

Saskatoon Transit Battery Electric Bus Trial Performance Results

ISSUE

Key drivers for research to be conducted into the feasibility of alternate propulsion systems for the Saskatoon Transit fleet were: 1) the City of Saskatoon Low Emissions Community plan to phase in a transit electric fleet starting in 2022 to meet environmental sustainability goals and, 2) the operating impacts of extreme cold weather events on emission control systems on the current Saskatoon Transit diesel bus fleet. What is the feasibility and business case of transitioning the Saskatoon Transit diesel bus fleet to Battery Electric Buses?

BACKGROUND

In early 2019, Saskatoon Transit was approached by the Saskatchewan Research Council (SRC) with the idea of conducting a Battery Electric Bus (BEB) feasibility study. Saskatoon Transit was exploring bus electrification, and this seemed to be a timely and good opportunity to begin a partnership. In March of 2019, SRC presented their feasibility study to Transit management.

Their report outlined potential operating savings, high-level life cycle costing information, carbon, and Green House Gas (GHG) reductions as well as other environmental benefits. It also outlined a process to complete a more thorough trial. At that time, Saskatoon Transit did not have sufficient capital funding to purchase a BEB but could take advantage of a matching grant from the Federation of Canadian Municipalities (FCM) for a BEB lease. The SRC recommendation was for a one-year term which would allow thorough gathering of information on how the bus would react in all four seasons, introduce the maintenance and operating groups to the differences of a BEB, and trial it on as many runs as possible to test its capabilities on a day-to-day basis.

Through a Negotiated Request for Proposals (NRFP), Saskatoon Transit secured a BYD K9MC 40-foot BEB for a one-year trial. The bus was outfitted with Transit's Information Transit System (ITS), fare box and radio, and a telematics system to monitor the function of the bus's various systems in operation. The bus was first used in service on October 5, 2020 displaying unit number 1948, the year the first electric trolleys were put in service in Saskatoon.

CURRENT STATUS

The lease ended on September 30, 2021 and the bus was returned to the vendor. SRC has completed the final analysis of the telematics information gathered during the trial period. Appendix 1 includes the Saskatoon Transit Electric Bus Performance Report completed by SRC.

With the \$2.64 million of funding approved for bus fleet replacement in the 2022-23 budget, Saskatoon Transit is working with Supply Chain Management to prepare a Request for Purchase (RFP) for the purchase of two BEBs for possible delivery in mid 2023.

DISCUSSION/ANALYSIS

Energy Consumption

Through the trial, the bus averaged 1.4 kWh/Km of electricity consumption. This was substantially higher in the winter and summer months when the Heat, Ventilation and Air Conditioning system (HVAC) was required to heat or cool the vehicle. The lowest usage was in May when minimal HVAC was required and the average was 0.7 kWh/Km, as the batteries were driving mainly the traction motors.

Effective Range

The BYD bus has a 330 kWh battery, and this equated to a 470 km effective range, approximately the distance of the longest run that a current diesel bus goes before coming back to the garage for refueling. The highest energy consumption was in February when temperatures of -40 Celsius were seen for a few weeks. During this time, a peak average usage of 2.2 kWh/km was observed, which results in a maximum effective range of 150 km.

Annual Operating Costs

The annual average energy cost for a BEB is estimated to be \$6,990. A diesel bus will use approximately \$29,100 of fuel annually. The annual operating costs are based on the average annual distance of 50,000 km travelled by a Saskatoon Transit bus. Annual operating costs are estimated to be, on average, 76% lower for a BEB than a diesel bus.

Annual Maintenance Costs

The average annual maintenance cost for a BEB versus a diesel bus is estimated to be \$9,000 and \$43,000 respectively, savings of approximately 79%.

Alternative Heating Option

The report from SRC recommends that Saskatoon Transit explore alternate methods of energy to support the HVAC, for example a biodiesel heater. The report further outlines that this may seem counterintuitive, but a biodiesel generator for the HVAC would reduce the carbon emissions of a BEB over an electricity generated HVAC by approximately 6 tonnes of CO2 emissions annually. The benefits to this solution expand beyond the environmental impact, but would also increase the range of the bus, further impacting the diesel/electric bus replacement ratio more favourably, saving on capital replacement investments.

Social Impacts

The report also outlined social benefits that can be realized by moving to BEBs. Reference was made to a German study showing up to a 14 dB reduction in noise produced by BEBs at low speeds compared to diesel buses. However, in most cases, a

reduction of 5 dB is more likely. Along with the reduction of noise from a diesel engine, comes the elimination of exhaust/soot/odour from the buses. All these benefits combined provide for a more comfortable ride and a more pleasant environment for the public interacting in proximity of the buses.

Summary of Operating Costs

While the capital cost of purchasing electric versus diesel buses is higher, BEBs have much lower operating costs:

- The capital cost of diesel versus electric buses for Saskatoon Transit are approximately \$660,000 and \$1,200,000, respectively.
- BEBs are known to have lower operating costs than diesel buses. The annual maintenance costs of a diesel versus electric bus, driving 50,000 km/year, are expected to be \$43,000 and \$9,000 respectively.
- Fuel costs to operate a diesel bus are currently significantly greater than the electricity costs to operate a BEB for the same distance. When driving 50,000 km/year, these are estimated to be \$29,100 and \$6,990 per year.

With these operational savings, the BEB becomes more financially attractive over time and at the 10-year point of an 18-year life cycle, the BEB begins to show savings, compared to the equivalent life cycle of a diesel bus.

Total Cost of Ownership

The total cost of ownership of a diesel versus BEB travelling 50,000 km per year, operating over an 18-year lifetime is expected to be \$1,957,320 and \$1,487,800, respectively. If a diesel-powered coolant heater unit were used to provide cabin heating for a BEB, the total cost of ownership is expected to be slightly increased from \$1,487,800 to \$1,517,150, but the effective range of the BEB would double in the coldest months. An electrically heated BEB, with a low effective range in cold weather and large variations in effective range throughout the year, may result in the need for a larger bus fleet. Therefore, a BEB with a diesel-powered coolant heater may reduce the overall capital costs of a BEB fleet.

Even with the significantly higher upfront capital cost for the BEB, the analysis shows that approximately \$470,000 can be saved over the total life of the bus, a savings of 24%.

With that number applied to a fleet with 140 buses, it is close to \$66 million over the life of the fleet, or approximately \$3.6 million annually. The operational savings could be reallocated to offset a portion of the capital costs for the bus renewal strategy/asset management plan in the future. However, these savings will only be realized once the fleet has been completely converted.

Charging Infrastructure

Further to the investment for the BEBs is the charging infrastructure upgrade. The current COC facility should be sufficient to sustain approximately 30 BEBs. Beyond that further analysis is required to determine the requirements to charge the entire fleet, in a

staged fashion, with future proofing incorporated into the design. Preliminary estimates are in the range of \$200,000 to \$1,000,000, but more study needs to be completed to ensure all the variables have been included.

Summary

Although it would be attractive in the short term to purchase four diesel buses versus two BEBs in 2022 to deal with the immediate fleet needs, the Administration believes that the move to BEBs for both financial and environmental reasons will be difficult no matter when the decision is made. There will always be limited funds and a high degree of urgency for fleet replacement. Considering all factors, the Administration believes that moving to BEBs now makes sense because this investment will lower the long-term costs to the City and provide for better performance in cold weather. This will advance the timeline that the City realizes the financial benefits of the move to electrification, which will in turn improve the City's ability to keep up with fleet replacement.

FINANCIAL IMPLICATIONS

With the \$2.64 million of funding approved for bus fleet replacement in the 2022 budget, Saskatoon Transit is working with Supply Chain Management to prepare a Request for Purchase (RFP) for the purchase of two BEBs for possible delivery in mid 2023.

To align with the requirements of the Transit Asset Management Plan, the bus replacement plan for the fixed route system is up to ten 40-foot equivalents per year to meet the recommended industry standard average age of 7.0 years. If Saskatoon Transit is to proceed with a replacement strategy of all BEBs this would require an annual capital fleet replacement budget of \$12.0 million.

On January 27, 2022 Infrastructure Canada announced they are accepting applications for both the planning and capital funding streams of the Zero Emission Transit Fund. Saskatoon Transit is working with the Finance Department to review eligibility and application requirements.

Saskatoon Transit has also investigated the various funding options available through the Canadian Infrastructure Bank for vehicles and infrastructure upgrades to support zero emission vehicles.

OTHER IMPLICATIONS

There are no privacy or legal implications identified. Social and environmental implications are discussed in the report.

NEXT STEPS

1. Saskatoon Transit will collaborate with Supply Chain Management to prepare a Request for Purchase (RFP) for the purchase of two BEBs for possible delivery in mid 2023 funded from the \$2.64 million approved for transit fleet replacement in the 2022 budget. The RFP will explore the option of including a biodiesel powered heater cooler to allow for increased effective range and overall reduced GHG emissions. If a biodiesel powered heater cooler system is purchased,

discussions will also take place with SRC on the possibility of another partnership to equip at least one of the new BEBs with data logging systems to gather additional performance data that can be compared to the performance data from the trial BEB. This data can be analyzed to assist with specifications for future BEB purchases.

2. Administration will submit a report to City Council in the second quarter of 2022 with further details on the Zero Emission Transit Fund and seeking approval to apply to the Fund to leverage funding to start the transition to a BEB transit fleet.

APPENDICES

1. Saskatchewan Research Council (SRC) - Saskatoon Transit Electric Bus Performance Report - Updated Jan 2022

Report Approval

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