Electric School Bus Business Case:

A Calgary Demonstration Case Study

Funders:

Scotiabank

Alberta ecotrust

Implementing Partners:

Pollution Probe

RFS ENERGY

Mobility Futures Lab

SOUTHLAND

safely home

The content of this report was finalized in October 2023.

Pollution Probe
902 – 130 Queens Quay Easy
Toronto, ON, M5A 0P6,
Canada

For more information, please contact:

Steve McCauley | SENIOR DIRECTOR , POLICY
smccauley@pollutionprobe.org

Cedric Smith | DIRECTOR, TRANSPORTATION
csmith@pollutionprobe.org

Marc Saleh | LEAD CONSULTANT
msaleh@mobilityfutureslab.ca

Rebecca Fiissel Schaefer | CEO & CO-FOUNDER
rebecca@rfs.energy

Christina Pidlaski | SENIOR CONSULTANT
christina@rfs.energy

ACKNOWLEDGEMENTS

Pollution Probe has received funding from the Alberta Ecotrust Foundation and the Scotiabank Net Zero Research Fund. The views expressed in this report are not necessarily those of the Alberta Ecotrust Foundation or Scotiabank.

The project team extends its gratitude to Southland Transportation Ltd. for their valuable contributions, including leasing the electric school bus, providing administrative support to the project, and providing resources related to the ongoing maintenance and operation of the bus.

The Calgary Board of Education (CBE) also played a supportive role by involving the electric school bus on their routes and contributing funding for the bus charger.

LAND ACKNOWLEDGEMENT

With a focus on mobility in what is now known as Alberta – subject to Treaties 6, 7 and 8 – this project is inherently land-based. The project team recognizes the true history of these lands and the injustices that First Nations, Métis, and Inuit peoples continue to experience through colonial systems and structures. We acknowledge these lands as the traditional and ancestral territory of many peoples – the Blackfoot Confederacy– Kainai, Piikani, and Siksika – the Cree, Dene, Saulteaux, Nakota Sioux, Stoney Nakoda, the Tsuu T'ina Nation, and the Métis People of Alberta.

We encourage readers to learn about the Indigenous history of where they live and work and the Truth and Reconciliation Committee of Canada's Calls to Action. We invite you to reflect on your own relationship with the lands you occupy and what meaningful actions you can take toward reconciliation.

About Partners

Web | Facebook | Twitter | Instagram | YouTube | Donate

Pollution Probe

Pollution Probe is a Canadian charitable environmental organization that is a leading agent of change at the intersection of communities, health and environment. Since 1969, we have been defining environmental problems through research, promoting understanding through education and pressing for practical solutions through advocacy. Pollution Probe has a proven track record of working in successful partnership with industry and government to develop practical solutions for shared environmental challenges.

Pollution Probe is one of Canada's leading independent transportation solution providers. Our work supports aggressive actions to address climate change and reduce air pollution while promoting job creation and economic growth. In addition to projects we actively contribute to expert transportation committees and working groups at local, regional, national and global levels. We are technology neutral and work collaboratively with a wide variety of stakeholders to develop transportation decarbonization solutions across all modes.

Mobility Futures Lab

Mobility Futures Lab is a leading sustainable transportation consulting firm that is at the forefront of innovation and research in the field of mobility. The firm's services are designed to help clients navigate the complex landscape of sustainable transportation, with a focus on proprietary software tools and data-driven solutions. Our approach is based on a deep understanding of the interconnections between transportation, energy, and the environment.

RFS Energy

RFS Energy brings people together to propel planning, research, and climate change policy into the marketplace.

With 50+ years of combined experience working with non-profits, think tanks, 25+ utilities and government agencies across Canada, the RFS Energy team draws from unique experience rooted in on-the-ground program implementation to support clients and bring innovation to life.

Southland Transportation

Founded in 1971, Southland Transportation is a leader in student transportation throughout Canada and a trailblazer in forward-thinking transportation solutions. Operating over 3500 routes daily, Southland understands the GHG impact of the transportation industry and is actively reducing emissions in the communities we serve. With Canada's largest alternative fuel fleet and a growing zero emissions fleet, Southland is creating a sustainable future for the students we deliver Safely Home each day.

Executive Summary

Electric school buses (ESBs) present a promising solution to reduce greenhouse gas emissions and mitigate health risks associated with diesel exhaust.

Recent advancements in battery manufacturing technology have lowered the cost of ESBs, and further cost reductions are expected in the next decade due to significant investments in battery electric vehicle technology. Although the literature to this point indicates that the total cost of ownership (TCO) for ESBs is currently higher than internal combustion engine (ICE) buses in jurisdictions evaluated, federal financial incentives provided through the Zero Emission Transit Fund (ZETF) can make ESBs financially viable for operators willing to pilot the technology and start training their staff.

The TCO of ESBs varies based on the local operational conditions of the bus, which dictate how much energy the bus is consuming, and the local electricity prices, among other factors. ESBs' energy usage can fluctuate, especially in winter, based on their operating conditions. Moreover, each province's unique regulatory framework results in varying electricity costs and billing methods. As a result, it is crucial to assess the TCO of ESBs at the local level, considering local electricity expenses and real-world data on operational energy consumption.

Pollution Probe was funded in partnership with RFS Energy and the Mobility Futures Lab by the Alberta Ecotrust Foundation and the ScotiaBank Zero Emission Fund to conduct a demonstration of an ESB in Calgary, Alberta. The project involved monitoring the operational performance of the ESB and its charger over the course of a school year.

This report presents the business case for an ESB compared to a diesel bus based on the observed costs and operational energy consumption during the demonstration. Key findings include:

- In the Alberta context, the TCO for an ESB over a 13-year period is 19% higher than that of a diesel school bus. However, when factoring in the federal financial incentives aimed at capital costs, the TCO of an ESB is 21% lower compared to a diesel school bus.
- The business case for ESBs entails higher upfront costs offset by operational savings throughout the vehicle's lifetime. Financing programs are crucial in enabling fleet operators to overcome the initial higher capital cost of ESBs, particularly in the initial stages of the ESB transition where financial lenders charge higher interest rates for ESBs relative to diesel school buses due to the uncertain resale value of the vehicle in case of a fleet operator default.

Executive summary

- The economics of ESBs varies based on the size of a deployment. Operators could take advantage of the limited infrastructure cost requirements of small deployments to start training the staff on the technology in advance of further cost reductions expected in the sector through the recent significant investments from the industry that will promote economies of scale in ESB manufacturing.

- Regulatory and technological barriers to potential revenue sources such as vehicle to grid (V2G) should be explored further in the Alberta context.

- Certain factors, such as reduced noise and fumes, contribute to a more pleasant driver experience with ESBs. However, on certain routes, operators may have to decide between sending drivers back to the yard in between the morning and afternoon run for charging, or using an auxiliary diesel heater that would extend vehicle range. Routes requiring drivers to return to the yard between runs might have a negative impact on driver satisfaction. More research is needed to determine the overall impact of a transition to ESBs on driver satisfaction.

Table of Contents

Clean Air • Clean Water • Healthy Planet

A Calgary Demonstration Case Study

1. INTRODUCTION

Approximately 90% of Canada's fleet of 50,000 school buses rely on diesel fuel, resulting in the emission of 110 tonnes of carbon dioxide (CO_2) throughout their lifespan.

These diesel buses also release harmful air pollutants that directly impact human health. Electric school buses (ESBs) offer a promising solution to reduce greenhouse gas (GHG) emissions generated by the school bus sector while mitigating the detrimental health effects caused by diesel exhaust on children and the general population. [1]

Technological innovations in the battery manufacturing sector have significantly reduced the cost of batteries over the past decade and improved the economics of ESBs. Recent large-scale investments into the supply chain of battery electric vehicle technology manufacturing across North America are expected to continue the cost reductions of the technology over the next decade.[2]

Although the literature to this point indicates that the total cost of ownership (TCO) for ESBs is currently higher than internal combustion engine (ICE) buses in jurisdictions evaluated, federal financial incentives provided through the Zero Emission Transit Fund (ZETF) can make ESBs financially viable for operators willing to pilot the technology and initiate the electrification of their fleet.[3]

The TCO of ESBs varies based on the local operational conditions of the bus, which dictate how much energy the bus is consuming, and the local electricity prices, among other factors. ESBs' energy usage can fluctuate, especially in winter, based on their operating conditions. Moreover, each province's unique regulatory framework results in varying electricity costs and billing methods. As a result, it is crucial to assess the TCO of ESBs at the local level, considering local electricity expenses and real-world data on operational energy consumption.

1 Pollution Probe (2022). Opportunities for Accelerating School Bus Electrification in Ontario. Retrieved from: https://www.pollutionprobe.org/wp-content/uploads/2022/05/White-Paper-Opportunities-for-accelerating-school-bus-electrification-in-Ontario.pdf

2 Environmental Defense Fund (2022). Medium and Heavy-Duty Electrification Costs for MY 2027-2030, Roush Industries, Inc, Retrieved from: http://blogs.edf.org/climate411/files/2022/02/EDF-MDHD-Electrification-v1.6_20220209.pdf

3 Dunsky (2023). Pathways for Canadian Electric School Bus Adoption. Retrieved from: https://www.equiterre.org/en/resources/pistes-de-solutions-pour-lelectrification-du-parc-dautobus-scolaires

1 Introduction

Pollution Probe was funded in partnership with RFS Energy and the Mobility Futures Lab by the Alberta Ecotrust Foundation and the ScotiaBank Zero Emission Fund to conduct a demonstration of an ESB in Calgary, Alberta. The demonstration consisted of the deployment of a single ESB in collaboration with local fleet operator Southland, contracted by the Calgary Board of Education. The project involved monitoring the operational performance of the ESB and associated charger across a school year. Telematics equipment was installed on the bus to collect energy consumption data between December 7, 2022, and June 28, 2023.

This report presents the business case for an ESB compared to a diesel school bus based on the costs and operational energy consumption observed during the demonstration. The report assesses the capital and operational costs associated with the deployment of an ESB and highlights the impact of federal financial incentives available to the sector.

Economics of ESBs

2.1 Costs

2.1.1 Capital costs

ESB deployments involve various capital costs. One of the most significant costs is the acquisition cost of the electric buses themselves. ESBs have a higher upfront purchase price compared to traditional diesel buses. Additionally, charging infrastructure is a crucial capital cost. This includes the installation of charging stations, and any infrastructure upgrades required to support increased power loads. Charging infrastructure costs can vary depending on the number of charging stations required, their capacity, and the electrical upgrades needed. **Table 1** presents the specifications of the ESB and charging station used as part of the demonstration.

Table 1: Vehicle and charger specifications

Procurement Item	Specifications	Standards and codes
Blue Bird Vision Electric	Type C, Up to 77 passengers, 145 kWh NMC battery[4]	Level II (AC) - J1772 & Level III (DC) – CCS-Combo
Nuvve charging stations	19 kW level 2 (1 Phase)[5]	J1772

2

4 Blue Bird (2023). Vision Electric Bus. Retrieved from: https://www.blue-bird.com/buses/vision/vision-electric-bus

5 Nuvve (2023). Nuvve PowerPort. High-Power AC charging station. Retrieved from: https://nuvve.com/wp-content/uploads/2022/01/nuvve-powerport-single-phase-spec-sheet-jan2022.pdf

2 Economics of ESBs

A type C 145 kWh battery capacity 2022 Blue Bird ESB was leased for the duration of the 2022-2023 school year. The ESB was fitted with air brakes, a braking system more commonly found in electric vehicles due to their higher weight compared to diesel vehicles. Drivers need to undergo a one-day training to obtain certification for operarting air brake-equipped vehicles. The training expense amounts to approximately $250 per driver.

The purchase cost of a type C ESB is around $400,000 (can vary based on battery size) while a type C diesel school bus costs around $150,000. The economics of ESBs entails higher upfront costs offset by operational savings achieved by lower fueling and maintenance costs throughout the vehicle's lifetime.[6] As ESB manufacturing capacity increases, school boards or bus operators can benefit from lower ESB prices by leveraging joint procurement initiatives through large-scale purchase orders.

A Level 2 AC 19.2 kW Nuvve charger was purchased and installed at the yard for a cost of $5,100. Level 2 chargers are significantly cheaper than faster charging DC capacity chargers. The Level 2 charger operated at a charging rate of 12.5 kW, resulting in a full charge in around 11-12 hours. Although bus drivers typically retain the bus throughout the day, in this case, the driver had to return to the yard between runs in winter months to charge the bus and ensure sufficient range. Overall, the limited charging time available between runs proved to be adequate when utilizing the Level 2 charger, enabling the bus to complete its scheduled routes. [7]

When deploying ESBs at a yard, the size of the deployment may necessitate grid upgrades to accommodate increased power demands. These upgrades involve increasing the power limit at the yard, enabling multiple buses to charge simultaneously without overloading the electrical system. In the context of this demonstration, a single low power Level 2 charger was installed that fit within the existing power limits at the yard, eliminating the need for grid upgrades.

Additional capital expenses can arise from the need to enhance maintenance and repair facilities to support electric buses. These enhancements often entail the installation of specialized equipment and the training of personnel to handle the maintenance and repair of electric vehicles. Furthermore, there are administrative costs associated with planning and implementation, such as conducting feasibility studies, acquiring permits, and coordinating with relevant stakeholders. Since this demonstration project involved only a single school bus, these costs were negligible. Staff members participated in ESB training offered by the vehicle manufacturer, while maintenance needs were addressed by the local dealership responsible for providing the bus.

6 Dunsky (2023). Pathways for Canadian Electric School Bus Adoption. Retrieved from: https://cms.equiterre.org/uploads/CESBA_STUDY_Pathways-for-electrification_May-2023-ENGpdf.pdf

7 Further testing is required in extreme winter conditions to confirm this finding

2 Economics of ESBs

2.1.2 Operational costs

Maintenance costs

ESBs have a much smaller number of components compared to diesel powertrain technology, leading to decreased maintenance requirements. Additionally, unlike diesel school buses, which necessitate routine fluid changes, oil changes, and brake replacements due to frequent stop-and-go operations, ESBs capitalize on this movement pattern using regenerative braking technology. This technology enables the bus to generate energy during these conditions and reduces brake wear by up to five times compared to diesel buses. [8]

The length and size of this demonstration did not permit an estimation of maintenance costs per kilometer travelled as a larger sample size is required. A total of 81 runs were conducted between December 7, 2022, and June 28, 2023, resulting in a distance travelled of 4,000 km. The number of runs completed by the bus over the course of the demonstration was limited not only by maintenance requirements, but by logistical driver changes that resulted in bus downtime despite the bus and charger being functional. Maintenance costs for an ESB are accounted for in this analysis based on estimates from the Argonne National Laboratory Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool, which assume a 40% reduction in maintenance costs for an ESB relative to a diesel bus per kilometer. [9]

Interviews conducted with fleet maintenance personnel indicate that there is a need for capacity building in local technician and dealership expertise for ESB maintenance. Local maintenance expertise would decrease reliance on vehicle manufacturers and reduce maintenance costs (repairs can be conducted locally for a lower price), as well as reduce opportunity costs associated with bus downtime (bus does not need to travel long distances for servicing making repair timeframes shorter).

Maintenance events were tracked during the demonstration and are presented in **Table 2**.

8 US department of Energy (2023). Alternative Fuels Data Center. Flipping the Switch on Electric School Buses: Cost Factors. Retrieved from: https://afdc.energy.gov/vehicles/electric_school_buses_p8_m3.html

9 Argonne National Laboratory (2020). Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool. Retrieved from: https://greet.es.anl.gov/afleet

2 Economics of ESBs

Table 2: Demonstration maintenance events

Issue	Failure Date	Downtime	Required Dealership Servicing
Coolant leak due to loose clamp	November 21, 2022	14 days	Yes
Frozen charging handle	February 27, 2023	1 day	No
12V battery failure	April 10, 2023	2 days	No
Thermal management system coolant error	April 21, 2023	13 days	Yes

Charging costs

Energy consumption was monitored separately in both the charger and the ESB. While operational energy consumption from the ESB showed an average energy intensity across the demonstration of 0.95 kWh/km, the charger consumed additional energy while the bus was parked resulting in an average energy intensity of 1.35 kWh/km across the school year. The higher energy consumption observed through the charger is due to energy transfer losses from the charger into the bus, charging occurring while the vehicle is parked to pre-heat the bus in winter conditions and charging events that occur particularly in winter to keep the ESB battery at a certain temperature while parked.

The cost of charging for the ESB in this analysis is estimated based on the energy consumption of the charger. Utilities in Alberta do not offer time of use pricing, with electricity priced monthly based on weather and market conditions. Based on the historical changes in electricity costs over a 5-year timeframe, an average yearly price of $0.155/kWh is projected and used in this analysis over the 13-year lifetime of the ESB.

Another critical cost associated with charging is demand charges. Demand charges are fees levied by utility companies based on the peak amount of electricity used within a specific timeframe (charged once per month). In the context of a fleet charging multiple ESBs at a yard, demand charges can become significant. As multiple buses are simultaneously plugged in and charging, they collectively draw a substantial amount of power from the grid, resulting in high peak demand. This peak demand triggers demand charges, which can significantly impact the overall electricity costs for the fleet.

Efficiently managing and minimizing these charges is crucial for the financial viability of the electric bus fleet operation. Strategies such as load balancing, smart charging, and implementing energy management systems can help optimize charging schedules and reduce peak demand, thereby mitigating demand charges and ensuring cost-effective operation of the ESB fleet. In the context of this demonstration, demand charges were negligible as the charging consisted of a single ESB with a low power Level 2 charger.

2.2 Revenue sources and financial incentives

2.2.1 Revenue sources

ESB operators have the potential to generate revenue through Vehicle-to-Grid (V2G) technology and Clean Fuel Regulation Credits. V2G enables electric buses to not only draw power from the grid but also send excess electricity back to it when the buses are parked and connected. By participating in V2G programs, operators can offer grid services such as energy storage and load balancing, earning revenue from utilities or grid operators. This can help offset the operational costs of charging the buses and provide an additional revenue stream. However, V2G still faces many regulatory barriers across Canada, with the feasibility of the technology still being explored in the Alberta context. [10] V2G is therefore not considered as a revenue source as part of this analysis.

Clean Fuel Regulation Credits are another avenue for generating revenue. ESB operators can accumulate credits based on the amount of clean energy they use in their fleet. These credits can be sold or traded to other entities that require them to meet their clean fuel obligations. By participating in clean fuel credit programs, operators can monetize their environmentally friendly operations. [11] Potential revenue for operators in Alberta from this program is reduced compared to other provinces as revenue is tied to emission savings potential and the Alberta grid has a higher emission intensity than other Canadian provinces as of 2023. Clean fuel credits were not tracked as part of the demonstration as the operator partner had not joined a Clean Fuel Regulations program. The operator partner is, however, in the process of joining a Clean Fuel Regulations program.

2.2.2 Financial incentives

In 2021, the Government of Canada launched the Zero Emission Transit Fund (ZETF), investing $2.75 billion over five years to support public transit and school bus operators to transition to zero-emission vehicles. [12]

The ZETF provides subsidies that cover up to 50% of the cost associated with the purchase of ESBs and charging infrastructure. The fund also covers costs associated with grid capacity upgrades required at a site for larger deployments. With no provincial programs available, ESB purchases in Alberta rely entirely on funding from the ZETF. Prior to being awarded grants for the procurement of vehicles and infrastructure, the ZETF requires applicants to conduct a planning study to ensure they have planned and allocated sufficient resources for the successful integration of ESBs into fleets. The ZETF covers up to 80% of the costs associated with the planning stage.

10 Electric Autonomy (2022). V2G from commercial fleet vehicles can drive Canada to a green future and the time to act is now. Retrieved from: https://electricautonomy.ca/2022/11/08/v2g-electric-school-buses-canada/

11 Environment and Climate Change Canada (2023). Clean Fuel Regulations. Retrieved from: https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations.html

12 Government of Canada (2022). Zero Emission Transit Fund. Retrieved from: https://www.infrastructure.gc.ca/zero-emissions-trans-zero-emissions/index-eng.html

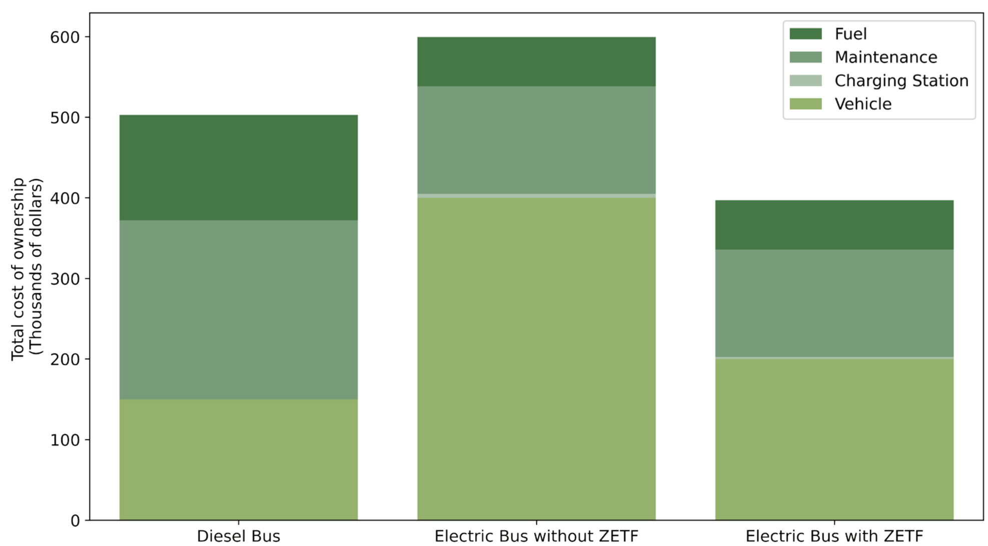
2 Economics of ESBs

2.3 Total cost of ownership comparison with a diesel school bus

A total cost of ownership analysis is conducted by comparing an ESB and a diesel school bus under an operational lifespan of 13 years. [13]

Figure 1 presents the total cost of ownership of a diesel school bus, an ESB without financial incentives, and an ESB with a 50% cost reduction for the bus and charging station under the federal ZETF financial incentive. The TCO of an ESB without access to ZETF funding is 19% higher than that of a diesel bus due to the significant difference in the capital cost of the ESB. On the other hand, the TCO of an ESB with access to ZETF funding is 21% lower than that of a diesel bus, highlighting the effectiveness of the federal financial incentive in making the business case for ESBs. It is important to note that TCO analysis results can vary depending on the financial assumptions used. Conducting a sensitivity analysis by adjusting factors such as diesel prices and electricity rates can help identify the impact of various components.

Figure 1: Total Cost of Ownership of each technology after 13 years



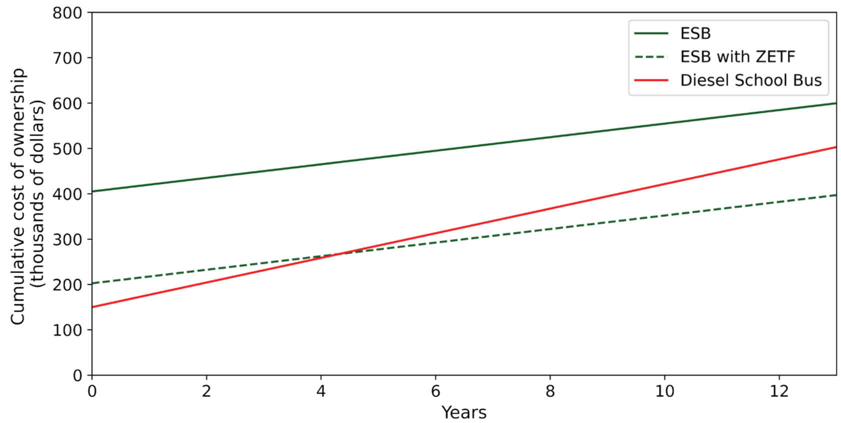
13 Buses are assumed to operate 22,500 km yearly. Diesel bus efficiency is assumed at 33.13 L/100 km and a diesel price of $1.35/L is assumed based on the average retail cost of diesel in Calgary over the past 3 years as of 2023 (With no consideration for an increase in diesel prices over time through carbon pricing)

2 Economics of ESBs

As was mentioned earlier, the economics of ESBs entail higher capital costs that are offset by operational savings through lower maintenance and fueling costs throughout the lifetime of the vehicle. It is therefore possible to estimate the number of years required for an ESB to breakeven with a diesel bus from a total cost of ownership perspective based on yearly costs.

Figure 2 presents total cost of ownership curves over 13 years of a diesel school bus, an ESB without financial incentives, and an ESB with a 50% cost reduction for the bus and charging station under the federal ZETF financial incentive. The reduction in incremental capital costs by 50% through the ZETF fund would reduce the breakeven numbers of years from 20.9 years to 4.3 years. In other words, an Alberta operator can reach cost parity with diesel buses after operating an electric school bus under similar deployment conditions for around 4.3 years with the federal ZETF financial incentive. On the other hand, an operator would need to operate an ESB for 20.9 years to reach cost parity with a diesel school bus from a TCO perspective without the financial incentive (Green and red lines to intersect in Figure 2). The average lifespan of a school bus is 13 years.

Figure 2: Cumulative Cost of Ownership of each technology over 13 years



It is however important to note that the cost of financing is not included in the analysis as it is very dependent on the size and financial strength of the fleet operator purchasing the buses. The cost of financing electric vehicles tends to be higher than diesel vehicles due to the uncertain resale value price of ESBs at this early stage of the transition. Financial lenders are not able to accurately predict the resale value of ESBs in case of default on the loan. In the present early adoption stage, where resale values of ESBs are still undetermined, the implementation of ESB specific financing programs can play a vital role in facilitating purchases. The Canada Infrastructure Bank provides such financing through its zero emission buses initiative.

Moreover, the TCO and the time needed to recover costs can vary for a larger deployment due to the following factors. The operational expenses of ESBs in larger deployments, from a single yard requiring simultaneous charging, are subject to demand charges that increase operational costs. Additionally, accommodating a larger fleet often necessitates utility upgrades and more expensive higher power charging station infrastructure expenses. These additional expenses will likely extend the breakeven period to a longer timeframe. However, operators could capitalize on existing financial incentives by starting with small deployments and limited infrastructure costs. This approach allows them to train their staff on the new technology and take advantage of the prominent economic benefits achieved by financial incentives while further cost reductions are achieved through the recent significant investments from the industry that will promote economies of scale in ESB manufacturing.

2.4 ESBs and driver satisfaction

The transition to ESBs introduces features that could play a role in improving driver comfort, including reduced noise, vibrations, and fumes, as well as notably smoother acceleration.

These observations were supported during multiple driver interviews, where the consensus was that the electric bus provided a superior driving experience compared to diesel buses. Moreover, the ESB serves as a source of pride for the drivers, as they recognize their organization's progress towards a net-zero future.

Nevertheless, the drivers also noted a major inconvenience with the ESB. It is common practice in the school bus industry for drivers to keep the bus with them throughout the day and only return it to the yard after their afternoon run. However, on most routes, the bus was required to return to the yard to be charged in between the morning and afternoon run to ensure enough range. These logistical changes might, in turn, have a detrimental effect on driver satisfaction. An alternative solution for certain routes would involve implementing an auxiliary diesel heater, which can extend the vehicle's range and eliminate the need for mid-day charging.

More research is needed to determine the overall impact of a transition to ESBs on driver satisfaction. Should this transition on the whole have a positive impact, this could provide benefits to operators.

Summary and key points

- In the Alberta context, the TCO for an ESB over a 13-year period is 19% higher than that of a diesel school bus. However, when factoring in the federal financial incentives aimed at capital costs, the TCO of an ESB is 21% lower compared to a diesel school bus.

- The business case for ESBs entails higher upfront costs offset by operational savings throughout the vehicle's lifetime. Financing programs are crucial in enabling fleet operators to overcome the initial higher capital cost of ESBs, particularly in the initial stages of the ESB transition where financial lenders charge higher interest rates for ESBs relative to diesel school buses due to the uncertain resale value of the vehicle in case of a fleet operator default.

- The economics of ESBs varies based on the size of a deployment. Operators could take advantage of the limited infrastructure cost requirements of small deployments to start training the staff on the technology in advance of further cost reductions expected in the sector through the recent significant investments from the industry that will promote economies of scale in ESB manufacturing.

- Regulatory and technological barriers to potential revenue sources such as V2G should be explored further in the Alberta context.

- Certain factors, such as reduced noise and fumes, contribute to a more pleasant driver experience with ESBs. However, on certain routes, operators may have to decide between sending drivers back to the yard in between the morning and afternoon run for charging, or using an auxiliary diesel heater that would extend vehicle range. Routes requiring drivers to return to the yard between runs might have a negative impact on driver satisfaction. More research is needed to determine the overall impact of a transition to ESBs on driver satisfaction.

For more information, please contact:

Steve McCauley | SENIOR DIRECTOR , POLICY
smccauley@pollutionprobe.org

Cedric Smith | DIRECTOR, TRANSPORTATION
csmith@pollutionprobe.org

Marc Saleh | LEAD CONSULTANT
msaleh@mobilityfutureslab.ca

Rebecca Fiissel Schaefer | CEO & CO-FOUNDER
rebecca@rfs.energy

Christina Pidlaski | SENIOR CONSULTANT
christina@rfs.energy

Funders:

Scotiabank
ALBERTA ecotrust

Implementing Partners:

Pollution Probe
RFS ENERGY
Mobility Futures Lab
SOUTHLAND
safely home