INFORMATION REPORT

TO:	Chair and Members Public Works Committee
COMMITTEE DATE:	July 12, 2018
SUBJECT/REPORT NO:	Electric Buses (PW18061) (City Wide) (Outstanding Business List Item)
WARD(S) AFFECTED:	City Wide
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Council Direction:

At the March 19, 2018 Public Works Committee meeting, staff were directed to investigate, and possibly test, battery electric buses in preparation for future procurement, and report back to Public Works Committee.

Information:

The primary objective of this report is to determine whether it is timely to introduce battery electric buses ("e-buses") into service in Hamilton. Also to consider the potential impact of e-buses on factors external to the Hamilton Street Railway (HSR): the City, its citizens and the power grid.

Electrification of transit buses has been evolving for many years in various forms. Trolleybuses have been operating with electrical components all over the world for decades. Hybrid buses with electrical components have been common and abundant for several years, and fuel cell in smaller demonstration fleets around the world.

Although it may seem their arrival on the Canadian market was rather sudden, today's battery e-buses are the result of several generations of vehicle technology, which has been extended to include electric trains, tramways, trolley buses, diesel-electric hybrid buses and fuel cell buses. The key challenge for e-buses has always been the energy storage system (ESS), in particular, developing a battery chemistry that meets the operational requirements of e-buses. While there is certainly improvement expected with the current offering, today's batteries already allow e-buses to compete with the cost of traditional diesel buses on a lifecycle basis.

The world market for electric and hybrid-electric buses amounted to nearly 15,000 units

in 2014. Sales are expected to grow at a compounded annual growth rate of 19.6% over the period 2015 - 2020. At the end of 2015, China alone was expected to operate approximately 500,000 plug-in hybrid electric and pure-electric vehicles.

Based on the information available at the time this report was prepared, electric buses could be used in service in Hamilton and could perform as reliably as the rest of the fleet of Compressed Natural Gas (CNG) and diesel buses but will require thorough planning, training, and resources to ensure the City of Hamilton derives the full benefits of their use.

Municipalities in Alberta, namely Edmonton and St. Albert, as well as in Montreal, Quebec, have had e-buses generate environmental and potential economic benefits. An e-bus operating today will emit approximately 38-44% less CO2 (from the power generators) than its diesel equivalent. It is also expected that the economic benefits of using e-buses relative to using CNG or diesel buses will grow in the future as the cost of operating fossil fuel powered buses will outpace that of e-buses due to CNG/diesel fuel price increases, to rising carbon cost, and to electricity prices continuing to progress at a slower pace.

E-buses are a cleaner choice for the environment than the current fleet. Investment in electric vehicles improves street level air quality in the city, and in the atmosphere. The electric transportation modal shift is expected to accelerate as the cost of batteries decreases and electric vehicle performance improves. For every 1,000 battery-powered buses on the road, about 500 barrels a day of diesel fuel will be displaced from the market, according to BNEF (Bloomberg New Energy Finance) calculations.

Two charging technologies are available for this project: (rapid) en-route charging (pantographs installed at transit centres provide a quick charge to the buses - 5 minutes) and (slow) trickle charging (buses are charged at the garage overnight and/or between runs). The use of en-route charged e-buses presents risks that are different than those of operating trickle-charged buses. With the former, the charging infrastructure required can be restrictive in terms of route planning flexibility as the cost of moving the charging equipment once in place is high. With trickle-charged buses, an electricity grid failure where the garage is located may cripple the e-bus fleet for the duration of the failure (unless a sufficiently large backup generator is installed). The current range of trickle charged e-buses can also limit the routes that can be assigned to those buses.

While electric motors have long been used in industry, batteries as a main source of energy made their entry in the transit market less than 10 years ago with the advent of diesel-electric hybrid buses. From a reliability perspective, they have performed very well.

Batteries installed on diesel-electric hybrid buses have in fact exceeded industry expectations in terms of their life and degradation performances. The HSR has had up to 30 diesel/electric buses in service for over a decade, and have only purchased two replacement battery packs due to failure or substandard service.

But new battery chemistries are reaching the market, sometimes without the benefit of a proven track record. This represents a risk for the HSR, but at least one manufacturer has expressed a willingness to offer innovative financing terms for their buses that might make it possible to shift the risk of ownership of the energy storage system to the manufacturer.

Handling batteries in the maintenance garage or in the context of accidents requires that operators, first responders and maintenance staff know the risks associated with the battery chemistry selected when e-buses are purchased, and that all personnel be trained accordingly to mitigate such risks.

Adopting a new technology invariably presents operational risks as well. If nothing else, time is required for staff to adapt to the new vehicles. The adaptation period will be longer for maintenance staff as technicians will have to learn to deal with issues currently unfamiliar to them.

The current shorter range of e-buses compared to diesel buses theoretically implies that more e-buses may be required to provide a level of service equivalent to diesel buses. Using the latest generation of e-buses will also have an impact on the image of Hamilton as being a progressive, environmentally conscious city.

The introduction of a small fleet of e-buses at HSR can likely be accommodated by the current capacity of the electricity grid in Hamilton. However, if e-buses are introduced in large numbers, portions of the electricity grid in Hamilton may need to be upgraded to ensure there is sufficient power at the locations where the large fleet would be charged.

As well as the environmental benefits, operational costs can be mitigated through the use of e-buses. The fuel cost to operate per km; the e-bus = $.12 - $.18, Diesel = $.51 - $.53. Longer term operating cost benefits include motor replacement at approximately $10k/motor = $20K every six years vs two engines/transmissions = $45K. There are a number of other potential savings with brakes being the most frequent service on a conventionally powered bus. E-buses use electrical regeneration to slow the vehicle down to reduce the use of the brake system, therefore extending its life.

The City has entered into a GHG competition and if successful, the ability to use the GHG funds (if awarded to us), along with either PTIF funding (new, expansion buses), or GHG funds and current capital replacement dollars (50/50) to take diesel buses out of service and replace them with e-buses. The GHG funds would effectively put the buses at the same cost to the City, with the reduction in operating and fuel costs recognized through the Operating budget. Zero emissions, reduction in noise, and increase in customer acceptance (noise reduction, internal and external).

In 1985 the Hamilton Street Railway piloted a program to use Compressed Natural Gas(CNG) as a propulsion fuel in place of diesel fuel to reduce emissions and operating costs. For the subsequent two decades, development of that technology was slow paced, and not widely implemented across Canada. Also, cars and trucks of that era were not widely converted to CNG or propane as a fuel, so subsequently there was a lack of infrastructure to support its growth. In 2013, Council made a decision to stop procurement of diesel powered buses and revert to CNG bus procurement for the same reasons identified in 1985. Since the Council decision, Transit has mitigated fuel costs, and there has not been any measurable increase in maintenance costs operating the less expensive, cleaner CNG fuel.

The entire world has a level of infrastructure in place to be able to operate battery electric cars and buses with charging stations possible at one's residence as well as a growing number of public charging stations. E-bus technology has the advantage of this global infrastructure and a rapidly developing technology that will increase its operating range and dependability while maintaining sustainable operating costs.

As directed, staff has contacted the three e-bus manufacturers that have current CMVSS approval, and have made arrangements for late Q3/early Q4 testing of each bus for a period of up to one week. The charging stations will be provided on a stand-alone basis and the buses will not be in revenue service, but will mirror existing routes.

As we get closer to the dates of the testing, staff will report back to Council with information specific to each of the vehicles we will be testing, the dates and times that these vehicles will be operational as well as the routes that they will be operating on. Staff will develop a strategy to ensure that the vehicles are utilized on a wide number of routes to allow customers the opportunity to experience a ride on an electric vehicle. Staff will also be developing a communication strategy to keep customers informed.

Appendices and Schedules Attached

None