Powering Up: The Path to Electric School Bus Adoption in Canada

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Canadian Electric School Bus Alliance

Équiterre

Green Communities Canada

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About CESBA

Led by Green Communities Canada in partnership with Équiterre, the Canadian Electric School Bus Alliance (CESBA) is an initiative that brings together various provincial and federal school bus actors, including school boards, environmental organizations, and bus manufacturers. Their goal is to advocate for policies that can accelerate the transition from fossil fuel-powered school buses to electric school buses, aligning with Canada's climate targets. With the support of a steering committee, CESBA gathers insights and best practices to formulate recommendations and implement engagement strategies aimed at mobilizing decision-makers and increasing awareness of the issue. This project, running from January 2022, spans across Canada and draws upon best practices from North America and beyond, with a focus on specific regions or provinces, including Atlantic Canada, Québec, Ontario, and British Columbia.

This project aims to:

- → Strengthen the network of actors involved in school bus electrification across Canada;
- → Increase knowledge transfer and sharing of best practices around school bus electrification;
- → Increase awareness on the social and environmental justice issues related to the transition to electric school buses;
- → Increase federal policy support for the electrification of school transport.

About Équiterre

As one of the main environmental organizations in Québec, Équiterre seeks to make the necessary collective transitions towards an equitable and environmentally sound future more tangible, accessible, and inspiring. Since 1993, Équiterre has worked with citizens, organizations, and governments to develop projects in transportation, agriculture, energy, consumption, and climate change.

About Green Communities Canada

Founded in 1995, Green Communities Canada (GCC) is a national non-profit association of 24 community-based environmental organizations working together for a vibrant, equitable, and sustainable future. GCC connects community-based climate action groups through a national network to share resources, inspire innovative programming, and elevate our collective impact.

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List of Acronyms and Symbols

$	Canadian dollars
$M	Million(s) dollars
$B	Billion(s) dollars
B.C.	British Columbia
CESBA	Canadian Electric School Bus Alliance
ADHD	Attention-deficit/hyperactivity disorder
ASD	Autism Spectrum Disorder
ASTSBC	Association of School Transportation Services of B.C.
CRFC	Clean Fuel Regulation Credits
CIB	Canada Infrastructure Bank
CO_2	Carbon Dioxide
DC(FC)	Direct Current (Fast Charging)
ESB	Electric School Bus
EV	Electric Vehicle
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWh	Gigawatt Hour
ICE	Internal Combustion Engine
MFSAB	Multifunction School Activity Bus
MHDV	Medium- and Heavy-Duty Vehicle
MTMD	Ministère des Transports et de la Mobilité durable
N.B.	New Brunswick
N.S.	Nova Scotia
OEM	Original Equipment Manufacturer
P.E.I.	Prince Edward Island
PETS	*Programme d'électrification du transport scolaire*
OASBO	Ontario Association of School Business Officials
RFP	Request for Proposals
STB	School Transportation Board
V2G	Vehicle-to-Grid
ZEBI	Zero-Emission Buses Initiative
ZETF	Zero-Emission Transit Fund
ZEV	Zero-Emission Vehicle
ZEVAI	Zero-Emission Vehicle Awareness Initiative
ZEVIP	Zero-Emission Vehicle Infrastructure Program

Executive Summary

Electrification of Canadian school buses is progressing, but at a much slower pace than needed. About 70% of the 50,000 school buses run on diesel, while there are only 1,930 electric school buses, comprising less than 4% of the fleet.

Compared to 2023, the number of electric school buses in Canada doubled from 900 (2% of the total fleet) to 1,930 (3.9% of the total fleet). However, this growth falls far short of the nearly 2,900 annual electric bus additions that are needed to reach a fully electric fleet by 2040 and to align with Canada's net-zero objectives.

Shifting entirely to electric school buses could reduce greenhouse gas emissions by at least 1.17 million tonnes annually and save over 601 million dollars ($M) in healthcare costs over 12 years, the average lifespan of a school bus. This reduction is equivalent to the annual greenhouse gas emissions of 260,360 gasoline-powered passenger vehicles. Electrifying school buses helps mitigate health risks, like acute respiratory symptoms and asthma exacerbations, by cutting diesel-related air pollutants. Additionally, it reduces noise pollution, which can lessen sensory processing disorders and ADHD symptoms in students. This electrification also enhances students' mental health by addressing climate change.

Electric school buses require 80% less energy and 50% less maintenance due to their design. In addition to the economic opportunities in manufacturing, electric school bus operators can generate up to $8,000 in annual potential revenues per bus through the Clean Fuel Regulation Credits and vehicle-to-grid participation.

Moreover, equity concerns must be addressed throughout the transition to electric school buses, from raw material extraction to manufacturing, training, and disposal. It's essential to ensure that all communities benefit equally, especially those disproportionately affected by environmental harm, and that equity-deserving groups are meaningfully engaged. This transition should prioritize protecting both people and the environment, in Canada and globally.

Despite proactive efforts from various actors, the electrification of school bus fleets continues to encounter many of the same challenges and barriers as in previous years. **Complex application processes and program structures** impede the adoption of electric school buses by fleet operators due to delays and limited access to financial support. Additionally, the electrification of school bus fleets faces **significant financial hurdles**, with Type C electric school buses costing approximately $250,000 more than their diesel counterparts, forcing certain jurisdictions to scale back their electric school bus adoption target. Additionally, charging infrastructure is often inadequate, leading to connectivity issues and delays in connecting to electric grids. **Inadequate charging infrastructure** across provinces hampers the electrification of school bus fleets, with challenges including limited chargers, connectivity issues, and delays in network access, particularly affecting remote Indigenous communities. Recent initiatives aim to improve access and efficiency through installing home charging stations for drivers, collaborating with charging companies for adaptive power delivery and increasing the number of chargers. **Logistical challenges**, including limited range, winter performance issues, maintenance delays, and inadequate infrastructure, hinder the adoption of electric school buses, particularly in rural and cold-weather areas. Moreover, **the lack of specialized training programs for zero-emission MHDVs**, combined with **insufficient knowledge and awareness**, poses significant challenges to adopting electric school buses, prompting initiatives in various provinces to enhance training and support for technicians and drivers.

While some regions have taken steps towards electrification targets and funding, CESBA urges the acceleration of school bus fleet electrification, offering key recommendations:

RECOMMENDATIONS

1. Enact policy standards to integrate electrification within current frameworks;
2. Increase provincial and territorial subsidies as well as funding from Indigenous Services Canada, to cover the full capital costs of electric school bus fleets;
3. Extend federal funding programs for electric school buses;
4. Review and streamline funding program structures, including shortening review process and aligning with school operators timelines;
5. Increase accessibility to charging infrastructure and improve network connectivity;
6. Explore the economic and energy potential of electric school buses in vehicle-to-grid technology;
7. Review the retirement standards of internal combustion engine buses;
8. Revise existing contracts with fleet operators;
9. Invest in training programs for electric school bus operation and maintenance;
10. Increase awareness of electric school bus benefits and existing funding programs;
11. Systematize data collection and information sharing.

Introduction

The famous yellow North American school bus has been transporting children to school since the 1930s, fueled almost exclusively by fossil fuels. 90 years later, nearly all school buses in Canada still rely on these carbon-emitting energy sources.

The first section of this report outlines the range of benefits offered by electric school buses (ESBs). It shows that ESBs contribute to achieving greenhouse gas (GHG) emission reduction targets set by Canadian jurisdictions, in addition to reducing diesel-related air pollution and associated respiratory illnesses. The transition to ESBs also generates economic spin-offs and can create employment opportunities. ESBs are thus an essential tool for tackling climate, health and economic challenges.

The second section paints a picture of the school transportation sector in Canada. It begins by presenting the latest data on the distribution, age, types and electrification share of the Canadian school bus fleet. It then provides an overview of federal and provincial policies and funding programs that have contributed to the adoption of ESBs in certain regions of the country.

The third section explains the complexity of acquiring ESBs, ranging from logistical issues such as range limitations to administrative obstacles related to costs and financing of ESBs, as well as barriers related to charging infrastructure and workforce training issues.

In the fourth section, the report outlines CESBA's goal of achieving a complete transition to ESBs by 2040, covering all 50,000 buses responsible for transporting children across Canada and aligning with Canada's targets of respectively achieving 100% of total medium- and heavy-duty vehicle (MHDV) sales as zero-emission vehicles (ZEVs) by 2040.

As part of the final section, the report offers a comprehensive set of recommendations to realize CESBA's goal, ranging from funding measures to lower the cost of ESBs and to install more charging infrastructure, to policy proposals to reduce administrative burden and logistical intricacies, as well as recommendations to ensure an equitable transition.

1. Why Canada Should Embrace ESBs

In the context of the ongoing global climate and health crisis, electrifying the Canadian school bus fleet presents a unique opportunity to make significant strides towards decarbonizing the transportation sector (IPCC, 2023; Health Effects Institute, 2020). This would support the necessary energy transition, while generating health and economic benefits for the country.

Indeed, the shift to ESBs could be seen as a low-hanging fruit, as this helps reduce GHG emissions, improve air quality, foster economic development, and generate savings in the long run. This section delves into the climate, health and economic benefits of transitioning away from diesel school buses for society, but more specifically for governments and those affected by school transportation actors in Canada.

1.1. CLIMATE BENEFITS

To this day, Canadian school bus fleets are still powered primarily by diesel. Along with other MHDVs, school transportation contributes to 30% of GHG emissions within Canada's transportation sector, which, in turn, accounts for 22% of total national emissions (ECCC, 2021; Government of Canada, 2023b).

Electrifying school buses presents a promising opportunity to **reduce GHG emissions** associated with fossil fuel combustion, in line with the GHG reduction targets set forth by various Canadian jurisdictions (see **Appendix B**).

In fact, manufacturers estimate that the replacement of a standard diesel bus with an ESB reduces GHG emissions by 23 tonnes, which is equivalent to taking five cars off the road (Government of P.E.I., 2021b). Nationwide, this would mean that electrifying Canada's entire bus fleet has the potential to remove 1.17 million tonnes of GHG emissions annually, the equivalent of avoiding 1.66 million one-way flights from Halifax to Vancouver every year (Curb6, n.d.) (see **Appendix A**). Put differently, annually, a school bus fleet consisting entirely of ESBs would have the same emissions reduction impact as 260,360 gasoline-powered passenger vehicles being driven for the same duration, considering an average annual distance traveled of 18,538 kilometers per vehicle (EPA, 2023). Additionally, an entirely ESB fleet would eliminate around 243,000 liters of fossil fuel that the school transportation sector consumes annually (Statistics Canada, 2023).

Electrifying Canada's entire bus fleet has the potential to remove 1.17 million tonnes of GHG emissions annually, the equivalent of avoiding :

1.66	260,360	243,000
million one-way flights from Halifax to Vancouver every year	gasoline-powered passenger vehicles	liters of fossil fuel

In provinces, such as Quebec, where electricity emits very little GHG, the reduction in emissions during the use phase of an ESB could reach 92% (Équiterre, 2019). The Government of Quebec estimates that, by electrifying 65% of the school bus fleet by 2030, it could avoid nearly 800,000 tons of GHG emissions (MTMD, 2023). In Nova Scotia., a fleet of 100% ESBs powered by clean electricity would save almost 23,000 tons of carbon dioxide (CO_2) per year (Ecology Action Centre, 2022).

1.2. HEALTH BENEFITS

In addition to GHG emissions, the electrification of school buses provides a significant avenue to **decrease diesel-related air pollutants**, including nitrous oxides (N_2O), sulfur oxide (SO), and particulate matter (PM). This reduction directly translates to mitigated health risks, such as acute respiratory symptoms, asthma flare-ups, cardiovascular diseases, and cancers (CCNB, 2022). According to Health Canada (2022), the collective impact of traffic-related air pollution results in approximately 1,200 premature deaths annually, as well as 2.7 million instances of asthma symptoms and 210,000 asthma symptom days.

ESBs significantly reduce noise exposure, offering various health benefits due to their electric motors, which generate minimal vibrations compared to internal combustion engines (ICE). This alleviates annoyance, enhances sleep quality, supports better cognitive development in children and even improves school attendance (Snider, 2022; Pedde & al., 2023). Unlike traditional diesel engines that produce noise through combustion, electric motors operate quietly. This benefits approximately 5-16% of children diagnosed with sensory processing disorders, 5-7% with ADHD, and 1 in 50 diagnosed with Autism Spectrum Disorder (ASD) (eMental Health, 2023; Public Health Agency of Canada, 2022). This benefit is echoed by school bus operators like Autobus Chambly, who note that the quiet, vibration-free ride in ESBs creates a calm, peaceful environment for both drivers and children, allowing even the slightest sounds to be heard; one driver, for example, requested an ESB specifically to help manage her stress and continue her job (Langlois, 2024).

Reduced noise and air pollution could particularly benefit school bus drivers and the 2.2 million children transported daily across the country (Task Force on School Bus Safety, 2020), as well as marginalized communities who are often located near major roadways and bus routes.

In regards to mental health, electrifying school bus fleets offers a chance for schools to address eco-anxiety through climate action. Riding an ESB every day provides tangible evidence that climate change is being addressed, empowering students and fostering hope for a more sustainable future (Delphi Group, Pollution Probe & CPCHE, 2022). Above all, the transition to 100% ESBs helps to **combat climate change and mitigate its effects on students' mental health**, including post-traumatic stress after climate change-induced natural disasters, climate anxiety, feelings of government betrayal and moral injury (Delphi Group et al., 2022).

1.3. ECONOMIC BENEFITS

By alleviating air pollution and its burden on the healthcare system, electrifying school buses could **generate significant savings in health costs**. The shift to ESBs could yield annual healthcare savings of approximately 1 million dollars ($M) in Quebec (Équiterre, 2019) and $7.2M in Ontario (Delphi Group et al., 2023). Similarly, by electrifying its public school bus fleet, B.C. could see savings of up to $15M over a 12-year bus life, or $11,800 per bus (Pembina Institute, 2022). Scaling this impact to encompass the entire Canadian school bus fleet, potential healthcare savings would exceed $601M over 12 years (see **Appendix A**).

Transitioning to ESBs also has the potential to **drive economic growth**. In Quebec, if all school buses were converted to electricity, it is estimated that the trade balance could improve by an annual amount ranging from $50M to $100M (Équiterre, 2019). This means that Quebec's financial situation, particularly its imports and exports, could benefit by this significant amount each year due to its concentrated production of ESBs with major ESB manufacturers such as Girardin, Blue Bird and Lion Electric. In Ontario, the electrification of 65% of the school bus fleet by 2030 promises to generate 10,800 jobs and 1.5 billion dollars ($B) in gross domestic product (GDP). This estimate excludes the 2,400 extra jobs and an additional $300M to the GDP generated by the manufacturing and installation of charging infrastructure (Smith, Jantz & Lloyd, 2023).

For fleet operators, ESBs provide significantly **reduced operational expenses**. In comparison to ICE buses, ESBs cost 80% less to power due to their higher engine efficiency and the lower cost of electricity. There is also an estimated 50% reduction in maintenance costs due to fewer moving parts (Dunsky Energy + Climate, 2023a). ESBs also **offer potential revenue sources**, such as the Clean Fuel

Regulation Credits (CFRC), which provide credits to operators of electric vehicle (EV) charging sites when they opt to power their vehicles with clean fuel. At an assumed credit rate of $300, ESB operators can harness the CFRC to generate over $5,000 in revenue per ESB per year (Dunsky Climate + Energy, 2023a). However, early adoption of ESBs presents challenges, particularly with operating costs. Autobus Chambly notes that while the cost difference between diesel and electric buses is often expected to narrow over time, significant gaps persist even after six years, partly due to higher maintenance demands during the early stages of technology adoption (Langlois, 2024).

ESB operators can further generate income by using vehicle-to-grid technology (V2G), which utilizes the vehicle's onboard energy storage system to provide power back to the grid. The annual average revenue for V2G participation is estimated at $3,000 per ESB per year, thereby reducing the payback period of an ESB by 2 to 3 years (Dunsky Climate + Energy, 2023b) (see **Appendix B**).

Box 1: Canadian public appeal to ESBs

These climate, health, and economic benefits make a compelling case for the adoption of ESBs, resonating strongly with public opinion. In 2023, Abacus Data and the Canadian Lung Association conducted a poll revealing that 78% of Canadians are concerned about the health impacts of school bus emissions on children. Notably, 83% favor accelerating the electrification of school buses, advocating for a commitment to 100% electric new school buses by 2040, along with 82% supporting interim 5-year targets to achieve this goal. Furthermore, 77% support implementing a sales mandate that requires a minimum percentage of school bus fleets to be electric (Ecology Action Centre, NB Lung, & Canadian Conservation Council of New Brunswick, 2024). The enthusiasm for ESBs extends beyond adults, as students in various communities have expressed excitement about these quieter and smoother-driving buses, which also enhance bus driver satisfaction.

2. Mapping Canada's School Bus Landscape

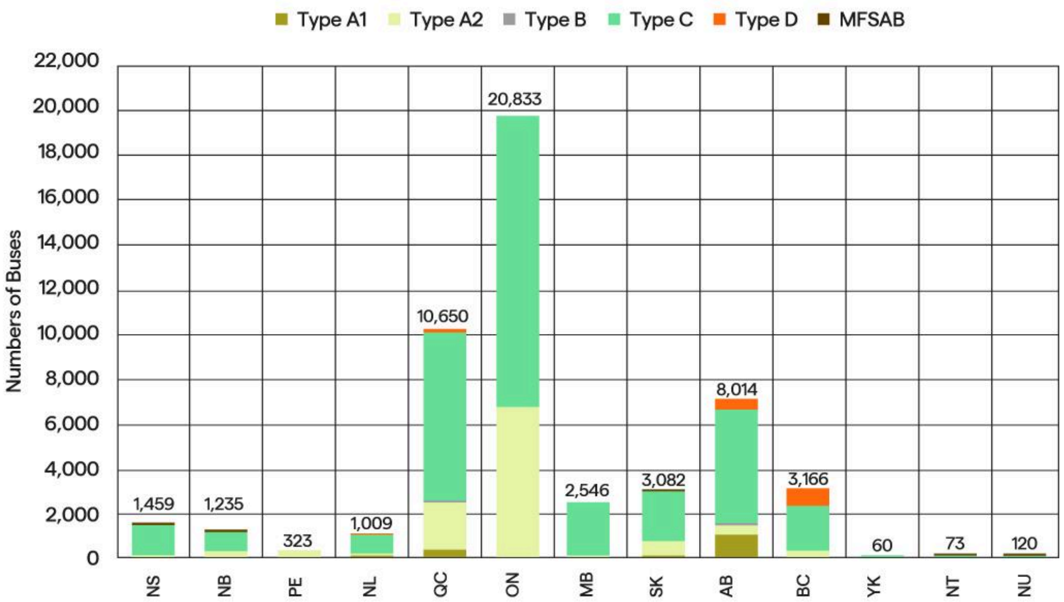
This section delves into the current state of school bus electrification in Canada, exploring the opportunities, challenges, and policy measures in place to accelerate this transition. To gain a comprehensive understanding, we examine the Canadian school bus fleet, its electrification progress, and the support mechanisms offered at both provincial and federal levels.

2.1. CANADA'S SCHOOL BUS FLEET

Across Canada, there are **between 45,000 and 50,000 school buses**, with approximately **70% using diesel fuel** (Statistics Canada, 2023; Kozelj, 2022). School buses are mostly concentrated in Ontario (20,833), Quebec (10,650) and Alberta (8,014) (Task Force on School Bus Safety, 2020).

Canada's school bus fleet is relatively young, with **45% of buses being less than five years old** (**Figure 1**). Considering that school buses must be withdrawn from service when they reach an **average age of 12 years old** (after which they are no longer deemed safe for student transportation), these buses will continue to be on the road for another 7+ years. This demonstrates the importance of putting the immediate brakes on the purchase of new ICE buses.

Figure 1. Breakdown of provincial and territory school bus fleets by type



Source : Dunsky Energy + Climate (2023a).

2.2. STATE OF SCHOOL BUS ELECTRIFICATION

In contrast to ICE buses, the number of ESBs operating in Canada is small. Recent data, though limited, indicates a **total of 1,930 ESBs**, **representing 3.9% of the total Canadian fleet**. A similar situation prevails in the United States, where ESBs make up about 2.4% of the school bus fleet, with 12,000 ESBs out of a fleet of more than 500,000 (Clark Estes, 2024).

In terms of absolute numbers, Quebec is at the forefront with 1606 ESBs on the road, followed by B.C. (158), P.E.I. (107), Ontario (25), N.B. (22), Alberta (around 10)[1], Newfoundland & Labrador (1) and Saskatchewan[2] (1) (Charbonneau, 2024; Government of P.E.I, 2024; For Our Kids, 2024; Ecology Ottawa, 2023b; TDSB, 2024; Ecology Ottawa, 2023a).

The jurisdictions currently lacking ESBs include Manitoba, Nova Scotia, Yukon, Nunavut, and the Northwest Territories (CCNB, 2023). Nova Scotia has announced a pilot project for their first ESB. In Manitoba, meanwhile, many obstacles are hindering the transition to ESBs. The Seine River School Division paused its electric bus plans due to concerns about winter performance in rural areas, safety, and the high costs associated with infrastructure changes and driver air brake certification. Current recommendations favor urban use, making the transition impractical for their rural operations (Lambert, 2024).

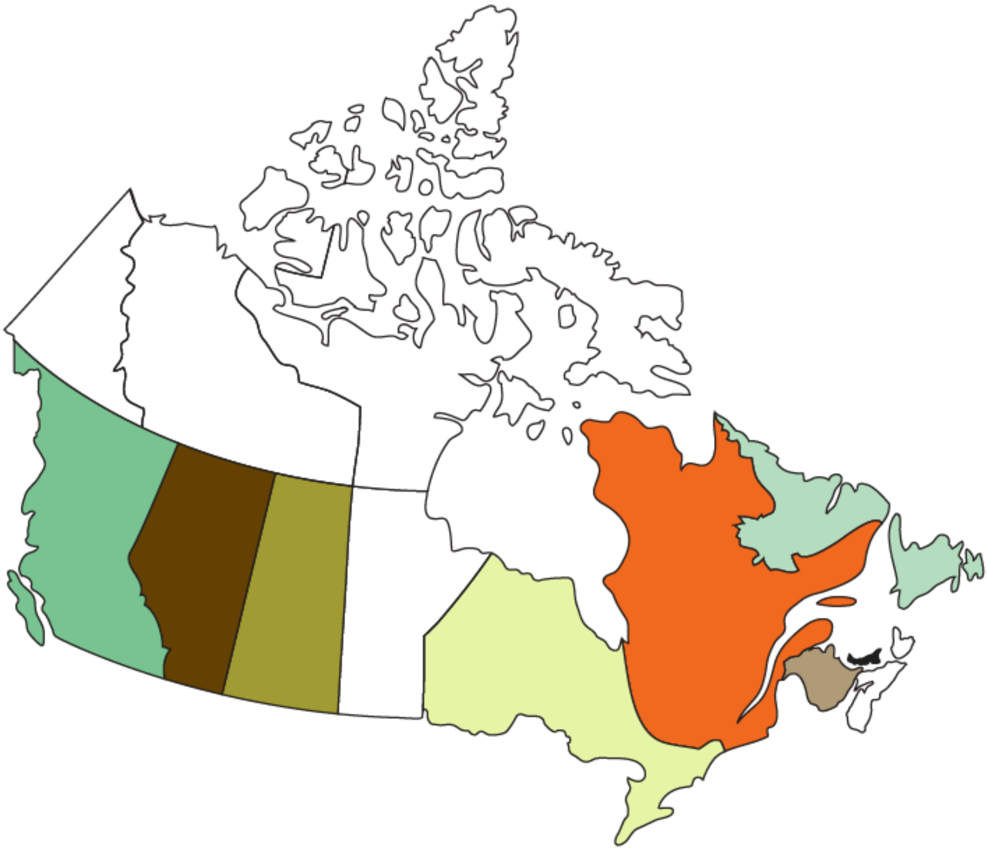
When considering the share of ESBs relative to their respective school bus fleets, P.E.I. emerges as a leader with 43% of its fleet now electrified (Ecology Action Centre, NB Lung, & Canadian Conservation Council of New Brunswick, 2022). In contrast, Quebec and B.C. have a much lower share of their fleets electrified, at 15% and 3%, respectively. This higher number of ESBs in Quebec, B.C. and P.E.I. can be attributed to the adoption of favorable policy measures at the provincial level aimed at accelerating the electrification of their school bus fleet.

[1] The number might be higher for Alberta as Lion Electric has received a conditional purchase order from Highland Electric Fleets for 50 LionC ESBs, which will be serviced by Rental Bus Lines in Alberta (Hampel, 2023).
[2] In Saskatchewan, the Saskatchewan Rivers School District has become the first in the province to receive an ESB, which will transport students from Red Wing School and help the district assess its performance in Prairie weather conditions (Nordlund, 2023).

Figure 2. State of School Bus Electrification in Canada

Total ESBs in Canada: Over 1,930
(3.9% of total Canadian fleet)

Comparison to the U.S.: 2.4% of the U.S. fleet
(12,000 ESBs out of 500,000)



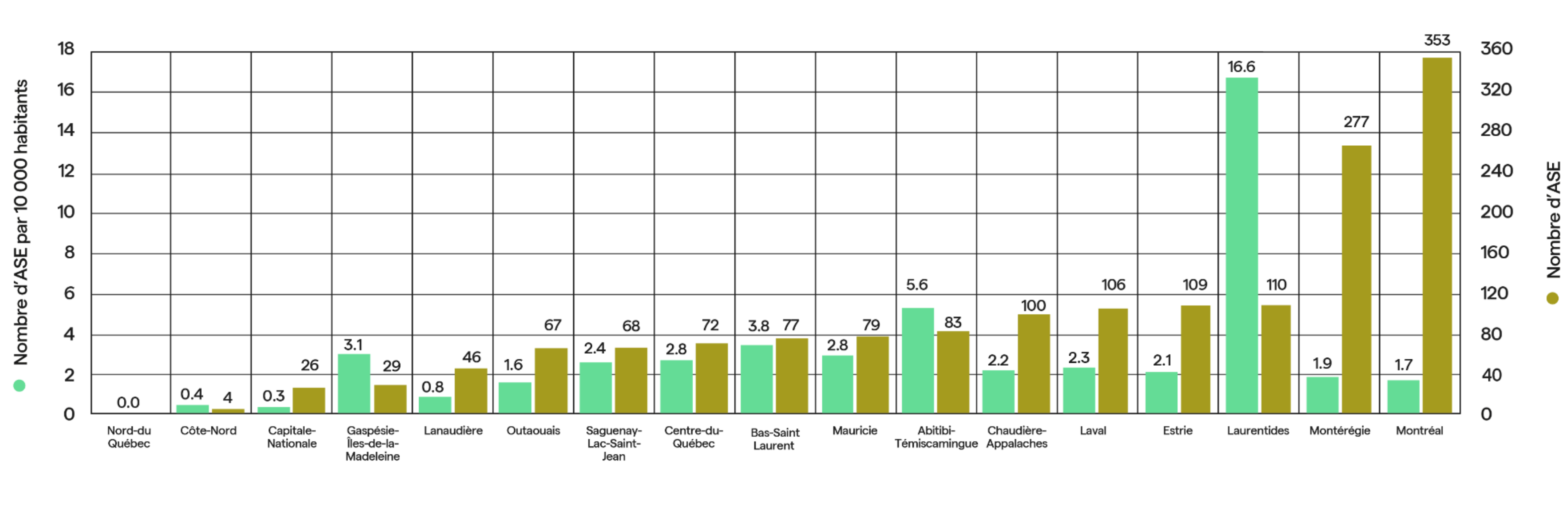
- Québec: 1,606 ESBs
- P.E.I.: 107 ESBs
- B.C.: 158 ESBs
- Ontario: 25 ESBs
- New Brunswick: 22 ESBs
- Alberta: ~10 ESBs
- Newfoundland & Labrador: 1 ESB
- Saskatchewan: 1 ESB

Jurisdictions Without ESBs: Manitoba, Nova Scotia, Yukon, Nunavut, Northwest Territories

Box 2: Electrification progress and regional distribution of ESBs in Quebec

According to MTMD's regional analyses, the regional distribution of ESBs in Quebec reveals a significant concentration in urbanized and densely populated areas. Montreal leads with 353 ESBs, followed by Montérégie with 277 and Laval with 106, reflecting the prioritization of deployment in regions with higher student populations and established infrastructure. In contrast, rural and remote regions, such as Côte-Nord (4) and Gaspésie–Îles-de-la-Madeleine (29), have far fewer ESBs, likely due to logistical challenges and limited resources (MTMD, 2024b). See **Appendix C** for more detailed information.

Figure 3. Regional distribution of ESBs in Quebec by number of ESBs and number of ESBs per 10,000 inhabitants.



Approximately 600-700 operators operate in the province, with about half having begun their transition to ESBs . There is no significant distinction in adoption rates based on the size of school bus operators. However, it is noted that family-owned companies, particularly in rural areas, face challenges. While there is a concentration of larger operators in the Greater Montreal area, this does not represent the majority of operators across Quebec. Smaller operators in remote regions encounter difficulties due to longer distances, and although the ministry is aware of these challenges, there are no additional incentives specifically for them (Charbonneau, 2024)

The shift towards ESBs in Quebec has led to significant market consolidation among transportation operators. Smaller businesses that choose not to invest in ESBs—due to concerns over reliability, cost, or the challenges associated with electrification—are often forced to sell their fleets to larger competitors. This trend risks driving smaller operators out of the market, reducing competition and centralizing fleet ownership among a few dominant players, potentially leading to reduced service flexibility and increased costs for school districts (Charbonneau, 2024).

2.3. POLICY & FUNDING SUPPORT

Amidst the pursuit of electrifying school bus fleets across the country, specific jurisdictions have taken a proactive stance by adopting specific electrification targets and by allocating dedicated funding to support this mission. This table provides an overview of programs and incentives implemented in B.C., Quebec and P.E.I. that have contributed to achieving the highest provincial share of ESBs compared to other provinces. For more detailed information, see **Appendix D**.

Table 1. Summary of ESB targets and funding programs per jurisdiction

Jurisdiction	ESB Target	Funding Programs
B.C.	Anticipated ZEV targets for MHDVs are set to be formulated in accordance with California's standards, which mandate that all new trucks and buses should transition to electric power by 2036.	• Clean BC Go Electric Rebates Program: Rebates up to $100,000 for Type C/D ESBs and $75,000 for Type A buses (ends 2024 for public districts). • BC Hydro EV Fleet Ready Program: 50% of fleet and infrastructure assessment costs, up to $10,000, and 50% for electrical infrastructure upgrades. • Clean BC Fleet Charging Program: Up to $75,000 for DCFCs and up to 50% of project costs (max $4,000) for Level 2 chargers. • Clean BC Commercial Vehicle Pilots Program: 33% of total project costs. • Additional funding support is provided for Indigenous communities and businesses, with programs like the Clean BC Go Electric Rebates, BC Hydro EV Fleet Ready Program, and Clean BC Go Electric Fleet Charging Program
P.E.I.	Aiming to decarbonize at least 40% of registered MHDVs by 2040 and electrify half of the province's school buses by 2027.	• The Government of P.E.I. and Canada are jointly allocating $40.3M over five years, including $6M from Infrastructure Canada, for the acquisition of ESBs. • P.E.I. currently has about 100 ESBs in its fleet of more than 300 vehicles, all of which were cost shared

		between the provincial and federal governments.
Quebec	Beginning in November 2021, all new school bus purchases shall be electric, with a goal of achieving 65% ESBs in Quebec by 2030.	• PETS: Up to $150,000 per ESB, up to $175,000 for larger battery buses (batteries of 155 kWh and beyond). The program will end on March 31, 2025 and will be renewed with changes. • Charging station support: Up to 75% of costs, capped at $30,000 for DCFCs and $10,000 for Level 2 chargers. • Transportez Vert: Up to $150,000/year for DCFC stations and support for fleet electrification. • Annual Ministry of Education grant of $7,900 per ESB, plus $5,000 one-time per operated ESB.
Federal	No official ESB adoption goal; ESBs fall under the goal of having 35% of MHDV sales as ZEVs by 2030 and 100% by 2040.	• ZETF: $2.4B for ESBs and infrastructure (50% of capital projects, 80% of planning projects). • ZEVIP: Up to $100,000 for Level 3 DCFC stations, $5,000 per port for Level 2 chargers (capped at $5M/project). • CIB ZEBI: Loans repaid via ESB operational savings, tax benefits under the Accelerated Capital Cost Allowance program.

3. Hurdles to ESB Adoption

While government funding mechanisms have undoubtedly played a role in subsidizing the electrification of school districts and private fleets, challenges persist in accessing these programs. Purchase incentives are pivotal in facilitating fleet electrification, but they constitute just one aspect of the overall process. This section sheds light on the diverse factors that are impeding the transition to ESBs, encompassing cost and funding, charging infrastructure, administrative hurdles, logistical complexities, as well as training, knowledge, and awareness gaps.

3.1. ADMINISTRATIVE BARRIERS

There are various administrative challenges that school bus operators across different Canadian provinces face when transitioning to ESBs.

Federal funding options, notably the ZETF program and CIB loan program, are encumbered by procedural challenges (Dunsky Energy + Climate, 2023a). At a broader level, the structure of the ZETF program results in prolonged processing times and difficulties in orchestrating timely vehicle replacements. These hurdles are primarily attributed to delays inherent in the approval process. For example, in the Sudbury district (ON), three operators applied for ZETF three to four years ago. Two operators received approval to proceed with their applications, but there has been no official approval of ZETF funding and currently, no ESBs are on the road in the Sudbury district (Boucher, 2024).

Delays in federal funding are forcing certain jurisdictions, such as P.E.I., to scale back their climate action commitments. For instance, the P.E.I. government has announced the purchase of 30 diesel school buses this year to replace aging vehicles, contradicting its pledge to phase out diesel buses. This decision was largely driven by the delays in ZETF federal funding for ESBs, with the province currently awaiting new financial support from Ottawa (Bruce, 2024).

These challenges often involve navigating complex application processes for subsidies and loans. For instance, operators seeking federal funding for ESBs and charging infrastructure must contend with the requirement to apply to two separate programs, namely ZEVIP and ZETF. In B.C., operators face an even more intricate process, involving applications to three distinct programs: ZEVIP, ZETF, and *CleanBC Go Electric Rebates* and *Charging Program*. To help address these complexities, organizations like the Association of School Transportation Services of B.C. (ASTSBC) have stepped in, collaborating with Indigenous schools, public school districts, and independent schools through a cooperative application process. ASTSBC have brought together 65 operators in a single application to access ZETF funding. Moreover, ASTSBC collaborated with the CUB to create a new program that streamlined the process for school districts to purchase ESBs by removing barriers.

Moreover, despite operators in the Maritimes being eligible for federal programs, many opt not to apply due to the intricacies of the application process, resulting in a notably low number of ESBs in N.B. and N.S.

Furthermore, school districts in B.C., for instance, find themselves grappling with the time-consuming and complex application process for obtaining loans from the CIB. Taking loans from the CIB program for these school districts is an unusual practice since they are not permitted to do so under normal circumstances; therefore, many school districts in B.C. remain hesitant to engage in such financial commitments (Pembina Institute, 2022). The process of applying to multiple funding programs also introduces its own administrative strain, especially in provinces where both federal and provincial funding opportunities coexist.

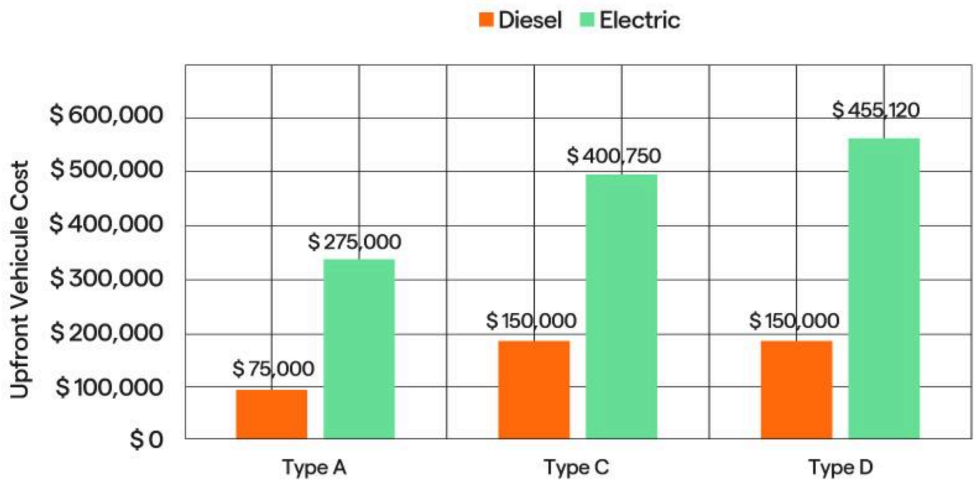
Lastly, the pre-existing contractual framework adds another layer of complexity to the transition process. Typically, contracts between school bus companies and school boards possess a relatively short duration, spanning around 5 years (Delphi Group et al., 2023; Équiterre, 2019). This limited contractual time frame does not incite fleet operators to contemplate the adoption of ESBs. Therefore, the short-term nature of these contracts falls short in providing a conducive environment for bus companies to commit to the transition, thereby exacerbating the challenges inherent in altering the composition of school bus fleets.

These administrative complexities can significantly impact the adoption of ESBs in various regions, highlighting the need for streamlined processes and improved accessibility to funding opportunities.

3.2. COST AND FUNDING

The electrification of school bus fleets in Canada encounters substantial financial hurdles. Comparatively, the cost of ESBs looms significantly higher than their diesel counterparts. In general, the purchase price of an ESB before subsidies can cost anywhere between 1.5 to 2.5 times an equivalent diesel bus (**Figure 4**). Certainly, a Type-C ESB typically carries an average price tag of $400,750, while a Type-C ICE school bus comes in at an average upfront cost of $150,000 (Dunsky Energy + Climate, 2023a).

Figure 4. Initial cost of Type A, Type C and Type D ICE buses and ESBs



Source: Dunsky Energy + Climate (2023a)

At the federal level, the ZETF was established to facilitate the electrification of school bus fleets, yet funding levels have not increased, despite the target of 100% MHDV sales by 2040. Currently, the ZETF is over subscribed, with the majority of its resources already allocated and a recent budget cut of $350 million, reducing the total from $2.75 billion to $2.4 billion (McGregor, 2024).

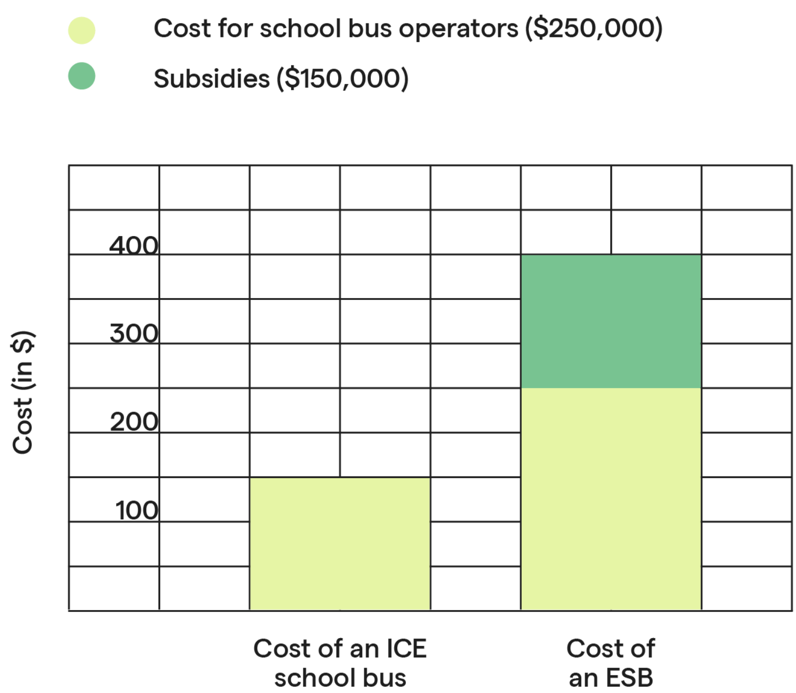
Although the fund was intended to support both transit and school bus electrification through 2025/2026, the lack of increased funding and the oversubscription indicate serious limitations on its capacity to meet the needs of fleet operators. Moreover, federal funding may prove insufficient for fleet operators, particularly those residing in provinces lacking their own provincial funding streams to supplement federal support. This disparity can create financial challenges for operators striving to electrify their fleets.

Certain provinces such as Ontario, N.B. and N.S. do not provide funding options that could be stacked with existing federal funding sources. In Ontario, the Ministry of Transportation introduced the Transportation Services Allocation, a new funding framework to ensure transparent and reliable funding for student transportation. It covers vehicle, fuel, and driver costs, with adjustments based on local needs and operational benchmarks (Ontario Ministry of Education, 2023). Despite ongoing efforts by the Ontario Association of School Business Officials (OASBO) to work with the Ministry to modify this formula to incentivize the purchase of ESBs, no specific funding has yet been allocated for ESBs under the current structure (Ontario

Ministry of Education, 2023; Boucher, 2024). Therefore, Ontarian fleet operators must still allocate an additional $260,000 compared to diesel-powered school buses; this situation makes it difficult for fleet operators to replace even 10% of their current bus fleets with ESBs (Delphi Group et al., 2023).

While provincial funding sources in certain provinces offer additional assistance, their limitations present a significant obstacle for fleet operators and school districts striving to bridge the cost gap between ICE buses and ESBs. In B.C., core bus funding from the Ministry of Education and Child Care (2022) is only accessible for replacing buses nearing retirement. This leaves new additional buses without the benefit of this funding and requires fleet operators to allocate an additional $60,000 to $147,000 to bridge the gap between diesel and electric models (Pembina Institute, 2022). All fleet operators surveyed in Quebec identify the primary challenge associated with purchasing ESBs as the substantial cost, even after factoring in subsidies (Équiterre & Propulsion Québec, 2023). Indeed, with ESBs priced around $400,000 and typical subsidies of $150,000, school bus operators are still left to cover a significant $250,000, which is around $100,000 more than the cost of an ICE school bus (Bergeron-Courteau, 2024). For example, Autobus Chambly states that the current price difference between diesel and electric buses is $68,000, with electric buses being the more expensive option, and reports that maintenance costs for these electric buses are higher than promised, often matching those of diesel buses (Langlois, 2024).

Figure 5. Comparison of ESB and ICE school bus costs: subsidies and remaining expenses for fleet operators (Bergeron-Courteau, 2024).



In Quebec, another challenge associated with its funding options, particularly PETS, is its requirement for ESBs to be assembled entirely in Canada. This is attested by the majority of surveyed fleet operators who have expressed the need for the expansion of available ESB models within the framework of PETS (Équiterre & Propulsion Québec, 2023). Not only does it restrict the range of eligible models and manufacturers, but also contributes to exacerbating delivery delays in Quebec, which can further hamper the overall adoption of ESBs within the province. Additionally, school bus operators in Quebec, such as Autobus Chambly, have highlighted the lack of clarity surrounding the renewal of the PETS funding program. The uncertainty arises because announcements regarding the program's renewal are typically made only at the end of the funding cycle, creating significant uncertainty and complicating long-term planning for fleet operators (Langlois, 2024).

The need for significant investment extends beyond the purchase price, encompassing charging infrastructure and potential electrical upgrades. This poses a challenge, especially for school transportation operators, as these costs can be substantial. For instance, annual maintenance for a Level 3 charger might reach up to $3,000 (Propulsion Québec, 2022). According to a survey by Équiterre and Propulsion Québec (2023), fleet operators expressed concern about additional expenses related to charging infrastructure procurement and installation.

3.3. CHARGING INFRASTRUCTURE

One of the pivotal challenges in electrifying school bus fleets is the inadequacy of charging infrastructure. This deficiency is felt across multiple provinces. In P.E.I., there are only 12 chargers for the fleet of 82 ESBs, caused by installation delays and supply chain shortages (Huntington & Curran, 2022).

This scarcity forces fleet managers into the complex task of sharing limited chargers and coordinating charging schedules, especially for buses traversing extended distances. As a strategy to mitigate this issue, P.E.I. is initiating a pilot project to install home charging stations for some bus drivers (Ross, 2022). In contrast, while British Columbia boasts widespread public EV charging infrastructure, even in remote areas, it predominantly caters to smaller vehicles. Unfortunately, there is insufficient space or accessibility for electric buses to use these charging depots, significantly limiting the infrastructure's usefulness for larger vehicles like school buses (For Our Kids, 2024). In Quebec, the situation has improved significantly, aiming for a target of one charging station per bus. Initially, there was a gap, as more ESBs were ordered than charging stations. However, this discrepancy has been addressed, with a substantial increase in the number of charging stations ordered and installed, now closely aligning with the desired one-to-one ratio (Charbonneau, 2024).

Adding to these challenges, school transportation operators in B.C. grapple with issues surrounding network connectivity and charging port availability (Pembina Institute, 2022). For instance, a district faced connectivity problems, leading to overnight charging failures; they addressed it by using a standalone charging station. However, this solution might hinder load management and accessing cost-effective nighttime charging rates for the district. To prevent overnight charging failures, operators are also encouraged to avoid purchasing unapproved chargers, as these can lead to compatibility issues and unreliable charging performance. Standardizing the equipment helps ensure smoother operations and minimizes disruptions during critical charging periods (ASTSBC, 2024).

In addition, in Quebec, fleet operators face delays in connecting to the Hydro-Québec network, delaying the transition to 100% ESBs, with the survey findings indicating that one fleet operator experienced a postponement lasting up to 9 months (Équiterre & Propulsion Québec, 2023).

Box 3: Ensuring equitable access for remote and Indigenous communities

Ensuring equitable access to ESBs with the necessary grid and charging infrastructure across Canadian communities is a significant challenge. Remote and northern communities face specific barriers, including a lack of connection to the electrical grid and higher costs for installing charging infrastructure. Many of these communities have a substantial Indigenous population and experience a notable absence of EV charging facilities, despite efforts by certain governments (e.g. B.C. and Government of Canada) to invest in such infrastructure. This lack of charging options is particularly critical because the distances to be covered in rural communities are often more extensive. This situation hinders the adoption of ESBs, even though these communities deserve to have equitable opportunities to transition and benefit from the associated environmental and health improvements. Furthermore, Indigenous communities are disproportionately impacted by the detrimental impacts of the EV transition, such as resource extraction.

Recent advancements in charging infrastructure are particularly noteworthy. Collaborations with charging companies have led to improvements where chargers can now adjust power delivery based on backward calculations to optimize battery temperature (ASTSBC, 2024). These "backward calculations" refer to the charger analyzing the battery's current state, such as temperature and charge level, to determine the ideal power delivery rate. This is important because maintaining an optimal battery temperature during charging helps prevent overheating, which can damage the battery or shorten its lifespan. By adjusting power delivery, the charger ensures safer, more efficient charging and improves overall battery performance. Additionally, partnerships with charging software manufacturers are made to develop a branded software solution that promotes compatibility across school districts. This ensures a seamless integration between different types of chargers and buses.

Charging infrastructure at bus drivers' homes is becoming increasingly common. In B.C., most bus drivers have access to chargers at their residences, typically owned by the bus operator or an official rather than directly by the school itself (For Our Kids, 2024). In P.E.I., an increasing number of charging stations are being installed at the homes of drivers who take ESBs home after their shifts, finding that this approach may offer overall cost savings compared to a central depot charging model by avoiding major depot upgrades and reducing demand charges on electricity bills (Collins, 2024; Huntington & Curran, 2022).

3.4. LOGISTICAL ISSUES

Logistical intricacies pose significant barriers to the adoption of ESBs across various dimensions.

With the existing technology and infrastructure, ESBs fall short in covering the entirety of routes, particularly those that serve essential educational programs requiring transportation. This challenge is particularly pertinent in B.C., where the issue of range poses constraints on the ability of ESBs to serve all routes while upholding the requisite service quality. In Ontario, deploying ESBs on all routes, especially long-distance ones like those covering 400 km per day, would not be feasible due to range limitations, but in urban centers where buses can return to the depot between runs, their use becomes much more practical and achievable (Boucher, 2024). Similarly, P.E.I. raises valid concerns about range loss caused by factors such as headwinds, uphill driving, and frequent stops (McEachern, 2022). Moreover, the use of winter tires on ESBs can lead to a 15% reduction in range (Collins, 2024). School bus operators echo these concerns, with Autobus Chambly highlighting that limited vehicle range is a major challenge. The current range of just 150 km restricts their ability to use ESBs for longer trips, such as school outings, significantly limiting their operational flexibility (Langlois, 2024).

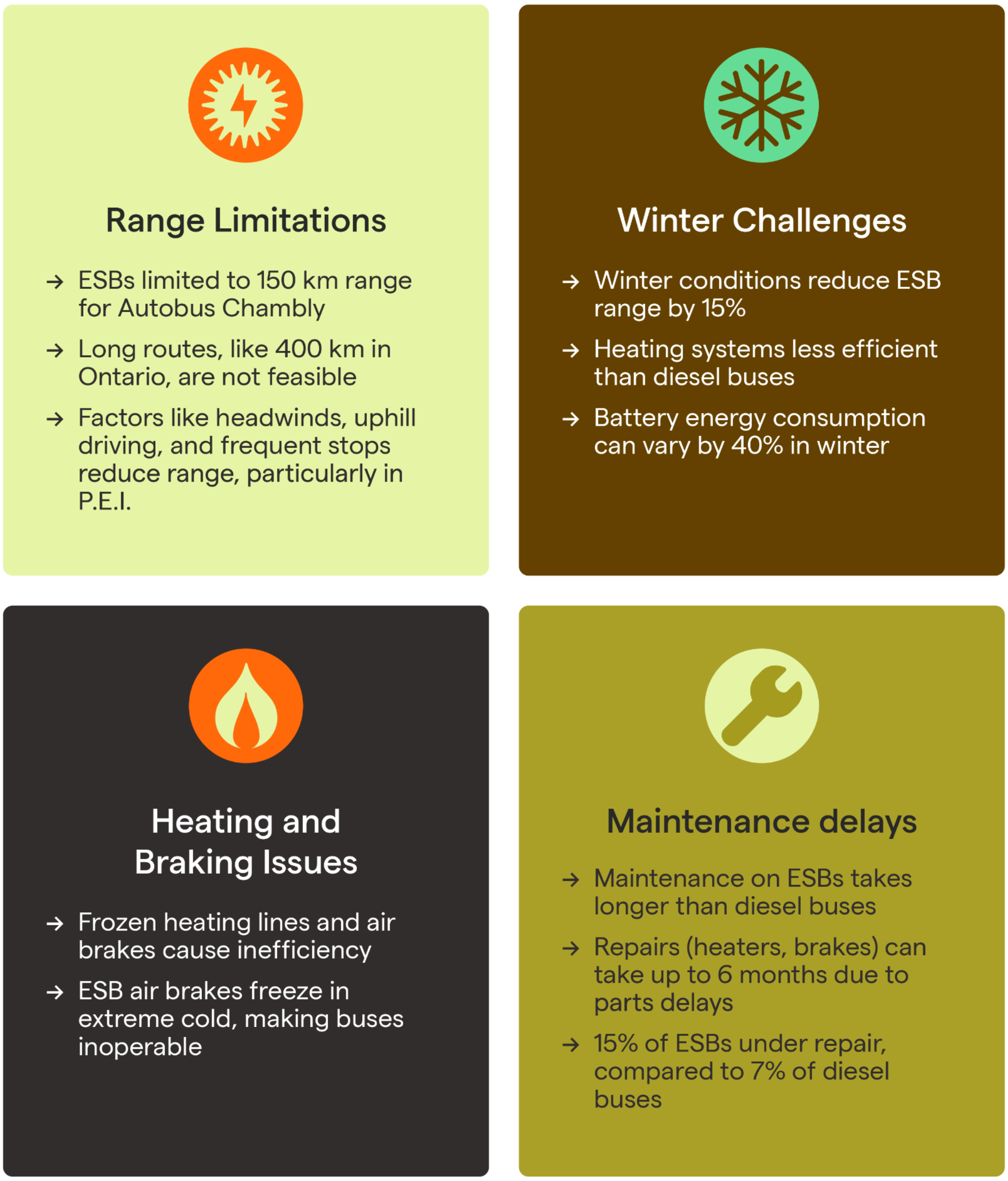
Concerns regarding range and autonomy become significant, particularly in rural areas with extended routes and harsh cold weather conditions. In Ontario, winter operations are one of the most commonly cited barriers to the adoption of ESBs (Burgoyne-Allen & O'Keefe, 2019). In northern rural B.C. , adoption has been limited due to winter climates, with concerns about performance in extreme temperatures. Although some buses operate successfully in mixed climates, such as the Okanagan and Kootenay regions, where temperatures can drop to -20 to -25 degrees Celsius in winter and rise to 35 degrees Celsius in spring and fall, heating systems in ESBs do not perform as effectively as those in diesel buses (ASTSBC, 2024). Studies show that EV battery energy consumption can vary by up to 40% under winter conditions (Rastani et al., 2019).

Issues have arisen with exposed heating lines freezing, affecting efficiency, though feedback from operators has prompted improvements from manufacturers. Indeed, when these heating lines, designed to prevent components from freezing, are exposed to extremely low temperatures, they can become inoperative, resulting in inefficient heating and potential system failures (ASTSBC, 2024). Additionally, challenges with regenerative braking systems have been noted, with some manufacturers disabling this feature when the battery is over 90% charged, leading to safety concerns; one bus lost its brakes and had to rely on pedal braking (ASTSBC, 2024).

Air brakes are still a concern for the upcoming winter due to the compressor freezing, making the buses inoperable, especially in P.E.I. Moisture and wind exacerbate this issue. Since the buses are manufactured in the U.S., they haven't been adequately tested for Canadian winter conditions (Collins, 2024). This is not a concern in Quebec as most buses have hydraulic brakes (Langlois, 2024).

There have been ongoing maintenance issues with ESBs, primarily related to heaters and air brakes. In P.E.I, repairs have been slow. Out of 107 buses, only 5 to 6 heater repairs have been completed, each taking about eight hours, with an expected six months to address all repairs due to parts supply delays. There is even a reported 240-day wait for repairs on one bus(Collins, 2024). School bus operators are feeling the strain as well. For instance, Autobus Chambly reports that while around 7% of its diesel buses are typically under repair, this number jumps to 15% for ESBs, highlighting the greater maintenance challenges associated with ESBs (Langlois, 2024).

Figure 6: Summary of logistical issues during ESB adoption



Maintenance challenges are further exacerbated by the lack of adequate repair services. Autobus Chambly has expressed concerns over prolonged downtimes, citing persistent issues with the ESB manufacturer's service team, which has consistently missed repair deadlines and failed to meet service expectations (Langlois, 2024). In P.E.I., new concerns have emerged regarding cracks in the fiberglass paint of some ESBs, with visible rust appearing underneath (Collins, 2024).

In Quebec, all these logistical challenges associated with ESBs are leading many operators to invest in older models to extend their lifespan. This strategy allows them to maintain operational flexibility, as they can use a traditional bus as a backup when an ESB is out of service. Additionally, they can prolong the lifespan of these older vehicles, as regulations permit their operation for up to 14 years with proof of an order for an ESB (Charbonneau, 2024).

Box 4: Conundrum with fossil-fueled heaters

To cope with harsh winter conditions, ESBs rely on fossil-fueled heaters to conserve battery range. While electric heaters are effective, they consume 35-40% of the bus's charge, rendering a substantial portion of the school buses inoperable across Canada; this includes up to 80% of ESBs in P.E.I. (Collins, 2024).

However, fossil-fueled heaters also present challenges. Malfunctions can create icy conditions inside the bus, leading to the freezing of critical components like air compressors, which are vital for air brakes and suspension systems. This can severely impact bus safety and performance. Other diesel heater issues include moisture intrusion into the electronics, which requires annual maintenance (Collins, 2024).

Health concerns are associated with these heaters as well. Monitoring by NB Lung, Ecology Action Centre, and Canadian Conservation Council of New Brunswick revealed an average CO_2 concentration of 518 ppm inside moving buses, compared to 441 ppm during idling. For Autobus Chambly, using 100 liters of heating oil every two weeks raises concerns, especially since there are no pollution standards governing heating emissions (Langlois, 2024).

3.5. KNOWLEDGE, AWARENESS AND TRAINING

The shortage of appropriate training programs emerges as a significant obstacle hindering the widespread adoption of ESBs.

Across various provinces, a distinct lack of training programs designed for the maintenance of zero-emission MHDVs is evident (Delphi Group et al., 2023). There is pushback from technicians regarding the lack of high-voltage training. While manufacturers assert that ESBs require minimal maintenance, technicians feel that training is essential for safety (ASTSBC, 2024). Two notable challenges associated with ESB maintenance training, as reported by surveyed fleets operators from Quebec, are the insufficiency and inadequacy of the provided training programs and the shortage of qualified maintenance workers capable of working with zero-emission MHDVs (Équiterre & Propulsion Québec, 2023). In addition, Ontario colleges currently lack specialized training programs for motive power technicians specializing in zero-emission MHDVs. In P.E.I., an electrical charging course is offered, but it does not cover high-voltage systems. Lion is expected to assist a local college in setting up the high-voltage course, which is still in progress but not available as of September (Collins, 2024).

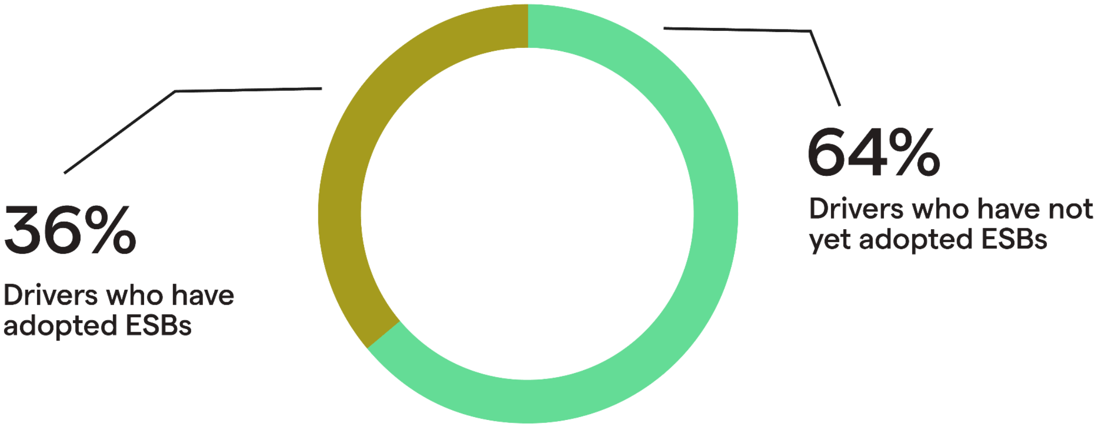
To address this, in B.C., technical schools are offering MHDV training programs, alongside training from original equipment manufacturers (OEMs). For instance, Lion Electric stands out by delivering a range of training initiatives for mechanics, drivers, and school district personnel as an integral component of its Learning Academy service. Collaborations are underway to develop a training program focused on high-voltage systems and safety, aimed for implementation soon with Clean BC (ASTSBC, 2024). In Quebec, the MTMD plans to implement training programs related to transportation to support the electrification of the sector. A specific program for electric heavy vehicles will be available, which includes training for medium and heavy vehicles. This initiative has involved training master trainers who will subsequently instruct cohorts of new drivers. Additionally, some manufacturers have lent buses for use in these training programs at various training centers (Charbonneau, 2024).

Due in part to the absence of training programs for drivers and technicians, a significant gap in knowledge and awareness emerges as an additional challenge in the journey toward adopting ESBs. In many provinces, fleet managers grapple with the lack of essential information, resources, and logistical support needed for a smooth transition and operational continuity with ESBs. As an instance, school districts within B.C. necessitate understanding the existing sources of funding and demand technical assistance in choosing, setting up, and managing suitable charging infrastructure (Pembina Institute, 2022). To help those in B.C., ASTSBC offers hands-on assistance for filling out applications and maintains a relationship with BC Hydro, which conducts initial assessments for districts considering fleet transitions and plans transformer upgrades accordingly.

Meanwhile, in P.E.I., the workforce's incomplete understanding of ESB components constitutes a significant concern. This gap in knowledge translates into extended periods of repair and maintenance cycles, directly affecting operational efficiency (Huntington & Curran, 2022).

From the school bus operator's perspective, a key challenge is convincing drivers to transition to ESBs. At Autobus Chambly, for example, 16 out of 44 drivers have made the switch. The company acknowledges that drivers have mixed feelings about ESBs, which they test out during summer programs like day camps. Many are initially hesitant, largely due to the high number of retirements and an average driver age of 59, leading to concerns about managing battery life and the fear of running out of charge—despite never having experienced an actual breakdown. However, once drivers gain experience and confidence in the vehicles' range and reliability, they strongly prefer not to return to diesel buses (Langlois, 2024).

Figure 7: Driver adoption of ESBs at Autobus Chambly



These deficits underscore the crucial imperative for the development of comprehensive training programs and robust support systems that can facilitate a successful transition to ESBs fleets. This holds significant importance, given that the process of strategizing, procuring, and implementing ESBs by a school bus fleet operator could span over a period of two years or more (Huntington et al., 2022).

4. The Shift to 100% ESBs

Achieving 100% ESBs by 2040 is a key objective outlined by CESBA, aligning with Canada's broader climate goals, such as reaching 35% of MHDV sales as ZEVs by 2030 and 100% by 2040. This transition aims to significantly reduce GHG emissions, improve public health by reducing air pollution, and stimulate the green energy economy, all while lowering long-term operational costs for bus operators.

In a report mandated by CESBA, Pathways for Canadian Electric School Bus Adoption, Dunsky Energy + Climate (2023a) has outlined a roadmap towards achieving 100% ESBs. This pathway required the calculation of the annual number of school buses that would need to be converted to electric, factoring in the current age distribution of the fleet and adhering to a standard retirement threshold of 12 years.

4.1. 2040 SCENARIO

To reach this target, an average of 2,850 school buses must be converted to ESBs annually from 2023 to 2040, accounting for the fleet's current age and a standard retirement threshold of 12 years. This consistent conversion rate ensures a smooth transition, with variations allowed to adapt to supply chain limitations in the early years. The total capital investment required is substantial—approximately $1.25 billion in 2023, gradually decreasing to $1.01 billion by 2040 as ESB costs decline. Over the transition period, the capital expenditure for ESBs will be roughly 2.5 times that of traditional diesel buses.

Table 2. Distribution of new school bus purchases as a percentage under a 100% by 2040 target with a consistent annual ESB adoption rate

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual School Bus Retirements	5,578	5,578	3,370	3,370	3,370	3,370	3,370	3,890	3,890	3,890	3,890	3,890	3,890	5,578	5,578	3,370	3,370	3,370
ESB Replacements	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857	2,857
ESB Share of Annual Replacements	51%	51%	85%	85%	85%	85%	85%	74%	74%	74%	74%	74%	74%	51%	51%	85%	85%	85%

Source: Dunsky Energy + Climate (2023a)

A key factor supporting this transition is the anticipated increase in ESB and battery production capacity. By 2030, North American battery production is expected to exceed 1,000 GWh annually, with ESBs requiring only 0.5 GWh for complete electrification by 2040 (Dunsky Energy + Climate, 2023a). However, despite this promising outlook, challenges such as supply chain constraints and the need for adequate charging infrastructure could slow progress.

Acting now to reduce a tonne of carbon emissions has a more significant impact on mitigating climate change than delaying action. Additionally, an earlier transition to fully ESB fleets would result in quicker improvements in air quality for communities and cost savings for school bus operators, along with quieter and more comfortable rides.

5. Recommendations for Swift Transition

To make the goal of a 100% ESB fleet by 2040 a reality, Canadian jurisdictions must adopt various proactive measures aimed at promoting and prioritizing the electrification of school bus fleets. A summary of these recommendations and their respective jurisdictions can be found in **Appendix F**. It should be noted that most of the recommendations stem from the work of CESBA's steering committee members.

Policy Standards and Funding

5.1. ENACT POLICY STANDARDS TO INTEGRATE ELECTRIFICATION WITHIN CURRENT FRAMEWORKS

Specific jurisdictions should consider initiating a commitment to transition to a 100% ESB fleet. This entails enacting legislative modifications that firmly embed the electrification of school buses within the policy framework of the respective jurisdictions.

For example, the Government of N.S. could make school buses part of the strategy for transportation electrification alongside transit buses. N.B. could do similarly by expanding its future EV strategy to include school buses and other MHDVs. Ontario could integrate ESB targets within its provincial policies and programs. Embracing this approach, CESBA advises these jurisdictions to articulate the requisite incentives, regulations, policies, and programs essential for achieving their ESB adoption goals.

Simultaneously, as the transition to ESBs fall under the current target to achieve 35% of total MHDVs sales being ZEVs by 2030 and 100% by 2040, there is a call for the Government of Canada to establish a nationwide mandate of 100% ESB sales, as proposed by Dunsky Energy + Climate (2023a). CESBA is confident that this initiative is geared towards ensuring a plentiful supply for the Canadian market, empowering jurisdictions to fully and effectively achieve their commitment to 100% ESB adoption.

In response to short ranging in ESBs, mandating minimum battery capacity for ESBs for bus manufacturers is essential. For example, CESBA suggests that the Government of B.C. should stipulate a minimum 200kWh battery requirement for type C and D ESBs from manufacturers. This could be applied to other jurisdictions such as Quebec where battery production tailored for MHDVs is substantial.

To further mitigate delivery delays as well as ESB short-range challenges, funding programs should extend their scope to include a wider array of ESB models eligible for funding, without confining them solely to assembly within Canada. For instance, CESBA urges the Government of Quebec to broaden the eligibility criteria of PETS, thereby encompassing bus models equipped with more advanced technologies.

Box 5: Exploring the potential of price caps in the ESB industry

Despite promises that ESBs would become cheaper over time, ESBs are significantly more expensive than diesel buses due to several factors: low economies of scale, as ESB sales remain limited; manufacturers passing fixed costs of new technology onto consumers; and price inelasticity from school districts under public pressure to electrify, reducing their bargaining power. One of the other major reasons are manufacturer price markups for ESBs that vastly exceed the implicit cost of the battery, likely due to a small number of manufacturers controlling the market. Markups are ten to almost fifteen times the battery cost, depending on the assumption of the battery cost per kilowatt-hour and the type of school bus (Spiller, 2024).

Given these dynamics, further research is needed to explore the feasibility and impact of implementing price caps in the ESB market. A dedicated project could analyze how price caps might alleviate financial pressures on governments and school boards while ensuring economic sustainability for manufacturers. By examining historical precedents, such as price caps used during the COVID-19 pandemic (Weber, 2021), World War II, and in regulated markets like rent control and utilities (Tucker, 2021), this research could provide valuable insights into how price caps might reduce ESB costs and limit reliance on subsidies. This in-depth analysis would inform future discussions and decision-making within the ESB ecosystem.

5.2. INCREASE PROVINCIAL SUBSIDIES TO COVER THE FULL CAPITAL COSTS

CESBA advocates for an establishment or augmentation of provincial subsidies to fully offset the capital expenses of ESB fleets. This approach alleviates the burden on fleet operators, eliminating the additional costs associated with ESBs in comparison to their diesel counterparts.

This emphasizes CESBA's urging for governments across provincial jurisdictions, regardless of whether they possess very limited or no provincial funding for ESB transitions, to embrace funding initiatives mirroring Quebec's PETS and CleanBC Go Electric Fleets program. This could apply to all jurisdictions lagging in the transition to ESBs, including Ontario, Manitoba, Nunavut, New Brunswick, Alberta, Newfoundland and Labrador, Nova Scotia, Yukon, and the Northwest Territories.

In Ontario, the government could offer provincial funding that aligns with the federal ZETF program, waive provincial sales tax for ESBs, increase the Ministry of Education budget to launch ESB pilot programs, and extend fleet operators the opportunity to access low-interest financing solutions (Delphi Group et al., 2023). The grants could be phased out when ESBs approach price parity with diesel school buses.

Box 6: A policy recommendation to enhance Ontario's Transportation Services Allocation for ESBs

To initiate and expedite the adoption of ESBs in Ontario, we recommend modifying the Transportation Services Allocation, a new funding framework from the Ontario Ministry of Education, to enhance the attractiveness of ESB investments for school boards and operators (Ontario Ministry of Education, 2023).

1. **Vehicle Component Adaptation:** Revise the capital funding formula to account for the higher upfront costs of ESBs by increasing the annual amortized cost allocation. This should include adjustments for reduced fuel costs and increased maintenance needs, such as battery replacement, charging infrastructure, and specialized repair services. Additionally, introduce a separate funding provision for charging station installation.
2. **School Bus Driver Component Adaptation:** Adapt the Driver component to incorporate specialized training for ESB operation, including battery management and safety protocols. Increase the existing $500 per route per year training provision to reflect the additional education needed. Finally, implement a retention and recruitment bonus for ESB drivers to

facilitate workforce transition and ensure adequate driver availability for ESB routes.

CESBA recommends the Government of B.C., the Government of Quebec and the Government of P.E.I. to extend their various respective funding sources to further provide ongoing assistance to fleet operators in a context of supply chain disruptions and consequent raw materials price inflation. In other words, provinces with existing funding programs, such as Quebec, B.C. and P.E.I, should consider amplifying their provincial funding allocation. In 2023, CESBA, responding to fleet operators' concerns about the declining subsidies of PETS amid raw materials inflation, urged the Quebec government to raise the ESB purchase assistance to $150,000 to adjust for inflation. In response, the Quebec Government not only restored financial assistance to $150,000 for the 2023-2024 school year but also extended an extra $25,000 in assistance for bus models equipped with batteries of 155 kWh and beyond. However, since school bus operators still need to cover approximately $250,000—about $100,000 more than the cost of an ICE school bus—CESBA recommends that the Government of Quebec enhance and renew the PETS by either increasing subsidies to cover at least 80% of the cost difference between ICE buses and ESBs or raising the funding to $250,000 per ESB, to effectively address the financial barriers faced by operators and ensure the program's success.

5.3. EXTEND FEDERAL FUNDING PROGRAMS FOR ESBs

In the short term, there's a substantial need for capital to support the nationwide transition to 100% ESBs. Since ESBs won't reach price parity with ICE buses by 2040, the federal government must allocate additional funds now (Dunsky Energy+Climate, 2023a). With federal funding, the total cost of ownership of an ESB becomes 21% lower than a diesel bus. To reach 100% ESBs by 2040, in line with the federal target for MHDV sales, almost 3,000 diesel models will have to be replaced next year (Dunsky Energy+Climate, 2023a), requiring $375 million in federal funding (assuming provincial matching). This added funding should be exclusively for ESBs, as transit projects have absorbed most of the ZETF. Therefore, as suggested by the Green Budget Coalition, CESBA recommends allocating $375 million in bridge funding specifically for school bus electrification, pending potential ZETF extension or restructuring.

Moreover, CESBA recommends allocating an additional $2.5B in dedicated funding for school bus electrification from the Canada Public Transit Fund between 2027 and 2032. CESBA also calls on the federal government to ensure additional funds for the ZEVIP after 2027.

5.4. REVIEW AND STREAMLINE FUNDING PROGRAMS STRUCTURE

CESBA advises the federal government to reevaluate funding allocation structures, aiming to mitigate competition between federal and provincial funding initiatives and increase equitable access to ESBs. This approach streamlines application procedures, curbing administrative delays for fleet operators while lowering barriers to capital funding.

The Government of Canada should consider replacing the second phase of the ZETF capital application process with a point-of-sale rebate mechanism to streamline applications and enhance budgetary certainty for fleet operators during the construction phase, while also addressing potential incompatibilities with Quebec's funding program.

With the aim of streamlining administrative processes, the Government of Canada should also contemplate dividing both ZETF and ZEVIP into distinct funding channels tailored to student transportation and transit electrification endeavors. In a context where a major share of ZETF funding goes to public transit agencies, this strategic division ensures an earmarked funding avenue solely for ESBs, guaranteeing ample financial support for ESB acquisitions. In this division, the ZETF should also earmark funding for Indigenous communities and other higher-needs populations, as is currently done in ZEVIP.

Further steps can be taken to ease the application burden for federal funding, including establishing direct or automated access to the ZETF. Simplifying and expediting the ZETF process would be particularly beneficial, as the current system does not align well with the demands of school boards, fluctuating market prices, and procurement timelines. This misalignment often results in applications becoming outdated by the time they are reviewed (For Our Kids, 2024). Streamlining the process would also enhance accessibility for Indigenous and low-income communities, which may lack the resources to navigate the existing complex application requirements.

Moreover, up-front funding to cover capital costs prior to purchases, rather than post-purchase disbursements, is essential to ease cash flow challenges for operators and accelerate the adoption process. School transportation operators face significant delays, with 8 months of waiting for charging infrastructure subsidies and 4 to 8 months to receive electric buses, further exacerbating financial and operational burdens.

Box 7: Collaborative funding and transparency for ESB charging infrastructure

CESBA recommends that actors nationwide collaborate to designate a suitable independent entity to apply for funding from Natural Resources Canada's ZEVIP program. The goal is to establish a dedicated funding stream, managed by a third-party organization, to support the procurement and installation costs of EV charging infrastructure for school bus operators. Additionally, it is crucial that the decision-making process be transparent, as communication with applicants has been problematic, with many finding it difficult to obtain timely or clear information. Improving transparency and communication will help address these challenges and further support ESB adoption (For Our Kids, 2024).

Charging Infrastructure

5.5. INCREASE ACCESSIBILITY TO CHARGING INFRASTRUCTURE AND IMPROVE NETWORK CONNECTIVITY

CESBA urges all jurisdictions to enhance their funding allocations for charging infrastructure, with a particular emphasis on developing infrastructure in rural and remote areas to support the widespread adoption of ESBs. For example, CESBA suggests that the Ontario government broaden its existing $91M commitment towards chargers to encompass the installation of charging stations for ESBs directly at schools.

In N.B., the government could amplify collaboration with NB Power and private partners involved in the eCharge Network particularly concerning the establishment of charging stations dedicated to school buses. This would help to facilitate a seamless transition to ESBs in the province.

Jurisdictions should also make the eligibility conditions for financial assistance for charging infrastructure more flexible. This adjustment would enable the provision of financial assistance for charging infrastructure requests to be provided at the time of order placement to accelerate the start of installation works and the circulation of ESBs. This would mirror Quebec's government recent announcement that allows for the submission of financial assistance applications for charging infrastructure prior to ordering the ESBs.

As the prevalence of ESBs grows, managing charging infrastructure can pose challenges. To address this, jurisdictions are encouraged to collaborate with their main electric utilities and grid operators to ensure that the electrical grid is adequately prepared to accommodate the increased demand from ESBs, while also streamlining power grid connections and minimizing delays. For example, CESBA asks the Government of Quebec to collaborate with Hydro-Québec to expedite power grid connection procedures.

CESBA recommends the establishment of comprehensive standards for the installation and maintenance of charging infrastructure at schools and bus depots, ensuring both sufficient capacity and accessibility. Governments should introduce regulations to standardize ESB charging infrastructure and ensure universal compatibility.

Box 8: A policy recommendation to address high electricity costs for ESB charging

CESBA recommends that jurisdictions implement policies to mitigate the financial burden of demand charges associated with charging infrastructure. Demand charges, which occur when energy usage spikes above a certain threshold, can significantly increase operational costs, particularly for school districts. This is especially relevant when using Level 3 chargers, which have high energy consumption and can substantially increase utility bills due to excessive demand charges. CESBA further recommends that jurisdictions explore incentives or funding mechanisms to offset demand charges for ESB charging infrastructure, particularly in areas where these costs could undermine the financial viability of adopting ESBs.

5.6. EXPLORE THE ECONOMIC AND ENERGY POTENTIAL OF ESBs IN V2G TECHNOLOGY

CESBA recommends that governments investigate the economic and energy opportunities offered by V2G technology as they transition towards the full implementation of ESBs (see **Appendix E**).

This might involve assessing factors such as the capacity of ESBs to store and provide energy back to the grid during peak demand periods, the potential cost savings and potential revenue streams for both bus fleet operators and utilities through financial modeling, and the overall impact on grid stability and energy efficiency. This could also lead to establishing systems to monitor and analyze data from ESBs participating in V2G programs, tracking energy flows, vehicle performance, and overall system impact. As an example, ASTSBC is exploring V2G possibilities and addressing capacity issues during peak demand by considering mega chargers in larger districts.

CESBA encourages school bus companies and school transportation boards (STBs) to undertake pilot programs to assess technological and regulatory challenges related to V2G implementation, with a special focus on ESBs as a potential application. It is imperative to analyze the regulatory barriers within provincial utility frameworks that may hinder V2G implementation. Such pilot initiatives hold the potential to enhance the economic viability of ESBs, advocate for regulatory modifications, and expedite the widespread adoption of this technology.

However, several significant concerns regarding V2G implementation must be addressed and taken into account. A primary issue is the limited operational time for V2G to be effective, as school buses are often in use for driving or charging during critical periods. Moreover, the charger requires a generator to operate during power outages, which adds an additional layer of complexity to its use. In P.E.I, there are also additional costs related to V2G. Implementing V2G would necessitate the installation of level 3 chargers, which significantly raises costs—estimated at $30,000 per charger, compared to $3,000 to $5,000 for home level 2 chargers. Furthermore, Maritime Electric, the main electricity supplier of P.E.I, has expressed reservations about allowing multiple level 3 chargers due to concerns over potential strain on the electric grid. The Department of Energy of P.E.I government is actively investigating these challenges (Collins, 2024).

Administrative and Logistical Issues

5.7. REVIEW THE RETIREMENT STANDARDS OF ICE BUSES

Governments are advised to implement policy measures aimed at phasing out aging diesel buses. In the context of Ontario, CESBA advocates for the introduction of a scrappage program (Delphi Group et al., 2023). This program, typically spearheaded by non-profit organizations with federal or regional government support and supervision, would provide financial incentives to fleets for both replacing older ICE school buses with ESBs and repowering existing ICE buses into ESBs, promoting fleet modernization. To help retire the current ICE buses in Ontario, CESBA also recommends Ontario's Ministry of Education to end the school bus diesel subsidy at 98¢ over time (Ecology Ottawa, 2023a).

Box 9: Extending the operational lifespan of existing ICE buses to manage better ESB demand and transition

CESBA suggests that the federal government collaborate with provinces to temporarily extend the operational lifespan of existing ICE buses. This approach aims to mitigate the sudden surge in demand for new ESBs required in the short term, further preventing potential bottlenecks in supply. To explain, when transitioning to ESBs, there might be a surge in demand for new ESBs, which could create logistical and financial strain on school districts and fleet operators. Extending the retirement age of existing ICE buses temporarily can help manage this transition period more smoothly. By allowing existing ICE buses to remain in service for a limited additional period, it can reduce the immediate need for a massive influx of new ESBs, giving school districts and fleet operators more time to plan for and gradually integrate the new ESBs into their fleets.

Another reason for this policy recommendation is that if there is a sudden push for ESBs, without a reasonable transition plan, fleet operators might be forced to make hasty decisions, including ordering new ICE buses, just to maintain their operations while they wait for ESBs to become available or for the transition process to be adequately planned. This could lock them into a cycle of continuing to use ICE buses for another possible 12 years, delaying the progress toward electrification.

5.8. REVISE EXISTING CONTRACTS WITH FLEET OPERATORS

In order to address the challenge revolving around the current length of contracts that exist with fleet operators, CESBA encourages STBs to increase the duration of contracts from the current 5 years to 10 years. Extending the duration of contracts would diminish the financial uncertainty associated with ESB acquisitions, enabling the utilization of ESBs' operational cost savings over an extended period within the vehicles' lifespan.

CESBA advises the Departments of Education across Canadian provinces and territories to conduct a financial analysis to determine an appropriate ESB allocation within transportation contracts. They should also consider incorporating a requirement into contracts, stipulating that a certain proportion of ESB purchases must be made when ICE buses reach the end of their operational life. Smaller operators may be granted exceptions in this regard. To further facilitate this transition, CESBA suggests the creation of a standardized resource or template to help school boards and transportation consortia incorporate ESB requirements into their RFPs with fleet operators, ensuring consistency and clarity in the procurement process.

Moreover, the funding allocated to STBs by Departments of Education for school bus operations should be augmented proportionally to account for the additional costs associated with ESB requisites. This incremental rollout would provide school bus service operators with the opportunity to acclimate to ESB operations and glean valuable insights. This process will equip them to expand ESB adoption as the total cost of ownership steadily approaches equivalence with ICE school buses.

Knowledge, Awareness and Training

5.9. INVEST IN TRAINING PROGRAMS FOR ESB OPERATION AND MAINTENANCE

CESBA encourages governments to offer subsidized ESB maintenance certification programs for existing MHDVs mechanics. With the growing adoption of ESBs, a proficient workforce will become essential for servicing and upkeeping the new

ESB fleet. In Ontario, the provincial government could broaden Ontario's Skills Development Fund to include training for ESB manufacturing, maintenance and repair as well as create an ESB/EV module for secondary schools with automotive programs. In British Columbia, CESBA recommends expanding the BC Institute of Technology's training capabilities and funding to include specialized ESB maintenance courses, while also integrating an ESB module into ASTSBC's existing training programs to equip school boards and operators with essential EV technology skills. These jurisdictions could learn from Québec who has multiple training programs for EV maintenance workforce. One example is Camoroute's continuing education program in electric bus mechanics which offers 30 hours of training for mechanics in transportation companies, with a 24-hour electrical upgrade if necessary and subsidized at 85% of employees' hourly wage during the training (Camoroute, n.d.).

Recent studies demonstrate that many cities engaged bus manufacturers for maintenance services upon integrating electric buses into public transit systems (Li et al., 2019). This points to a gap in expertise among maintenance personnel in handling electric powertrain technologies; and underscores the necessity for training and certification programs aimed at equipping existing heavy-duty diesel mechanics with the skills required for ESB fleets. Such training and certification not only enhance confidence in the technology but also cultivate advocates within fleet depots, mitigating any apprehension or reluctance toward the transition to ESBs. This approach also helps alleviate potential labor shortages as more bus operators transition to electrifying their fleets.

Jurisdictions without a zero-emission MHDVs maintenance training program can draw inspiration from the approach taken by the government of B.C. Through collaboration with colleges and universities, B.C. is introducing a pioneering EV Maintenance Training program (2022).

CESBA also suggests that fleet operators offer drivers retraining tailored to ESB technology. The objective is to strengthen drivers' acceptance of this technology while promoting driving practices that optimize battery efficiency and minimize operational expenses. This strategy aligns with Quebec's *Transportez Vert* program, which includes subsidizing 50% of costs for eco-driving training, with a cap of $1,000 per session, and providing complimentary training for eco-driving instructors (Gouvernement du Québec, n.d.).

5.10. INCREASE AWARENESS OF ESB BENEFITS AND EXISTING FUNDING PROGRAMS

CESBA suggests endorsing capacity development for school districts and other school transportation actors, while concurrently conducting educational and outreach efforts to enhance their awareness of potential funding avenues. As an instance, the Government of N.S. could undertake outreach and educational endeavors regarding the accessible funding for ESBs in collaboration with the Halifax Regional Centre for Education and other pivotal actors within the province.

Awareness could go beyond funding venues to ensure that fleet operators are well-informed of support mechanisms that can help with planning and strategy development, procurement and infrastructure, equity and community engagement and technological integration, such V2G technology.

For example, the Ontario Government and school boards could initiate the creation of guides and toolkits aimed at facilitating the transition to ESBs. These resources might encompass aspects like formulating strategies for fleet electrification, procuring vehicles, pinpointing funding outlets, and exploring potential regional charging partnerships for field trips and sporting events. With the aim of maximizing public messaging to the public, the Government of Ontario and the non-profit sector could collaborate to produce public education and awareness materials focusing on the health advantages of ESBs.

CESBA also suggests that the federal government develop awareness campaigns, utilizing initiatives like the Zero-Emission Vehicle Awareness Initiative (ZEVAI), to ensure that school bus operators are well-informed about the advantages of ESBs, as well as the funding programs and potential revenue sources accessible to them. In addition, appropriate third-party organizations could offer technical assistance to school bus fleets in provinces to facilitate access to federal ZETF funding. These campaigns should also work to dispel misconceptions about propane's environmental impact, emphasizing the superior environmental and health benefits of ESBs compared to propane-powered alternatives.

CESBA encourages strong support to actors in enhancing their knowledge about ESBs by providing comprehensive guidance on best practices for successful adoption, and by actively engaging with actors to streamline their access to technical assistance.

5.11. SYSTEMATIZE DATA COLLECTION AND INFORMATION SHARING

CESBA advises the establishment of a centralized database for operational data of ESBs. This database would facilitate data collection and knowledge exchange among provinces, reducing the necessity for repeated pilot projects. Managed at the federal level, it would enhance accessibility to ESB operational data concerning battery performance in diverse temperature conditions and the resilience of electric components in challenging weather environments, like snow and salt.

CESBA recommends investing in research to collect valuable data on the feasibility and benefits of using ESBs, particularly in rural and remote areas. The findings should be disseminated province-wide to support informed planning and implementation, ensuring that all actors can effectively leverage the insights gained from the research. Moreover, CESBA further suggests standardizing field data collection and promoting information sharing among school transportation providers within provinces.

CESBA advises governments to allocate funds for research focused on the conversion of school transportation systems. Investing in research in the field of conversion for school transportation is crucial because it can provide insights into the most effective and efficient methods of transitioning from ICE buses to ESBs. Such research can help identify technological advancements, operational considerations, and financial implications associated with the conversion process. Additionally, research in this area can facilitate the development of standardized practices, guidelines, and best practices that contribute to a smoother and more successful adoption of ESBs.

Conclusion

The path to fully transitioning to ESBs in Canada by 2040 is filled with both opportunities and challenges. This report highlights the complex landscape involved in the adoption of ESBs.

The benefits of transitioning to ESBs are manifold. ESBs offer a promising avenue for Canada to align with its targets of reducing GHG emissions. By promoting cleaner air, reducing noise pollution, and stimulating economic growth, the adoption of ESBs can result in healthier communities and more sustainable transportation systems. These buses are not only a step towards a greener future but also a pathway to job creation in the green energy sector.

The transition to ESBs involves a complex interplay of challenges, including high costs for buses and charging infrastructure, logistical issues like limited range and harsh winter impacts, and administrative barriers such as complex funding applications. Additionally, the lack of training for maintenance personnel, knowledge gaps among fleet managers and drivers, and the need for greater focus on equity considerations further hinder adoption.

To accelerate the transition, this report has provided a comprehensive set of recommendations aimed at addressing these barriers and promoting the adoption of ESBs. They call for increased government subsidies to cover the full capital cost of ESB fleets as well as an ESB price cap, along with extending federal and provincial funding programs. Enhancing accessibility to charging infrastructure and improving network connectivity are also vital aspects of the transition. Administratively, there is a need to streamline funding programs and review contract structures with school transportation operators. Moreover, investing in training programs for maintenance and operation, as well as providing driving retraining adapted to ESB technology, is essential to bridge the knowledge gap. Heightening awareness among actors about ESB benefits and existing funding programs is also crucial. A more extensive dive into equity considerations and the accompanying recommendations will be provided in the coming months in a separate report. By implementing the recommendations outlined in this report, Canadian jurisdictions can work towards a greener, more sustainable, and healthier future for the generations to come.

Appendices

APPENDIX A. METHODOLOGIES FOR CALCULATIONS

GHG emission reduction estimate across Canada

We took the Government of P.E.I's estimate that replacing a conventional diesel bus with an ESB can reduce GHG emissions by 23 tonnes (Government of P.E.I., 2021b). To calculate the total GHG reduction for the entire Canadian school bus fleet, we multiply the per-ESB reduction by the total number of school buses in the fleet. In this case, it's 23 tonnes per ESB multiplied by approximately 51,000 ESBs (Task Force on School Bus Safety, 2020). The result of this calculation is that electrifying Canada's entire bus fleet has the potential to remove approximately 1.17 million tonnes of GHG emissions annually.

Potential healthcare savings across Canada

This calculation was determined by multiplying the estimated healthcare savings per ESB over 12 years, which is $11,800, by the total number of school buses in the Canadian fleet, which is 51,000 (Pembina Institute, 2022). This multiplication provides an insight into the potential healthcare savings that could be realized if the entire Canadian school bus fleet were to transition to 100% ESBs.

Number of one-way flights from Halifax to Vancouver

The calculation involves finding the equivalent of 1.17 million tonnes of GHG emissions avoided annually, which results from having a 100% ESB fleet, in terms of the GHG emissions produced by one-way flights between Halifax and Vancouver, which is approximately 706.8 kilograms of CO_2 per flight.

To perform this calculation, you would divide the annual GHG emissions avoided by the emissions from one flight:

$$Equivalent\ Flights\ Avoided\ = \frac{Annual\ GHG\ emissions\ Avoided\ after\ full\ electrification\ (CO2e)}{Emissions\ per\ flight}$$

Substituting the values:

$$Equivalent\ Flights\ Avoided\ = \frac{1\ 173\ 000\ tonnes\ CO2e}{0.7068\ kg\ CO2e}$$

When you do this calculation, you'll find the equivalent of 1.66 million one-way flights avoided from Halifax to Vancouver every year due to the GHG emissions reductions achieved by having a 100% ESB school bus fleet. This means that the reduction in GHG emissions is equivalent to the emissions produced by 1.66 million flights between these two cities annually.

Range of total investment required to achieve 100% ESBs in B.C

To calculate the total investment required to achieve Pembina's goal of 100% ESBs in B.C. by 2040, we need to determine the number of buses that need to be replaced during this period, which is 1,210 buses according to data from the Association of School Transportation Services of B.C. (2022). Then, we can estimate the investment range by multiplying this number by $60,000 (representing the lower end) and $147,000 (representing the higher end). The average annual investment required over 16 years was calculated by subtracting the lower funding range ($72.6M) from the upper funding range ($177.9M) to determine the total funding range ($105.3M). This total funding range was then divided by the number of years (16) to arrive at an average annual investment of approximately $6.58M per year

APPENDIX B. SUMMARY OF GHG EMISSIONS REDUCTION TARGET PER JURISDICTION

Jurisdiction	GHG Emissions Reduction Target
Canada	40-45% reduction in GHG emissions below 2005 levels by 2030; net zero emissions by 2050 (2030 Emissions Reduction Plan)
British Columbia (B.C.)	40% reduction in GHG emissions by 2030 and 80% by 2050; 27-32% reduction in transportation emissions by 2030 (CleanBC Roadmap to 2030)
Ontario	30% reduction in GHG emissions below 2005 levels by 2030 (Made-in-Ontario Environment Plan)
Quebec	37.5% reduction in GHG emissions by 2030; 40% reduction in petroleum consumption by 2030; net zero by 2050 (2030 Plan for a Green Economy)
Prince Edward Island (P.E.I.)	40% reduction in GHG emissions below 2005 levels by 2030 (Climate Leadership Act)
New Brunswick (N.B.)	46% reduction in GHG emissions below 2005 levels by 2030; net zero by 2050; 20-40% reduction in GHG emissions from vehicles fleets by 2030 (New Brunswick's Climate Change Action Plan)
Nova Scotia (N.S.)	53% reduction in GHG emissions by 2030; net-zero emissions by 2050 (Nova Scotia's Climate Change Plan for Clean Growth)

APPENDIX C. REGIONAL DISTRIBUTION OF ESBs IN QUEBEC.

Administrative region	Population (2023)	Number of ESBs	Number of ESBs per 10,000 habitants
Bas-Saint-Laurent	202955	77	3,8
Saguenay–Lac-Saint-Jean	283234	68	2,4
Capitale-Nationale	795917	26	0,3
Mauricie	283188	79	2,8
Estrie	516919	109	2,1
Montréal	2124865	353	1,7
Outaouais	418999	67	1,6
Abitibi-Témiscamingue	148797	83	5,6
Côte-Nord	89979	4	0,4
Nord-du-Québec	46703	0	0,0
Gaspésie–Îles-de-la-Madeleine	92104	29	3,1
Chaudière-Appalaches	448665	100	2,2
Laval	451986	106	2,3
Lanaudière	551709	46	0,8
Laurentides	66451	110	16,6
Montérégie	1494119	277	1,9
Centre-du-Québec	260034	72	2,8
Total in Québec	**8874683**	**1606**	**1,8**

Source: Institut de la statistique du Québec. (2024). MTMD. (2024B).

APPENDIX D. ESB TARGETS AND FUNDING PROGRAMS PER JURISDICTION

1) British Columbia

The Government of B.C. has adopted new ZEV targets for MHDVs that are in line with California's targets. The proposed regulation would require **MHDV sales to be 100% ZEVs by 2036** (Government of B.C., 2023).

In B.C., several provincial programs support the electrification of school buses and the installation of charging infrastructure. The Clean BC Go Electric Rebates Program offers rebates for electric buses and infrastructure, although it will no longer be available to public school districts starting in 2024. Type C and D buses are eligible for a minimum of $100,000, and Type A buses for $75,000. The BC Hydro EV Fleet Ready Program, which requires pre-approval, provides 50% of costs for fleet and infrastructure assessments, up to $10,000, and up to 50% for electrical infrastructure upgrades, excluding chargers (ASTSBC, n.d.).

The Clean BC Go Electric Fleet Charging Program provides substantial financial support for the installation of Level 2 and DC Fast Charging (DCFC) stations for eligible entities, such as public school districts, private/independent schools, and First Nations schools. For Level 2 chargers, the program offers rebates covering 50% of project costs, up to $4,000 per charger for public school districts and private and independent schools, and up to 75% for First Nations schools, with rebates capped at $50,000 per applicant or site annually. For DCFC stations, rebates are available for 50% of project costs for public schools and private schools, with varying maximums depending on the charger's capacity—up to $20,000 for a 20-49kW charger, up to $50,000 for a 50-100kW charger and up to $75,000 for a 100-199kW charger. For First Nations schools, DCFC stations are eligible for a rebate covering 75% of total project costs, with specific maximum amounts: $35,000 for a 20-49 kW charger, $65,000 for a 50-99 kW charger, and $90,000 for a 100-199 kW charger. Additionally, rebates are capped per project, amounting to $60,000 for 20-49 kW chargers, $150,000 for 50-99 kW chargers, and $225,000 for 100-199 kW chargers.

The program also offers top-up options, where eligible applicants can receive additional funding to cover up to 75% of project costs. To participate, applicants must receive pre-approval, and the rebates are designed to help cover both charging equipment and associated infrastructure costs, making the program crucial for the expansion of EV charging capabilities across educational institutions. Finally, the Clean BC Commercial Vehicle Pilots Program funds up to 33% of total project costs across buses, chargers, and infrastructure, with minimum deployment requirements for certain vehicle weight classes (Plug In BC, n.d.).

The Ministry of Education and Child Care allocates core bus funding with an annual budget of $23.8 million for the replacement of buses that have reached the end of their service life. Of this budget, $9 million is specifically designated for the purchase of ESBs (Government of British Columbia, 2024). Additionally, based on bus size, an extra $25,000 to $30,000 is offered for each replacement. Further, the *Carbon Neutral Capital Program* offers a one-time grant of $50,000 to empower school districts in lowering their carbon footprint. Combined financial support ranges from $100,000 to over $200,000 per ESB.

2) Prince Edward Island

As part of its 2040 Net Zero Framework, the Government of P.E.I. (2022a) has set the goal of **decarbonizing at least 40% of registered MHDVs by 2040 and electrifying half of the province's school buses by 2027**.

In 2021, the government committed to a significant investment of $40.3 million over the next five years (Government of P.E.I., 2021a). This substantial investment, including $6M from Infrasture Canada as part of the Investing in Canada Plan, has already translated into the purchase of 100 ESBs in its fleet of more than 300 vehicles (Bruce, 2024).

3) Quebec

Quebec has committed to **electrifying 65% of the school bus fleet by 2030**, a target adopted as part of the *Programme d'électrification du transport scolaire* (PETS [School Bus Electrification Program]). This initiative aims to provide financial support for school transportation, where the *Ministère des Transports et de la Mobilité durable* (MTMD [Ministry of Transportation and Sustainable Mobility]) offers up to $150,000 for the purchase of an ESB (MTMD, 2024a). The MTMD had initially proposed a gradual reduction in funding for ESBs from 2021 to 2024, anticipating lower costs due to economies of scale (Charbonneau, 2024). However, as prices have increased, the proposed changes for 2022-2023 adjusted the funding structure to maintain fixed amounts over time, introducing a base subsidy of $150,000 with a maximum of $175,000 for ESBs with battery capacity of 155 kWh or more (MTMD, 2024a). Moreover, for charging stations connected to a building, the funding structure is as follows: for Level 2 AC charging stations, the financial assistance covers 75% of eligible expenses incurred for the acquisition and installation of a charging station, up to a maximum of $10,000 per station. For DCFC stations, the funding also corresponds to 75% of eligible expenses, but up to $30,000 per station. Additionally, for charging infrastructure powered by a dedicated electrical supply, the assistance covers 75% of eligible expenses, up to $50,000 per station (MTMD, 2024a). The program will end on March 31, 2025 and will be renewed with changes (Charbonneau, 2024).

This commitment to electrifying school buses is further reinforced by a mandate that took effect on November 1, 2021, **requiring all new school bus purchases to be electric**. Since then, the number of ESB orders has surged to 900 for the 2021-2022 school year and to 1625 for the 2023-2024, as reported by the MTMD (2023; Charbonneau, 2024).

Through the program *Transportez ver*t [Green Transportation], the *Ministère de l'Environnement, de la Lutte contre les changements climatiques, la Faune et les Parcs* [Ministry of Environment, Climate Change, Wildlife and Parks] offers up to $150,000 per year for the installation of DCFC stations, funding for hiring specialists, training in vehicle energy management, and support for school bus operators in planning their fleet replacement. The *Ministère de l'Éducation* [Ministry of Education] provides an annual grant of $7,900 to support the acquisition of ESBs and a one-time amount of $5,000 per operated ESB. The amounts are determined based on the subsidies provided by the MTMD.

4) Federal

While the Government of Canada **has not yet set a specific target for ESBs, they fall within the current target of 35% of total MHDVs sales to be ZEVs by 2030, and 100% by 2040**. However, as this pertains only to the sales of new vehicles, rather than the conversion of the entire fleet to electric by that date, this target falls short compared to those of certain Canadian provinces such as Quebec and P.E.I. (Dunsky Energy + Climate, 2023a).

The federal government does offer several programs to support ESB adoption. The Zero Emission Transit Fund (ZETF), announced in August 2021, allocates $2.4 billion over five years to support the electrification of public transit and school bus operations, including the purchase of zero-emission buses (ZEBs) and the development of necessary infrastructure (Government of Canada, 2023c). The maximum subsidy for capital projects under the ZETF is 50% of the total eligible costs, covering the purchase of ZEBs, charging infrastructure, and other related projects. Additionally, the ZETF offers funding for planning projects, which encompass studies, modeling, and feasibility analyses that facilitate the deployment of ZEBs, with a maximum contribution of up to 80% of the total eligible costs (Crestline Buses, s.d.). In Stage I, eligible applicants must complete an Expression of Interest form and submit it via email to Housing, Infrastructure and Communities Canada, which will assess the project's eligibility and direct applicants to the appropriate project stream. Successful Stage I applicants will then be invited to submit a full application in Stage II for either Planning Projects or Capital Projects (Government of Canada, 2023c).

Natural Resources Canada (NRCan) administers the Zero-Emission Vehicle Infrastructure Program (ZEVIP), providing $680M for EV charging and hydrogen refueling infrastructure (Dunsky Climate + Energy, 2023a). Commencing in June 2019, ZEVIP is currently scheduled to continue until 2027. NRCan has already funded over 40,000 chargers since 2019, with about 30,000 installed. This program is designed to help meet the goal of 84,500 chargers by 2029 (Banks, 2024). Funding allocations per type of EV charger vary, ranging from $5,000 per port for Level 2 chargers to $100,000 per port for Level 3 DCFC stations. NRCan's contribution through ZEVIP is limited to a maximum of 5 million dollars ($5,000,000) per project. ZEVIP also extends funding opportunities to Indigenous organizations and communities for projects centered on EV charger installation in public areas, on streets, within multi-unit residential complexes, at workplaces, and for vehicle fleets. Effective October 1, 2024, the federal government will restrict eligibility for support under the ZEVIP to products manufactured in countries that have established Free Trade Agreements with Canada (Government of Canada, 2023d). NRCan has launched a new Request for Proposals (RFP) under the ZEVIP until September 19 (Banks, 2024).

Additionally, the Canada Infrastructure Bank's (CIB) *Zero-Emission Buses Initiative* (ZEBI) offers direct loans to fleet operators to help facilitate ESB implementation. Repayment of CIB's loans through the initiative is directly derived from the savings resulting from the reduced operational expenses of ESBs compared to the higher operational costs of diesel buses. The CIB also provides tax credits under the Accelerated Capital Cost Allowance program. Specifically, zero-emission school buses fall under class 55, allowing profitable companies to deduct a larger portion of their ZEV purchase in the first year, resulting in enhanced tax benefits (Dunsky Energy + Climate, 2023a; Government of Canada, 2023a).

APPENDIX E. EXPLANATION OF V2G TECHNOLOGY AND ITS APPLICATION TO ESBs

Context	In a context where power outages are expected to increase with extreme weather events, the use of ESBs equipped with V2G technology appears more relevant than ever.
What is V2G?	V2G services function similarly to a battery storage system, offering a wide range of benefits. On the utility side, V2G allows EV batteries to serve as reserve generation system capacity, rapidly responding to changes in overall demand. It also facilitates the acquisition and storage of inexpensive electricity during off-peak hours, enabling the sale of electricity during peak demand periods when prices are at their highest. On the customer side, V2G-capable vehicles can help restore power to the grid during outages. Additionally, V2G participation can assist in reducing peak load and demand charges by utilizing the energy stored in EVs equipped with bidirectional chargers.
Why are ESBs perfect for this?	ESBs are well-suited for V2G participation due to their significant amount of downtime. On average, **school buses are only used for 4-5 hours per day and approximately 190 days per year**. In other words, they spend 80% of weekdays during the school year sitting idle, and for nearly 50% of the year they're not used at all. This provides ample opportunity to harness the energy stored in ESBs for grid benefits.

Source: Dunsky Energy + Climate (2023b)

APPENDIX F. SUMMARY TABLE OF RECOMMENDATIONS WITH EXAMPLES ACCORDING TO SPECIFIC JURISDICTION.

Barriers	Recommendations	Jurisdictions	Examples
Policy Standards and Funding	(1) Enact policy standards to integrate electrification within current frameworks	Federal	Establish a nationwide mandate of 100% ESB sales
		N.S.	Make school buses part of the strategy for transportation electrification
		N.B.	Expand future EV strategy to include school buses and other MHDVs
		All	Set a minimum battery capacity for ESB models to be eligible for grant programs
		Quebec	Expand criteria for models eligible under PETS
	(2) Increase provincial subsidies to cover the full capital costs	Quebec, B.C. and P.E.I.	Extend existing funding sources
		Ontario	Offer provincial funding
			Waive provincial sale tax for ESBs
			Offer low-interest financing solutions regardless of the fleet size
			Modify Ontario's Transportation Services Allocation to enhance funding for ESBs by adjusting capital costs, increasing training support, and introducing incentives for drivers
	(3) Extend federal funding programs	Federal	Allocate $375 million in ZETF bridge funding specifically for ESBs, alongside an additional $2.5 billion designated for ESBs from 2027 to 2032.
			Ensure additional funds for the ZEVIP after 2027
	(4) Review and streamline funding programs structure	Federal	Reevaluate ZETF's and ZEVIP's funding allocation structure to mitigate competition between federal and provincial funding initiatives
			Replace the second phase of ZETF capital application process with a point-of-sale rebate mechanism
			Divide both ZETF and ZEVIP into distinct funding channels for transit and school transport electrification
			Establish direct or automated access to ZETF
			Designate a third entity or government agency in charge of managing and transferring funding demands for ZEVIP

Charging Infrastructure	(5) Increase accessibility to charging infrastructure and improve network connectivity	All	Increase funding for charging infrastructure, with a particular emphasis in rural and remote areas
			Make eligibility conditions for financial assistance for charging infrastructure more flexible, notably by permitting applications to be submitted prior to ordering ESB
			Partner with public utilities and private electricity providers to streamline and accelerate connection of charging stations to the power grid and to ensure that the electrical grid is adequately prepared to accommodate the increased demand from ESBs
			Establish comprehensive standards to standardize the installation, maintenance, and compatibility of charging infrastructure for ESBs at schools and bus depots.
			Implement policies to mitigate demand charges and explore incentives or funding mechanisms to offset these costs for ESB charging infrastructure
		Ontario	Broaden the existing $91M commitment towards chargers
	(6) Explore the economic and energy potential of ESBs in V2G technology	All	Evaluate the capacity of ESBs to meet peak electricity demand and generate income for fleet owners
			Encourage school bus companies and STBs to undertake pilot programs to examine technological, operational, regulatory challenges related to V2G implementation
Administrative and logistical issues	(7) Review the retirement standards of ICE buses	All	Implement policy measures aimed at phasing out aging diesel buses
		Federal	Collaborate with provinces to temporarily prolong the lifespan of existing ICE buses in order to meet to ESB delivery delays
		Ontario	Introduce a scrappage program that provides financial incentives for replacing ICE buses by ESBs or repowering ICE buses into ESBs.
			End the school bus diesel subsidy at 98¢
	(8) Revise existing contracts with fleet operators	All	Encourages STBs to increase the duration of current contracts with fleet operators from 5 to 10 years
			Conduct a financial analysis to determine an appropriate ESB allocation with transportation contracts
			Include contract clause mandating ESB purchases when ICE buses reach end-of-life
			Increase funding to STBs for the operationalization of ESBs
			Develop a standardized template for school boards and transportation consortia to integrate ESB

			requirements into their RFPs with fleet operators, ensuring clarity in procurement.
Knowledge, Awareness and Training	(9) Invest in training programs for ESB operation and maintenance	All	Develop or fund ESB maintenance certification programs for personnel working on ICE MHDV, including school buses
			Develop or fund driver training programs adapted to ESB technology
		Ontario	Expand the Ontario's Skills Development Fund to include training for ESB manufacturing, maintenance, and repair, and create an ESB/EV module for secondary automotive programs
		British Columbia	Enhance the BC Institute of Technology's training capabilities to include specialized ESB maintenance courses and integrate an ESB module into ASTSBC's existing training programs.
	(10) Increase awareness of ESB benefits and existing funding programs	All	Support capacity building for school districts and other school transport actors regarding ESB funding
			Raise awareness of available funding options through information campaigns, being an opportunity to dispel misconceptions about propane's environmental impact.
		N.S.	Develop an awareness and education campaign on ESB funding in collaboration with the Halifax Regional Centre for Education and other relevant actors
		Ontario	Collaborate with school districts and the non-profit sector to produce information tools designed to facilitate the transition to ESBs for school bus operators and the general public
		Federal	Finance, via ZEVAI, awareness-raising campaigns for school bus operators on the benefits of ESBs and the available support measures
	(11) Systematize data collection and information sharing	Federal	Establish a centralized database of ESB operational date to facilitate data collection and access, and knowledge exchange between provinces
			Invest in research on ESBs' feasibility and benefits, standardize data collection, and promote information sharing among school transportation providers
			Invest in research focused on the conversion of ICE buses

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