



# Electric School Bus Feasibility Study



*A Preliminary Report  
for*  
**School District 64 (Gulf Islands)**

*prepared by*  
**Salt Spring Community Energy**  
*September 2019*

## Acknowledgements

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Thanks to John Cameron for supplying photographic images of SD64 school buses, and to Kjell Liem for images of Lion buses. Solar array image by Ron Watts. Stock images (noted) are from iStock. Document layout by David Denning.

This study was preceded by a previous investigation and successful implementation of public bus transportation on Salt Spring Island. We would like to acknowledge the dedicated work of Peter Lamb, who carried out a feasibility study for the public bus transit system, which helped to initiate this study. Members of the Salt Spring Community Energy Society involved in this study included Kjell Liem, Ron Watts, Tom Mitchell, Peter Lamb, Brian Smallshaw, Ian Mitchell, and David Denning with the assistance of Wade Cherrington and Rob James.



*Salt Spring Community Energy is a group of local citizens concerned about sustainability, encouraging renewable energy and clean technology development on Salt Spring. Our strategy includes developing partnerships with local organizations to create renewable energy projects that will inspire and educate our community to embrace renewable energy and a rapid transition to a low carbon economy. We are a registered non-profit society.*



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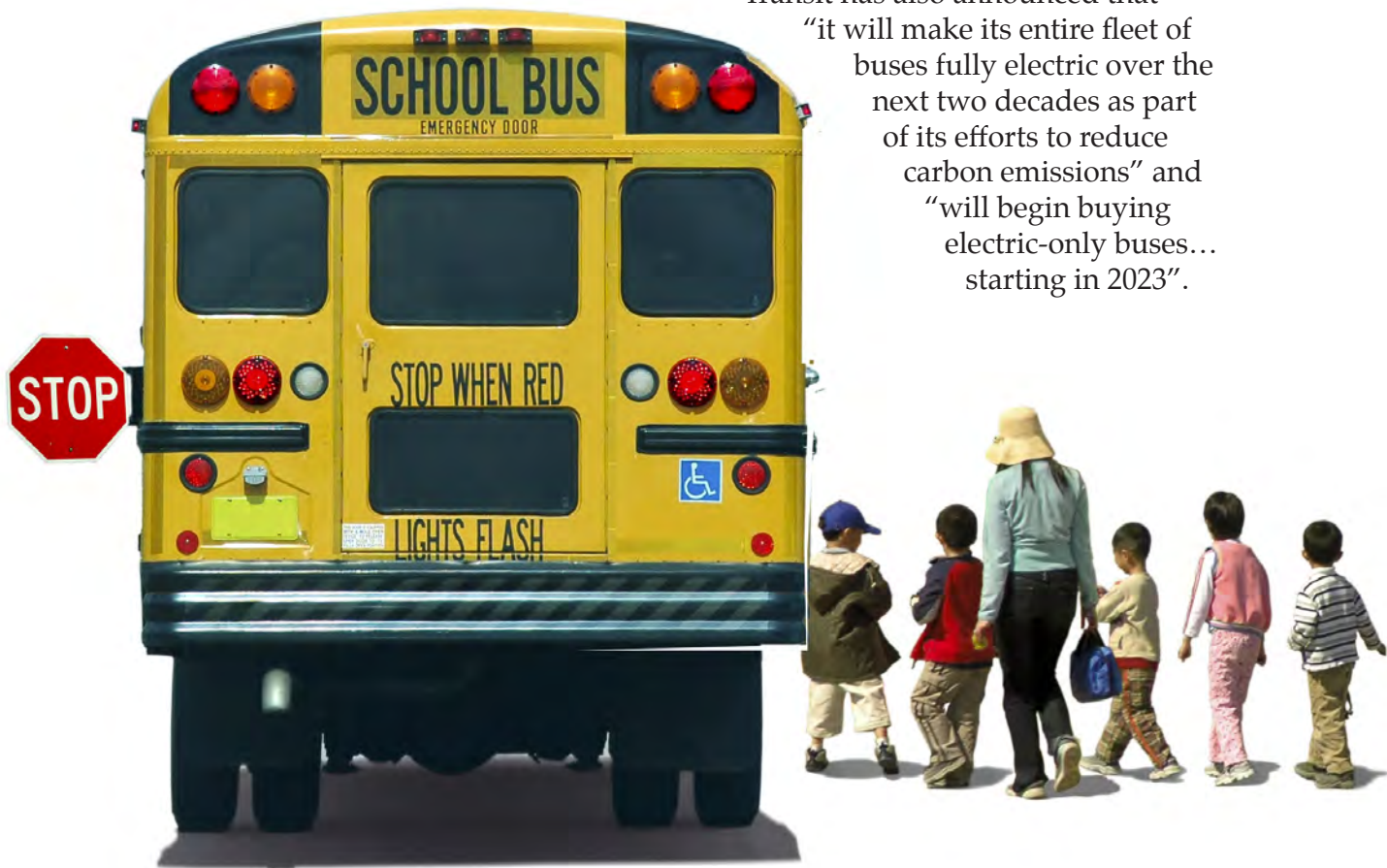
## Executive Summary

At a recent school bus safety conference in British Columbia a staff member from the Ministry of Transportation pointed out what would seem to be the obvious: “our children are the most precious cargo we transport”. With the growing recognition of the climate crisis and the shrinking window of opportunity with which society needs to take significant action to prevent runaway global warming and catastrophic ecological, economic, and infrastructure disruption it’s this precious cargo that challenges us to take swift action to lower greenhouse gases. As student Greta Thunberg says, “This is the biggest crisis humanity has ever faced. This is not something you can like on Facebook”.

It is in this spirit that Salt Spring Community Energy has undertaken a feasibility study for electric school buses in our community. Electric cars have been adopted enthusiastically on Salt Spring Island with over 230 privately owned electric cars in a population of 10,500 people. Now is the time to turn our attention to vehicle fleets, and to public transportation and school buses. By replacing polluting fossil fuel vehicles with electric vehicles powered with clean energy, we can mitigate the damaging effects of greenhouse gas pollution and help to create a safer future.

The BC government has recently acknowledged the value of updating public transit with joint federal and provincial funding of \$79 million for bus systems across the Province. BC

Transit has also announced that “it will make its entire fleet of buses fully electric over the next two decades as part of its efforts to reduce carbon emissions” and “will begin buying electric-only buses... starting in 2023”.



### Key Goals For The Study

- *To inform decision makers regarding the potential for electric school buses as a healthier and cost saving option for School District 64 (Gulf Islands)*
- *To provide the economic and social analyses needed for decision-making about electric school bus implementation*
- *To provide an analysis of the operational, maintenance and equipment issues involved with electric school bus implementation*

The future of electric school buses looks bright. Demand is growing and manufacturers are challenged to keep up with the growing market. Several manufacturers based in Canada that now export product to the US. Quebec OEM's are supported by Export Quebec showing their leadership in the global clean energy economy and clean job creation. Operating costs of electric school buses are significantly lower than for diesel buses. In fact, life cycle analyses, combining both capital costs and operating costs, over the expected life of the buses) now indicate that electric bus costs will soon be at parity or lower in comparison with those of diesel buses.

Few pilot studies for electric school buses have been carried out. However, with the uptake in sales pilot projects are being undertaken every year across North America and worldwide. We believe that School

District 64 (Gulf Islands) (SD64) is a particularly good District in which to study the implementation of electric buses. Our routes are shorter than average so range is not a significant issue. With only eight routes on Salt Spring Island, we have the option of testing the bus across a variety of terrains, and getting feedback from all of the District's on-island bus drivers. With our school calendar of 4-day weeks and 155 instructional days per year, our electric bus batteries will have fewer cycles per year and thus will likely outlast warranties providing good long-term value for the technology.

Our analysis in this study shows significant annual savings in fuel and maintenance expenses and a reduction in GHG emissions for electric school buses. We estimate an annual savings of about \$50,000 for the total school bus fleet in SD64. Electric buses are quieter, smoother riding, and safer overall than are diesel buses. Electric school buses provide significant health benefits over diesel buses which usually continue to idle around groups of children while they are loading or waiting at stops.

In light of the climate emergency and our need to drastically reduce greenhouse emissions, as well as our need to provide a safer, healthier future for our children, the case for rapid electric school bus adoption is compelling.



## Background

In 2014, the Board and Administration of SD64 formed a partnership with the Salt Spring Community Energy Society (SSCE) to create the Gulf Islands Secondary School (GISS) Solar Scholarship Project. Donations from the community and granting agencies were used to build an 84-panel, 21kW solar PV array on the high school gym. The electricity bill savings provided by the PV array to the District fund "Solar Scholarships" for GISS graduating students. In the last four years, seven graduating students have received a total of over \$9500 in sun-generated scholarships. This 30-year legacy is an excellent model of moving toward a low-carbon sustainable future,

but is only a first step in the tremendous challenge of reducing greenhouse gas (GHG) emissions 50% by 2030. SSCE appreciates the need to scale up our community's journey toward net zero GHGs by 2050 by focusing on transportation.



## Introduction

This study was initiated by the Salt Spring Community Energy Society in the fall of 2018. Agreement in principle from the Board and Administration of SD64 was provided in October 2018. The study was funded by the Society through the GISS Solar Scholarship project. It involved many hours of volunteer research and writing by members of the Society.

Due to the urgency of the climate crisis it is imperative to reduce GHG emissions in all sectors. Transportation and energy efficiency are the most easily approached sectors for school districts.

Declarations of a climate emergency by multiple levels of government (and by

over 800 jurisdictions around the world, including the Government of Canada, Capital Regional District, and Islands Trust) emphasize clearly the need to act quickly to reduce carbon emissions.

The Province of British Columbia has established a zero emissions mandate for new vehicles. By 2030 the province will bring emissions from transportation down by 6 million tons. By 2040 100% of new light-duty vehicles sold will be zero emission. Heavy duty vehicles, which includes school buses, are also a target for further emission reductions. In the spirit of responding to the climate crisis, the District can provide leadership through early electric bus adoption.

## Overview Of Current Sd64 School Bus Fleet

The SD64 bus fleet includes 12 working buses and a spare that is currently in use. None of the buses is equipped for handicap-accessibility. District buses travel a total of 140,000 km/year or about 14,000 km/year for an average route.

Yearly fuel use by District buses totals 40,213 litres for an average fuel efficiency of 3.5 km/litre (or about 10 mpg). The fuel used is diesel, which is also called biodiesel due to mandated 5% renewable fuel content. This is not to be confused with 100% recycled vegetable oil which is sometimes used as a diesel replacement. Buses are refueled at the maintenance plant by an off-island bulk fuel delivery truck.

### ***SD64 operates three sizes of buses with a total of four seating configurations:***

- 5 buses have a 71-person capacity (Used for elementary students) (Type C)
- 2 buses are 24-person capacity (Type A)
- 5 buses are 84-person capacity (Type D)
- 1 bus is 46-person capacity (Type C)

Recent annual maintenance costs (includes service bay and heavy duty mechanic on staff for routine maintenance) for the entire fleet amounted to \$0.18/km.



## Bus Replacement Program

The requirement from the Ministry of Education is to replace diesel buses at 300,000 km. The replacement program, funded by the Ministry, is implemented in collaboration with the Association of School Transportation Services of British Columbia (ASTSBC). The procurement process is not a “bulk purchase”, rather the ASTSBC secures standing offer prices for school buses. Annual budget for bus replacement is currently 13 million dollars.

In general, buses in SD64 have lower mileage than the Provincial average due to the shorter four day school week and the shorter service routes they run. With an average annual distance travelled of about 14,000 km, District school buses should have a 20-year life but will likely be replaced on a planned schedule. On average, SD64 replaces one bus every two years.



## Electric School Buses

### Battery Electric Bus Technology/History

From the early 1900s on, electric trams and trolleys were widely used in cities around the world, including Vancouver and Toronto. The City of Vancouver still uses 262 electric trolley buses with overhead wires. Vancouver's first trolley buses were owned and operated by the utility BC Electric and were made by a Canadian company, New Flyer, in Winnipeg. The shift to battery electric buses began in Shanghai China in about 2009. In September 2010, Chinese automobile company BYD Auto began manufacturing the BYD model K9.

The resurgence of interest in electric buses is linked to the need to address the climate crisis by replacing fossil fuel use in vehicles on a large scale. Worldwide, 27% of GHG emissions come from the transportation sector. In British Columbia (B.C.), the transportation sector contributes nearly forty percent of the total GHG emissions. On-road commercial vehicles such as medium and heavy-duty trucks and buses, account for more than one-third of these transportation-related GHG emissions. Bus fleet electrification can also drastically reduce the serious

particulate pollution problems in large cities that results in 6.5 million deaths a year worldwide. The cost of pollution-related health problems in Canada in 2015 hit at least \$39 billion — equivalent to about \$4,300 for a family of four<sup>1</sup>. Diesel vehicles are significant contributors to this problem.

Successes in China are pointing the way toward broad implementation. The city of Shenzhen, for example, has over 16,000 electric buses in its all-electric bus fleet. In January 2019, the electric bus manufacturer, BYD, produced its 50,000th electric bus.

Locally, the BC government has recently announced joint Federal/Provincial funding of \$79million to replace 118 transit buses. This commitment includes funding for 10 new electric buses. And BC Transit has now committed to purchasing only electric buses for large bus replacements in 2023 and for all of its buses to be electric by 2040.

### School Bus Community Use (other communities)

Diesel and gas-powered school buses are a logical choice for rapid replace-



ment with electric school buses. There are 480,000 school buses in the United States alone. In Ontario, there are 18,000 school buses, providing 300 million school rides each year. Given their widespread use and key roles in communities, replacing fossil fuel-powered school buses with electric powered buses will make a major impact in the transition to net-zero transportation.

The adoption of electric school buses is growing rapidly in many places. School districts in Quebec and Ontario, California, New York, Illinois and Indiana, among others, have purchased or set-aside funds for battery-electric school buses. Several hundred electric school

buses are in service, or on order in North America.

### Options available to meet SD64 needs.

Although there is a thriving electric bus manufacturing sector in China, at this time we favour pursuing Canadian-made buses, with those made in the U.S. as a second option. We looked at all Canadian and U.S. companies making electric buses.

At the time of this report, two Canadian companies are manufacturing/marketing a Type A electric school bus – Lion Electric Company from Saint-Jérôme, Québec and Bluebird is making the “MicroBird” in Drummondville, also in Quebec. We also looked at GreenPower Bus Company because they are making electric buses including school busses, have their headquarters in Vancouver, and they have expressed interest in working with local Districts. Unfortunately, GreenPower school buses have not yet qualified for Ministry of Transport D250 certification, at the time of this writing. Trans Tech, from the US also makes a Type A electric school bus.

Bluebird, Lion, GreenPower Bus, Transtech, Navistar, Thomas Bus all make larger electric school buses (see appendix A).

### Performance

The most important aspect of electric school bus implementation is its ability to displace significant amounts of greenhouse gas emissions over the life the bus, while at the same time saving thousands of dollars in fuel and maintenance costs. According to the US Department of Energy electric vehicles convert about 59%–62% of the electrical energy from the grid to power at the wheels. Conventional gasoline vehicles only convert about

17%–21% of the energy stored in gasoline to power at the wheels, therefore electric school buses are 2-4 times more efficient. Electric buses are robust. They have significantly fewer moving parts and have significantly lower maintenance costs and breakdowns. An advantage of buying a Canadian-built bus is that service and support might be more accessible.

Since operating electric school buses depends on reliable charging, electric grid reliability is a consideration. School Districts may have to adjust charging options and operational expectations once partial and full fleet electrification becomes standard. Buses will be charged after school and at night to be ready for the next day so an overnight outage will disrupt the next school day even if power is restored in time for the school to open. At times, it may become useful, or necessary, to recharge a bus in the midday break between trips. The technology is

available to store enough electricity to charge a bus or buses when the grid is interrupted over a typical overnight charge cycle. Battery banks are expected to play a larger role in grid operation over the next few years.

### **Maintenance capacity & training; Driver training**

Phone discussions with Canadian manufacturers, Lion Electric and Green Power Bus indicate their capacity and expectation to train drivers and mechanics. Other bus manufacturers such as Blue Bird and Thomas are supported by a local dealer exclusive to the OEM, located in Surrey, BC. Maintenance support, maintenance training, driver training and parts are available locally.

Lion Electric has an electric school bus maintenance tool kit available for under \$500.



## Electric Charging Infrastructure

Electric bus charging requires dedicated electrical circuits, battery chargers; and, at fleet scale, can make good use of an electric vehicle energy management system which can optimize fleet charging to a schedule for energy demand capacity or time of use billing needs. Charging and electrical infrastructure items are sometimes referred to as Electric Vehicle Supply Equipment (EVSE).

Electric buses have different charging requirements depending on the bus manufacturer and models. Most manufacturers use 100A level 2 (208/240VAC) chargers to service 19.2kW on board chargers. Green Power buses use level 2 or DC fast chargers. Their Type A bus uses one 10kW charger. Their larger models use two 10kW chargers; BYD uses proprietary 80kW chargers.

High voltage DC fast charging is not yet standard for electric buses as the high cost of these chargers has hindered implementation. There seems to be little operational advantage to have a DC fast charger for the District's buses as level 2 charging at 19.2 kW is sufficient for an overnight charge. At some point it may be helpful to have a local DC fast charger available and reserved for electric school buses that bring off-island students for sporting events or other extra-curricular activities



### Charger options available:

Level 2 chargers could be: Sun Country Highway SCH100 for 19.2kW of charging at 100A at a cost of \$2,799Cdn For more expensive DC fast charging consider: ChargePoint Express 250, 62.5 kW, \$35,800USD (see: <https://smartchargeamerica.com>)

Specialty chargers can also facilitate Vehicle to Grid (V2G) technology. V2G technology allows the battery to feed power back to the grid for grid management services, or as an energy supply in emergency events. Some utilities provide a payment for access to battery power,

which can help reduce the overall cost of the buses. This technology is expected to become available on electric school buses, most notably BlueBird products. We don't, however, expect BC Hydro to be offering to take advantage of this technology in the near future.

### Location:

Due to the existing electrical infrastructure, security, and staffing concerns it was determined that the bus compound at the Maintenance Plant Services on Rainbow Rd. was the preferred location for charging infrastructure. Alternative charging locations were discussed with the thought that the infrastructure might be able to serve the community as well as the district but this idea was ultimately rejected. This will allow for overnight charging at the Plant Services yard and mid-day charging if it is necessary.

A survey of the maintenance plant's electrical infrastructure revealed that parking for a Type A mini-bus and a 100A charger would be relatively inexpensive to implement with a suitable charger costing \$5,000 to purchase and install. In contrast to charging a Type A mini-bus, providing charging infrastructure for a larger bus will require new wiring and trenching under pavement. The construction will require appropriate scheduling, as it could disrupt daily maintenance operations.

Full fleet charging infrastructure for the school district would require 1000A or more of electrical capacity requiring a new service drop at a rough estimate of \$200,000-\$300,000 investment.

### BC Hydro Rate Structure:

The Maintenance Plant where the school buses are serviced and stored is on the BC Hydro Large General Service Rate. We have noted the components of that rate here for convenience. This is a very complicated and technical rate, which is difficult to understand. We modeled \$0.10/kWh in our financial analysis for convenience.

BC Hydro has filed an application with the BC Utilities Commission for a special rate for fleet charging. They are proposing to eliminate the demand charge for the Large General Service rate, which would reduce that cost of charging a school bus by as much as half depending on the power rating of the chargers used.

### Resources:

Plug in BC has links to planning & hosting charging stations. Download the Medium and Heavy Duty Fleet Procurement Analysis Tool as an Excel file here:

<https://pluginbc.ca/resource/medium-and-heavy-duty-fleet-procurement/>

West Coast Electric Fleets is an initiative of the Pacific Coast Collaborative (PCC), a joint initiative of California, Oregon, Washington, and British Columbia to accelerate a vibrant, low-carbon economy.

#### BC Hydro Charging Rates (2019)

- Energy charge: \$0.0606 per kWh
- Demand charge: \$12.34 per kW
- Power Factor charge is applicable below 90%
- Basic Charge: \$0.2673/day
- GST



## Funding Options

School Bus funding is the responsibility of the Ministry of Education. The Ministry of Education works with the Association of School Transportation Services BC for procurement services. With the Provincial Government's focus on climate action, the Ministry of Energy, Mines and Petroleum Resources, through the CleanBC program have an interest in school bus electrification. BC Hydro may also have an interest since they have been involved with public charging infrastructure and electric transportation needs electricity service.

### Ministry of Education

The Ministry of Education funds school bus procurement in the amount of \$13M per year. The budget targets are not set in as they have acknowledged that they are working from incomplete data that is to be provided by the school districts. The ministry is expecting to begin some electric school bus funding in year 2020-21.

### Ministry of Energy, Mines and Petroleum Resources

The Provincial Government has set a climate action target to reduce provincial GHG emissions to 40% below 2010 levels by 2030. CleanBC, the Provincial climate strategy, outlines actions to meet the targets. Modeling for CleanBC indicates that by 2030, 94% of bus purchases will be

zero-emission. The Ministry, through the Clean Energy Vehicle Program, Specialty Use Vehicle Incentive (details below) already offers incentives to support electric buses. To support CleanBC transportation commitments, the Clean Transportation Branch within the Ministry of Energy, Mines and Petroleum Resources is looking at the heavy-duty vehicle sector, including school bus fleets. To this end, Budget 2019 included \$10 million in funding for support of zero-emission options in medium-and-heavy-duty vehicles, including trucking, port and airport equipment, buses, and marine vessels. These programs are still under development and expected to launch later in 2019, but the programs could include specific support for piloting electric school buses to inform electric school bus adoption more broadly.

### Government Subsidies:

Provincial rebate: Specialty Use Vehicle Incentive Program:

<https://pluginbc.ca/suvi>

MSRP below \$300,000: \$20,000

MSRP above \$300,000: \$50,000

The federal government released EV rebates May 1, 2019 for light duty vehicles; however there are no current federal rebates for large duty vehicles such as electric school buses.

### Charging Incentives:

The Provincial Government has a subsidy program for commercial/business use charging. It is currently out of funds but may be available in the future.

There are federal (NRCan) incentives available now for public EV charging under the Zero Emission Vehicle Incentive Program. This offers up to \$5,000 per station for Level 2; up to \$15,000 for DCFC  $\leq 25$  kW; up to \$50,000 for DCFC  $> 25$  kW. Public charging at schools may present a viable option for on route charging in certain circumstances, especially if located where school buses are able to park. As mentioned before, there may be times when off island sports teams may be needing to charge a school bus while visiting for an event.

### Community Funding:

Grant funding may be possible from Salt Spring Island Foundation (spring and fall application intakes) to charitable organizations like the Gulf Islands Educational Trust Fund. Mid-Island Coop, Victoria Foundation also grant funds.

### Public Fund-raising Campaign

Salt Spring Community Energy can assist with grant applications and potentially a fund-raising project through the Gulf Island Educational Trust to provide charitable tax receipts for donors.

### Other:

- Green Municipal Fund offers smaller scale funding for pilot projects and larger scale funding for capital projects (low interest loan + 15% grant) <https://fcm.ca/en/funding>
- Gas tax through a CRD grant application



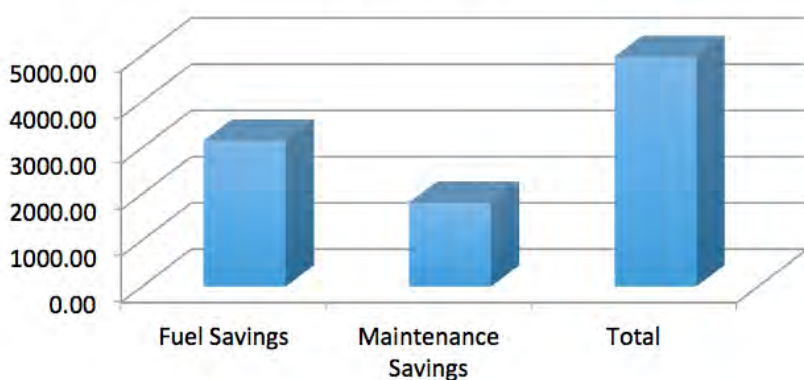
## Comparative Financial Analysis

A key financial feature of moving to a fleet of electric buses is the significant savings in operating costs. Specifically the relative cost of “fuel” from purchase of diesel fuel for the existing fleet, to the cost of electricity for recharging electric school buses, and from lower annual maintenance expenses. An important indirect savings for electric buses is the reduction in carbon taxes. Vancouver’s Translink estimates that life cycle cost parity -which

factors in the purchase cost plus operating and maintenance costs- will be achieved by 2023 for transit buses.

In order to provide an estimate of these annual savings, a spreadsheet model was prepared to compare the relative operating costs as well as the contribution to the Salt Spring Island legislated targets for greenhouse gas (GHG) emissions reduction.

## Average Annual Operational Savings in Dollars



Other operating costs that would be common to both types of buses, such as annual driver wages, insurance, licensing and administration are, at this stage, assumed to be the same. The prices for electric buses will, of course, depend on specifications, especially battery capacity, and are expected to come down as production volume increases and battery prices fall.

There will be additional up front costs associated with a transition to electric buses, including driver training (unless provided by the bus manufacturer), special tools and service equipment. In addition, electric charging stations will need to be purchased and installed at suitable locations as noted above.

Calculations were based on all the ten school bus routes currently in operation in the District as shown in a spreadsheet in Appendix B using 155 days of operation each year (based on SD64's four day week).

On Salt Spring, route distances vary from 69km to 129km while on Galiano/Pender Islands, routes vary from 40km to 64km.

It is estimated that replacing a diesel bus with an electric bus reduces GHG emissions by 9 tons of CO<sub>2</sub>e/year/bus. Replacing the entire SD64 bus fleet with electric buses would save over 90 tons per year.

Finally, the spreadsheet allows for a test of the sensitivity of the analysis to a range of reasonable assumptions. For example, a 10% increase in diesel fuel price results in a \$480/year increase on average in the electric bus cost savings. A 25% decrease in diesel bus fuel efficiency results in an approximately \$1600/year increase in electric bus cost savings.

### **Key Values Researched or Estimated in the Analysis**

- Cost of diesel fuel and electricity rates
- Fuel efficiency in km/litre for diesel and km/kWh for electric drive
- Relative costs for annual maintenance services in \$/km
- GHG emission rates for diesel and electricity use
- Number of days/year that school buses operate



## Social Considerations

There are important social benefits from the transition to electric buses from diesel-fueled buses that need to be considered in any purchasing decisions.

Diesel buses generate significant air pollution through exhaust particulates which impact all residents and visitors to the island and especially those vulnerable to the poor air quality. The public health costs arising from this air pollution and the resulting impact on taxes are important factors to be considered in any comparison of diesel and electric buses, (see below).

Electric school buses provide a cleaner, healthier and safer environment for the children using the buses particularly during idling at pick-up and drop-off places. The significant contribution provided by electric buses to lowering our island carbon footprint also helps to reduce the broader long-term risks of climate change on the island, including flooding, wildfires and sea-level rise.

Research accumulating for decades has established diesel exhaust as an acute and chronic health risk along carcinogenic and non-carcinogenic dimensions of human health. Children are at higher than average risk to these exposures, including but not limited to respiratory illness and lung cancer. Multiple independent studies have found that diesel school bus in-cabin exposure levels for several key health-critical diesel exhaust components may rise significantly above background pollution levels for a variety of vehicle types and ages.

The findings were strong enough to prompt follow-on attempts at various mitigation retrofits aimed at reducing in-cabin exposure enough to quantifiably reduce risk. These studies of course imply that the ultimate retrofit of bus electrification would save lives and improve general health at least as well or at a greater level than any partial reduction. We believe health considerations favor electrification and that will be particularly compelling for parents, children, and drivers.

*More information on this issue is given in Appendix D.*



## Conclusions

Electric buses provide important social and health benefits compared with the existing diesel school buses.

Electrifying the buses assigned to the longest routes will save the most money.

There are established Canadian manufacturers of electric school buses with proven operational experience.

The BC Government and BC Transit are committed to purchasing electric transit buses.

Expanded government financial incentives would stimulate the purchase of more electric school buses in BC and support their GHG emission reduction targets.

## Recommendations

1. ***That the District work with Salt Spring Community Energy to discuss with the Ministry of Education and the Ministry of Energy, Mines and Petroleum Resources on the potential for a pilot electric bus system in School District #64.***
2. ***That the District make use of West Coast Electric Fleets support and become a partner by pledging to incorporate Zero Emissions Vehicles (ZEVs) into its fleet of school buses.***
3. ***That the District press for all future replacement school buses in the District to be electric.***
4. ***That Salt Spring Community Energy support School District #64 in an assessment with BC Hydro of a credible electric bus charging infrastructure.***

## Appendix A: Electric Bus Manufacturers & Specifications

### Canadian Manufacturers:

#### 1. The Lion Electric Co.

921, chemin de la Rivière-du-Nord  
Saint-Jérôme (Québec) J7Y 5G2  
450 432-5466 | 1 855 546-6706

- Bus available (Fall, 2018) – The LionA Electric Type A, electric school bus
- Range: Lion Type C buses have 4 different ranges: 100km (\$270k), 150km (\$305k), 200km (\$200k) and 250km (\$375k). Type A has 2 different ranges: 120km (\$270k) and 240km (\$340k)
- Electric motor offers up to 129 kWh (200 HP)
- Embedded 19.2 kW charger
- Safe and high-performance batteries from LG Chem
- Fully assembled by Lion (chassis, battery packs, body)
- Up to 26 passengers
- Cost – Can\$265,000 (120 km configuration)
- Lion C up to 56 passengers \$265,000 and up.

#### 2. GreenPower Bus

Suite 240-209 Carrall Street  
Vancouver, BC V6B 2J2  
Phone: (604) 563-4144  
Email: [info@greenpowerbus.com](mailto:info@greenpowerbus.com)  
Phone: 604-563-4144

- (At the time of this document publication, GreenPower school buses are not Ministry of Transportation D250 approved. This Vancouver Company makes a Type D School electric school bus. The Company would like to work with the District to consider options.

### U.S. Manufacturers:

#### 3. Blue Bird Buses

Electric MicroBird G5 is made in Quebec. “For the Micro Bird G5 Electric, we partnered with ADOMANI and Efficient Drivetrains, Inc. (EDI). Leading-edge electric drivetrain system and technology allow the bus to meet zero-emissions standards.”

- Charge Time: 6-8 Hours
- GVWR: up to 14,500 lbs.
- Capacity: up to 30 passengers
- Range: up to 160km
- Blue Bird has full line of larger buses

#### 4. Trans Tech Electric School Bus

- Trans Tech builds the eSeries on a Ford E-450 chassis in partnership with Motiv Power Systems
- Available on Ford E-450, 14,500 lbs GVWR chassis rating
- Range up to 135km, top speed of 60 mph
- 106 kWh battery pack capacity
- On-board diagnostics standard
- Wheelchair lift control and interlock support
- Various seating configurations available
- Financing options available

#### 5. Thomas Bus

- Has the eC2 Jouley, Type C bus. 150km range

#### 6. Navistar

- Has a prototype International / Volkswagen Type C bus. Able to leverage European technology.
- Will be able to price Q4 2019 (Oct 15). Could expect delivery next year.

(More information needed)					
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## Appendix C: Regulations And SD64 Policy

The Transportation Ministry inspectors rely on OEM's to meet the regulations. School buses in Canada must conform to CSA standard D250. Manufacturers must comply with 2016 version D250-16. The relevant Transport Canada page on the subject is at:

[https://www.tc.gc.ca/en/services/road/school-bus-safety/about-school-bus-safety-canada.html#\\_Recent\\_regulatory\\_updates](https://www.tc.gc.ca/en/services/road/school-bus-safety/about-school-bus-safety-canada.html#_Recent_regulatory_updates)

BC Statute is here:

[http://www.bclaws.ca/civics/document/id/loo89/loo89/26\\_58\\_05](http://www.bclaws.ca/civics/document/id/loo89/loo89/26_58_05)

The permit to operate a school bus can be suspended if the vehicle does not meet the D250 standard.

Relevant SD64 policies include policy 410 Student Transportation, which was last revised in 2007 and is currently under revision. SD 64 values sustainability as mentioned in Policy 100 Mission, Values, Commitments, Goals: "Sustainability –

we honor interdependence with each other, our communities and our environment; we foster understanding of sustainability concepts and sustainable ways of life; and we promote and facilitate sustainability at personal, school and district levels". Procedures for Policy 100 include:

"promoting sustainability by:

- cooperating with the community in supporting and promoting environmental and ecological awareness, literacy, and sustainable practice
- promoting the integration of environmental themes across the curriculum
- considering environmental impacts when purchasing, utilizing and disposing of material resources
- practicing energy conservation in all district facilities"

SD64 has Policy 410 Student Transportation which was last revised in 2007, which is currently under revision.

<https://sd64.bc.ca/wp-content/uploads/2019/05/policy-410-90508.pdf>

## Appendix D: Public Health Considerations

Diesel exhaust (DE) is a chemically complex mixture of components. It directly contributes to ambient, on-road and in-cabin concentrations of NO<sub>2</sub>, O<sub>3</sub>, and PM<sub>2.5</sub>, each of which are known to have well-established chronic and acute health impacts [9]. In controlled experiments, DE exhaust has been found to be carcinogenic to humans (particularly lung cancer) and it is classified as a Group 1 carcinogen by the International Agency for Research on Cancer [1]. In addition, multiple non-carcinogenic health effects have also been established; drawing from [1] these include:

- “(1) adverse cardiovascular outcomes following chronic exposure
- (2) adverse reproductive and developmental effects and
- (3) central nervous system effects following acute exposure to DE.”

The healthy development of respiratory physiology through childhood has been shown in multiple studies to be placed at risk by exposure to DE as a whole or by its components. In one study, asthma onset risk was appreciably increased as a function of NO<sub>2</sub> exposure in a study of children ages 10-18 [6]. NO<sub>2</sub> is present in diesel exhaust at a higher level than gasoline due to the nature of the combustion. A recent review paper from 2018 [9] describes the disturbing breadth of health issues associated with in-cabin engine exhaust, and emphasizes the ongoing challenges of NO<sub>2</sub> in particular to bus drivers and passengers.

In proposing a shift towards fleet electrification, we would draw attention to studies of in-cabin pollution specifically.

In these studies, the methodology is to isolate the exposure level experienced by the passengers and driver of the vehicle over and above ambient or average on/near road levels; this is typically achieved by making suitable control measurements outside the vehicle. A sobering finding from 2001 in California [5] concluded with:

“The air was continuously sampled inside four elementary school buses that drove an actual bus route of about 45 minutes for 4 to 6 repetitions over 5 hours. Nearly 20 hours of sampling results were obtained. Findings indicated that children riding inside a diesel school bus, even buses not emitting significant amounts of black smoke, may be exposed to as much as four times the level of toxic diesel exhaust as someone standing or riding beside the bus, translating to from 23 to 46 times the cancer risk level considered significant under federal law.”

Many studies similar have followed and confirm notable levels of “in-cabin” or “vehicle self-pollution” of various DE exhaust components. For example, a study [2] from Washington State in 2008 found:

“Average concentrations aboard school buses (21 µg m<sup>-3</sup>) were four and two-times higher than ambient and roadway levels, respectively. Differences in PM<sub>2.5</sub> levels between the buses and lead vehicles indicated an average of 7 µg m<sup>-3</sup> originating from the bus’s own emission sources. While roadway concentrations were dominated by ambient PM<sub>2.5</sub>, bus concentrations were influenced by bus age,

diesel oxidative catalysts, and roadway concentrations. Cross-validation confirmed the roadway models but the bus models were less robust.”

A study from Texas from 2008 [3] suggests in-cabin elevation of NO<sub>x</sub> and ultra-fine particulates (smaller than PM<sub>2.5</sub>) over and above road levels:

“In-cabin NO<sub>x</sub> concentrations ranged from 44.7 to 148 ppb and were 1.3–10 times higher than roadway NO<sub>x</sub> concentrations. Mean in-cabin PM<sub>2.5</sub> concentrations were 7–20 µg m<sup>-3</sup> and were generally lower than roadway levels. In-cabin concentrations exhibited higher variability during cruising mode than frequent stops. Mean in-cabin ultrafine PM number concentrations were 6100–32,000 particles cm<sup>-3</sup> and were generally lower than roadway levels. Comparison of median concentrations indicated that in-cabin ultrafine PM number concentrations were higher than or approximately the same as the roadway concentrations, which implied that, by excluding the bias caused by local traffic, ultrafine PM levels were higher in the bus cabin than outside of the bus.”

Additional studies include 2004 study [7] that also found black carbon entering the cabin environment at high levels.

We believe the findings of these reports are particularly striking for rural busing. For many students, the daily school bus rides likely represents dominant source of diesel exposure (possibly in addition to marine exposure, in SD64 case). Given the nature of school busing, this exposure is recurring throughout the school years of childhood at levels that are quantifiable and non-negligible. The in-cabin

exposure findings appear to have been sufficient to prompt follow-on studies examining possible interventions to improve the exposure situation. In an example study [4]:

“School buses contribute disproportionately to ambient air quality, pollute near schools and residential areas, and their emissions collect within passenger cabins. This paper examines the impact of school bus emissions reductions programs on health outcomes. A key contribution relative to the broader literature is that we examine localized pollution reduction programs at a fine level of aggregation. We find that school bus retrofits induced reductions in bronchitis, asthma, and pneumonia incidence for at-risk populations. Back of the envelope calculations suggest conservative benefit–cost ratios between 7:1 and 16:1.”

This study specifically looks at benefits from specific retrofit scenarios. A later study also confirms concrete benefits of pollution reduction measures, specifically for children with existing respiratory conditions [8]. As electrification eliminates the in-cabin self-pollution exposure entirely, we can expect benefits to be at least as great when compared to any given retrofit or improved fuel standard outcomes.



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SCHOOL BUS



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