would cover 25% of the

costs. The study will also provide the necessary information to support any application to provincial and federal governments for Phase 2 funding.

Phase 2 – CUTRIC and the City will request funding from the federal and/or provincial governments to implement the project. The estimated cost of the project is based on current costs and a funding contribution from the City. Requesting funding is timely given the pending launch of Natural Resources Canada's (NRCan) comprehensive strategy for hydrogen. As part of the strategy, the federal government has shared preliminary recommendations that include, but are not limited to, building strategic partnerships, developing new policies and regulations, providing investments in hydrogen pilots, and identifying high priority transit agencies and infrastructure deployments within each region to create regional hubs. Mississauga is well suited to become a hydrogen leader for our region.

CUTRIC has been engaged with many potential project partners and key stakeholders that would play a role in creating a hydrogen ecosystem (e.g. hydrogen fuel suppliers, bus manufacturers, battery technology companies) over the last few years which include, but are not limited to, Alectra, Enbridge, Emerald Energy, Carlsun-7GFUEL, academic institutions, Ballard, Hydrogenics and New Flyer. Mississauga's predominant company in this sector is Hydrogenics, who was acquired by Cummins in September 2019. The Cummins' Mississauga facility is now their Centre of Excellence for hydrogen fuel cell power module and PEM electrolyzer research and development and production. Having a Centre of Excellence for a global company like Cummins is an extremely valuable asset to the City. Cummins' Mississauga location is renowned for its hydrogen fuel cell expertise with more than 150 high-quality jobs including several PhD employees, process and electrical engineering, research and development roles. Cummins has a significant real estate footprint in Mississauga and is expected to have continued growth in the future. In addition, Cummins has a significant and positive economic impact on the local supply chain. They currently work with 50 local machine and fabrication shops in the GTA, many of them in Mississauga. As Cummins continues to bring more of its component manufacturing in-house, they will continue to grow and scale their hydrogen product portfolio manufacturing for customers all over the world. As a result, this increased manufacturing will provide more business opportunities within Cummins and for local companies to supply Cummins with components and products.

Recently, Hydrogenics and Enbridge have partnered to deliver utility-scale energy storage in Ontario and may be a potential source of hydrogen fuel for the pilot project. This would allow local Mississauga technology and innovation companies the opportunity to support this initiative, and potentially play a role in this space moving forward. The success of the project will require a coordinated effort from all partners and all levels of government.

Subject to approval from Council, CUTRIC will carry out the scope of Phase 1 – Feasibility Study. After that, CUTRIC and the City will work on a funding application to the federal and/or provincial governments for Phase 2.

Benefits of Hydrogen Fuel Cell Electric Bus Pilot Project

There are a number of benefits to FCEBs, as well as the proposed pilot. In regards to FCEBs, some of their benefits include producing little to no GHG emissions, are simpler to maintain as there is no engine or transmission and fewer moving parts, produce less noise pollution, have better driveability, and are better for our residents' health.

As for the pilot, there will be additional benefits, including:

- Validation of performance of hydrogen fuel cell electric bus technology.
- Developing staff capacity for fleet planning, operating procedure and protocols, training, and maintenance.
- Maximizing access to external grant funding available to municipalities for GHG reduction initiatives.
- Achieving immediate and significant GHG reductions associated with transitioning from diesel to hydrogen propulsion – up to 120 tonnes of carbon dioxide (CO₂) per bus per year. A zero-emission bus will eliminate an estimated 1,440 tonnes of CO₂ over its 12-year lifespan, which is equivalent to taking 308 cars off the road. In addition, a zero-emission transit bus eliminates approximately 9 tonnes of nitrogen oxides and 150 kilograms of particulate matter over the life of the vehicle, thereby improving air quality.
- Showcasing corporate commitment to a zero-emission future and leveraging transformative technologies to meet CCAP targets.
- Allows for increased renewable energy use. (i.e. NRCan has identified EV-drive integration as enabling increased system flexibility and renewable energy penetration.)
- Other transit agencies across North America will learn and benefit from our experience, similar to how MiWay is currently learning about the battery-electric bus trials in Canada such as Toronto Transit Commission, Brampton, York Region Transit, Kingston, Guelph, Oakville, TransLink, Edmonton, and many others.

Challenges & Risks Addressed Through the FCEB Pilot Project

There are a number of potential challenges that could arise when operating FCEBs in MiWay's fleet, which we anticipate will be resolved during the pilot. There are also a number of risks that MiWay has recognized and should be able to manage effectively:

- A turn-key solution is required, where a third-party vendor would maintain the propulsion-related components, while MiWay would maintain standard bus components.

The turn-key solution will be required for the operation and maintenance of the hydrogen fuel cell components, fueling station, and fuel delivery and production.

- MiWay will need to understand where the hydrogen fuel is sourced. MiWay is not considering producing hydrogen on-site during the pilot stage therefore the fuel must be transported to MiWay facilities. It is vital that the hydrogen source is near-by as the hydrogen fuel will most likely be transported via trucks which produce GHG emissions during the delivery process.
- Storage and operation of hydrogen buses must be done at the outdoor Malton location. MiWay does not have physical space at the garage for onsite production of electrolyzed hydrogen.
- MiWay will need to upgrade the maintenance facility to accommodate these buses due to height restrictions and hydrogen related fire codes.
- With current fuel cell technology used in North America, MiWay will need to “plug in” their FCEB’s to an external power supply in the winter months to avoid fuel cell freeze up if ambient temperatures are below 0°C. There is a fuel cell in development that self-manages the moisture within the fuel cell stack and avoids freezing up to -25°C, however this fuel cell may not be available in the near future.
- New Flyer is the only Canadian company that manufactures hydrogen buses. From a competitive procurement perspective, MiWay will be forced to conduct the FCEB pilot with only New Flyer buses and specific fuel cells to meet operational requirements. Additional project components such as fuel production, hydrogen transportation, hydrogen fueling station and maintenance and support contracts may also have to be sole sourced for the pilot.

Minimum Viable Project Requirements

In order for MiWay to be able to participate in this project, the minimum viable project requirements must be understood and carried out:

- A turn-key solution must be available, where the maintenance of the fueling station and hydrogen-related components of the buses are delivered by a third-party vendor.
- Considering lack of space at the Central Parkway garage, a fueling station and dispenser must be installed at the outdoor Malton facility. This will include upgrading the existing facility to accommodate hydrogen buses. MiWay staff will be able to fuel buses with minimal training needed.
- CUTRIC must work with the City to secure provincial and federal funding for all phases of the project.
- Incremental operating costs including facilities, buses, fueling station, fuel, and fuel transportation must be funded through the capital project. The hydrogen fuel must also be delivered under contract.

- Given that there is currently no competitive market for hydrogen buses, MiWay must have the ability to sole source the buses including the fuel cell and hydrogen fuel contract. Other project components may also have to be sole sourced.

Strategic Plan

The introduction of FCEBs contributes to two strategic goals: **Move** (Develop Environmental Responsibility) and **Green** (Lead and Encourage Environmentally Responsible Approaches).

Mississauga has been proactive in sustainability and climate change governance for over two decades. This includes joining the FCM Partners for Climate Protection program in 1999, integrating climate change and environmental considerations into the City's Strategic Plan in 2009, developing the City's Living Green Master Plan, integrating climate change considerations into its Official Plan in 2012, and becoming a signatory to the Global Covenant of Mayors for Climate and Energy (coalition of 10,000 Cities) in 2017.

Financial Impact

A FCEB pilot project mitigates risk with an emerging technology and is likely the most cost effective approach for understanding how hydrogen bus technologies will integrate into MiWay's large conventional fleet.

For Phase 1, Funding of up to \$43,750 (25% of the feasibility study) will be provided through existing operating funding from MiWay and the Environment Section.

For Phase 2, only high-level cost estimates are available at this time. Mississauga's participation in the CUTRIC trial would be contingent on finding a way to operate buses at its Malton garage, securing funding from the provincial and/or federal government, and Council approval.

Subject to Council's approval for the City to participate, CUTRIC will coordinate efforts to obtain federal and/or provincial funding after Phase 1 has completed, which broadly includes the cost of the FCEBs, cost of hydrogen fuel for 12 years, and required infrastructure and support contracts. Shown in the tables below are the estimated capital and operating costs for the FCEB pilot project, which are subject to refinement as the Phase 1 – Feasibility Study will provide more accurate costs. MiWay has directed CUTRIC to stay clear of ICIP or Gas Tax funds for the hydrogen fuel cell electric bus pilot project, and to seek a different funding source. As with the 2018 proposal, the City's contribution to the project would remain the capital cost of (10) diesel buses and the equivalent operating costs of the diesel fuel and maintenance of diesel components on the buses for the 12 year life.

Estimated Capital Costs	Value (\$)
Phase 1 - Feasibility Study	\$175,000
(10) 40' Hydrogen Buses (Premium over the cost of a Diesel Bus)	\$11,000,000
MiWay Facility Modifications	\$601,000
Compression, Storage, Dispensing (CSD) at MiWay (600kg of storage)	\$2,300,000
Tube Trailer & Tractor	\$3,000,000
Total:	\$17,076,000

Estimated Operating Costs	Value (\$)
CUTRIC Program Management & Data Analysis Consulting Fees	\$350,000
Hydrogen Fuel (Premium over cost of Diesel fuel)	\$7,097,181
Maintenance of Fuel Cell Buses (Premium over the cost of a Diesel Bus)	\$2,742,384
Total:	\$10,189,565

Conclusion

City staff believes that it may be possible to revive the Pan-Canadian Hydrogen Fuel Cell Demonstration and Integration Trial in partnership with CUTRIC. The City's commitments are similar to the original pilot program although some of the potential partners have changed. The entire pilot is subject to funding from higher levels of government but CUTRIC believes there may be opportunities to put the City and MiWay at the centre of the hydrogen economy in Canada. Participation in a Phase 1 feasibility study involves minimal commitments and would inform our further participation and define the proposal further. Staff seeks Council endorsement to continue to work with CUTRIC and permission to participate in the Phase 1 feasibility study.



Geoff Wright, P.Eng, MBA, Commissioner of Transportation and Works

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