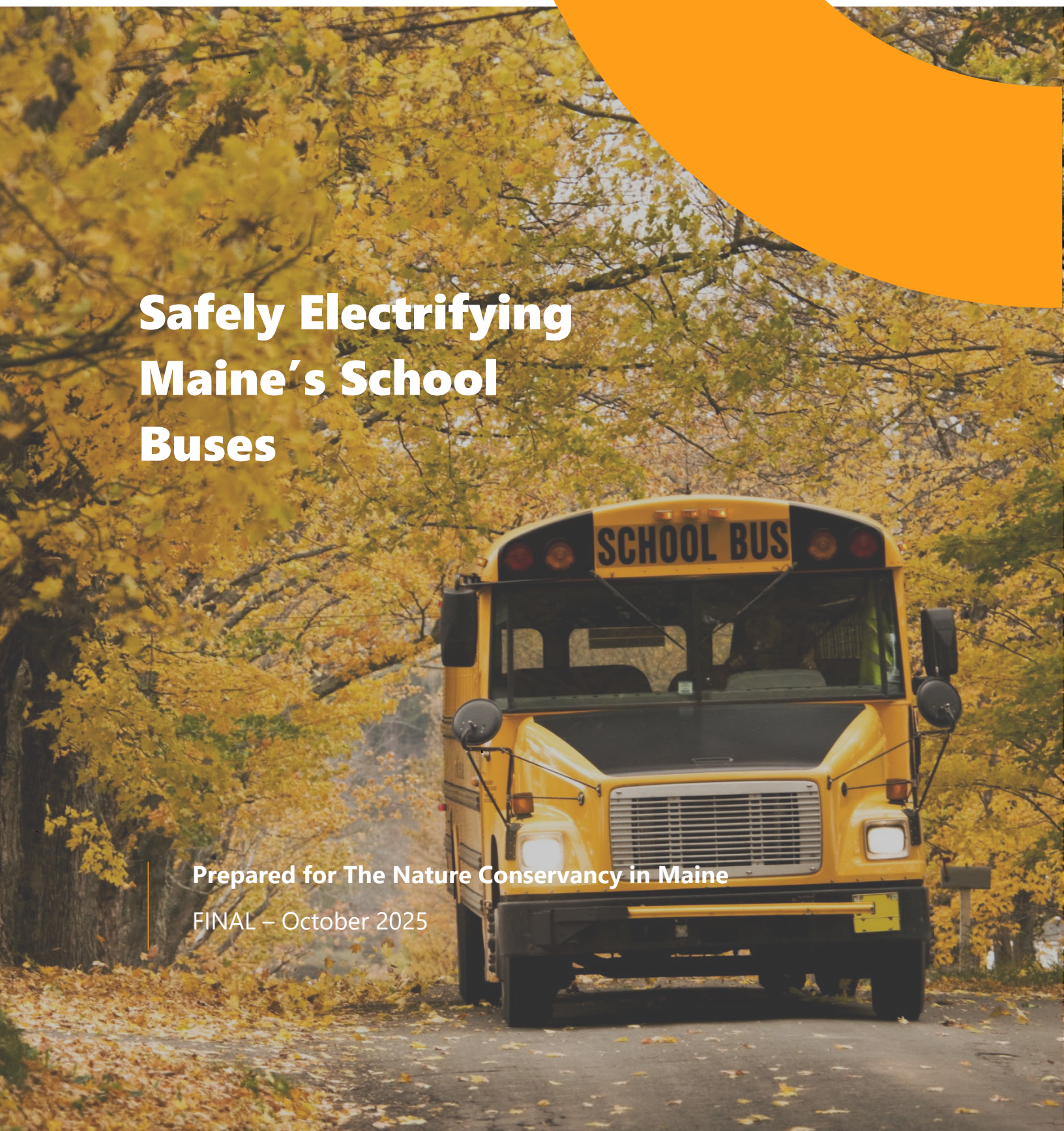
Safely Electrifying Maine's School Buses



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Background

Electric school buses (ESBs) are gaining traction and interest across Maine. With increased energy efficiency and zero tailpipe emissions, ESBs are reducing health risks to students and providing cost savings for urban and rural school districts across the state. Maine has made notable progress in adopting ESBs, with 82 ESBs committed to 29 school districts.[1] Neighboring states in New England are also adopting ESBs, with New Hampshire committed to 117 ESBs and Massachusetts committed to over 400. Maine's current ESB commitment makes up around eight percent of New England's total commitment of roughly 950 ESBs.

Major federal investments have helped make regional ESB adoption possible, including the Bipartisan Infrastructure Law (BIL) and the development of the Clean School Bus Program. Additionally, the Inflation Reduction Act (IRA) provided ESB funding to K-12 schools through tax credits. Under the IRA, districts could claim electric vehicle and charging equipment tax credits and receive funds directly from the IRS for their qualifying project or investment. To date, the U.S Environmental Protection Agency (EPA) has allocated over five billion dollars of funding to qualifying school districts for ESBs across the U.S.[2]

Since January 2025, several executive orders have sought to freeze appropriated funds from the Infrastructure Investment and Jobs Act (IIJA) and the IRA. This puts existing funding and programs at risk, including the EPA Clean School Bus Program. When Congress passed the "One Big Beautiful Bill Act," they moved up the expiration date for electric vehicle (EV) and charging tax credits. As a result, EV tax credits expired September 30, 2025 and charging tax credits will expire on June 30, 2026.[3] For current information on the status of federal funds available for ESBs, schools should consult with federal agency staff in their region.

As leaders in Maine and across the nation continue to pursue ESB adoption moving forward, it is critical that they have facts on ESB safety and reliability they can trust. This case study will serve as a resource on the safety of ESBs using reliable data and sources. School districts can use this information to help make informed decisions when considering whether to purchase an ESB. Policymakers can also use it to inform public policies related to ESB adoption. With strategic resources and planning, ESBs can provide numerous benefits to school districts, students, and communities.

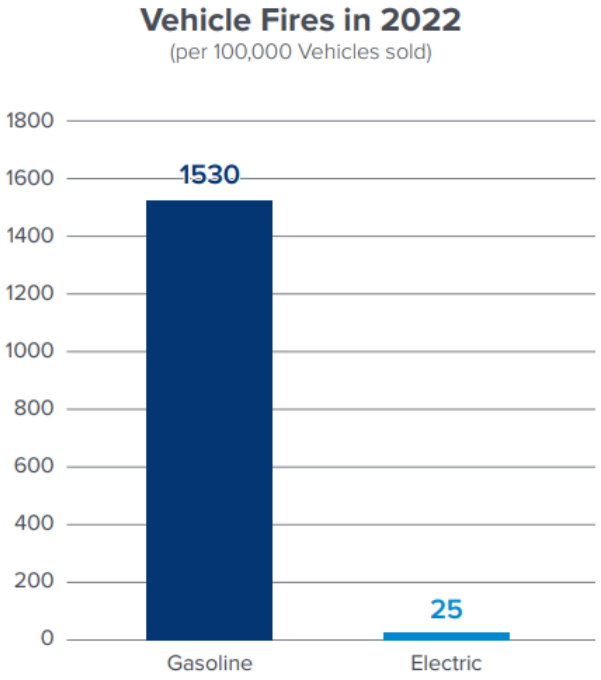
[1] WRI consider an electric school bus "committed" when a school district or fleet operator has been awarded funding to purchase it or has made a formal agreement for a purchase with a dealer or manufacturer.

[2] **Clean School Bus Program | US EPA**

[3] **EV and Charging Tax Credits After the One Big Beautiful Bill Act - Electrification Coalition**

Key takeaways

- **ESBs are required to undergo the same safety testing outlined by the National Highway Traffic Safety Administration (NHTSA) as conventional gas and diesel school buses.**
- **As of September 2023, only one bus fire incident had been reported with over 1,200 ESBs deployed across the U.S. Similarly, in 2022 the National Transportation Safety Board found only 25 electric vehicles (per 100,000) were involved with fires compared to 1,530 gasoline-powered vehicles (per 100,000).[4]**
- **The Electrification Coalition found that, on average, ESBs cost $0.37 per mile to operate, while conventional diesel or gas buses cost $1.31 per mile. This difference can amount to annual operational costs savings from $5,000 to $10,000 per bus due to a simpler drivetrain, higher efficiency, and low electricity rates compared to diesel or gas buses.[5]**
- **Integrating ESBs immediately reduces student exposure to harmful pollutants, which are linked to increased risks for cancer, asthma, and heart disease.**



[4] NYDERDA: Electric School Bus Guidebook 9: Safety
[5] EC-ESB-Total-Cost-of-Operation-One-Page-Overview-1.pdf

What is an electric school bus (ESB)?

Electric school buses run on electricity, which is stored in onboard batteries to power their electric drive motors. **ESBs are designed to look and feel identical to conventional diesel and gas school buses, but they provide a cleaner and quieter ride.** The exterior body frames of ESBs are similar in shape and size to conventional diesel and gas buses, and they come in the same type A, C, and D models.

Table 1. ESB class type descriptions[6]

ESB class type	Vehicle weight range (pounds)	Passenger capacity	Driving range (nameplate)	Charging time (hours)[7]	
				Level 2 (19.2 kW)	DC Fast (60kW)
Type A	14,200 – 21,500	21 – 30	100 – 130 miles	8	1-2
Type C	31,000 – 33,000	72 - 81	120 – 167 miles	8	3.4
Type D	36,200 – 42,900	83 - 90	120 – 300 miles	8	2.5-3

Type A buses are small and can accommodate up to 30 passengers. They are offered in a variety of makes and models, and they account for approximately 10% of the market. Type C buses can fit between 40 and 83 passengers. They have a prominent front hood, which houses the engine on internal combustion models. Making up 70% of the overall school bus fleet, they are the most commercially mature electric school bus market. Type D buses, the largest of school buses, have flat fronts (with engines at the rear of the bus), seat up to 90 students, and compose approximately 20% of the school bus market.

While ESBs look the same as conventional buses, there are a few key differences. ESBs use an all-electric drivetrain (electric motor) connected to multiple batteries located in the middle of the frame (or chassis) underneath the body of the bus. The chassis-mounted batteries are connected to a series of electrical components, together forming the high-voltage system that delivers power to various functions throughout the bus. Overall, ESB features are designed to mimic the looks of a conventional diesel- or gas-powered school bus.

[6] **Electric School Bus U.S. Market Study and Buyer's Guide: A Resource for School Bus Operators Pursuing Fleet Electrification | World Resources Institute**

[7] Based of **https://electricschoolbusinitiative.org/buyers-guide** 2024. Assumes Thomas E1 (type A), Thomas Saf-t Liner C2 Jouley (type C), and Blue Bird All-American (type D).

What are the benefits of switching to ESBs?

ESBs offer numerous economic and health benefits. Unlike diesel buses, ESBs produce zero tailpipe emissions, eliminating student and driver exposure to harmful criteria air pollutants (CAPs), many of which are known carcinogens. Reducing these emissions can lower the risk of illnesses such as asthma and heart disease, specifically among students.[8] Harvard's T.H Chan School of Public Health conducted a study that estimates that replacing a single conventional diesel school bus with an ESB can generate $43,800 in health-related savings due to improved air quality and reduced rates of childhood asthma.[9] Additionally, ESBs provide a quieter and smoother ride, enhancing the comfort of students and drivers.

Beyond health benefits, ESBs can also deliver long-term savings. Their predictable routes make them well suited for efficient operation. Because they have fewer mechanical components than diesel buses, they require less maintenance. ESBs do not need routine services such as oil changes, filter replacements, and transmission fluid checks. According to the Electrification Coalition, ESBs cost approximately $0.37 per mile to operate compared to $1.31 per mile for diesel buses,[10] which translates to $5,000 to $10,000 in annual savings per bus.[11] Over the vehicle's lifetime, these lower maintenance and fuel costs can result in substantial financial benefits for school districts.

While the upfront cost of an ESB is higher than that of a diesel bus, federal and state incentives can significantly reduce the financial burden. The World Resource Institute's (WRI) Electric School Bus Initiative maintains a comprehensive list of grants and tax credits available to school districts, which can help offset the initial investments and make the transition to ESBs more cost-effective.[12] By leveraging these funding opportunities, schools can help accelerate the adoption of clean transportation while maximizing both health and economic benefits.

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[8] **Benefits of Clean School Buses | US EPA**
[9] **Adopting electric school buses in the United States: Health and climate benefits | PNAS**
[10] Assumes 30-60 daily mile range per bus and 180-day school year.
[11] **EC-ESB-Total-Cost-of-Operation-One-Page-Overview-1.pdf**
[12] **Clearinghouse: Electric School Bus Funding and Financing Opportunities**

Are ESBs as safe as internal combustion vehicles?

Yes. ESBs are required to undergo the same safety testing outlined by the National Highway Traffic Safety Administration (NHTSA) as conventional gas and diesel school buses. The NHTSA requires all buses, including ESBs, to have basic safety features such as flashing red lights, cross-view mirrors, stop-sign arms, protective seating, high crush standards, and rollover protection features.[13]

The National Traffic and Motor Vehicle Safety Act (Safety Act) requires all school buses, regardless of fuel type, to meet all Federal Motor Vehicle Safety Standards (FMVSSs).[14] The FMVSSs are a set of safety regulations and standards required for motor vehicles and motor vehicle equipment to ensure minimum safety requirements are in place for vehicle design, construction, and performance. The standards apply to all vehicle types, each with their own set of specific minimum safety requirements.

Beyond basic bus safety requirements, additional safety standards have been enacted to protect passengers from the unique battery and electrical features of ESBs. The 2017 FMVSS (FMVSS 305) amendment requires ESBs to minimize battery acid spillage, prevent electrical shock by insulating high-voltage components, and use safety monitoring systems.[15] These additional safety measures provide added protection to passengers, drivers, and first responders by reducing the risk of battery spillage exposure and electric shock in the event of a crash.

ESBs have additional safety requirements to account for their electrical features, which make them more regulated than their diesel counterparts. The NHTSA requires ESBs to meet strict safety standards to ensure they are safer than passenger vehicles in preventing crashes and injuries.

How are ESB batteries made to ensure safety?

ESB batteries are typically made using lithium-ion-phosphate (LFP) cells and have total energy storage capacities ranging from 90 kilowatt-hours (kWh) to over 300 kWh. These batteries provide roughly 90 to 150 miles of driving range on a single charge.[16] LFP batteries, used in almost all ESBs, have a more stable thermal chemistry than nickel-manganese-cobalt (NMC) batteries. The thermal stability of LFP batteries reduces the risk of a potential fire spreading.[17]

ESB batteries are enclosed in weather-durable metal casing and laid between the chassis' frame rails. This location is known as the vehicle's safe zone because it is separated from passengers by a structural barrier and away from the front of the bus where collisions are more common. The battery is intentionally located in this area of the bus to protect against adverse physical impacts to the battery.[18]

ESBs also have automatic electrical disconnects that activate if the electrical system short circuits or if there is a moderate to severe crash event. This automatic disconnect prevents fires during these events by breaking the connection between the battery and electric motor. In the rare case that an automatic disconnect fails, there are manual cutoff switches to disable the connection.[19]

Are there regulations in place to monitor ESB battery production?

Yes. All batteries undergo rigorous testing before they are certified for sale. These tests include **SAE International's[20] J2929,** which sets a minimum set of acceptable safety criteria meant to ensure that lithium-based battery systems can be safely integrated into an electric or hybrid vehicle and that a battery function failure will not result in fire, explosion, or high voltage hazard. **ISO 26262** (International Organization for Standardization) is another system test required of ESBs and sets safety standards for the electrical components that monitor and control the batteries.[21] Manufacturers must also pass testing requirements developed by the **United**

[13] **School Bus Safety | Bus Stops, Drivers | NHTSA**
[14] **Federal Register: Federal Motor Vehicle Safety Standards; Electric-Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection**
[15] Id.
[16] https://www.maine.gov/doe/sites/maine.gov.doe/files/2022-06/MaineESBFactSheet.pdf
[17] **All About Electric School Bus Battery Safety | Electric School Bus Initiative**
[18] Id.
[19] Id.
[20] SAE is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive and commercial vehicle industries
[21] **ISO 26262-6:2018 - Road vehicles — Functional safety — Part 6: Product development at the software level**

Nations (UN) which ensures batteries can operate safely under normal use before battery cell manufacturers can sell batteries domestically and abroad.[22] In the United States, these requirements are regulated and enforced by the **U.S. Department of Transportation.**[23]

In addition to the international standards ESBs must meet, there are domestic safety certifications that battery manufacturers must complete before ESBs can be sold.[24] The **Underwriters Laboratories (UL)** safety certifications for lithium-ion batteries is a U.S.-based testing organization that conducts safety testing and certification for a wide range of products, setting industry standards for their safety and compliance, with a global jurisdiction.[25]

What are the fire risks associated with ESBs?

ESB fires are extremely rare. Statistically, school bus fires—whether electric or gasoline-powered—occur infrequently. As of September 2023, only one ESB fire incident had been reported out of over 1,200 ESBs deployed across the U.S. [26]

Data from the National Transportation Safety Board further highlights the safety of electric vehicles, showing that in 2022, only 25 electric vehicles per 100,000 experienced fires, compared to 1,530 gasoline-powered vehicles per 100,000. This remarkable difference is largely due to rigorous battery safety standards, including advanced battery management system technology and well-insulated high-voltage lines that deactivate the electrical system in the event of a collision or short circuit.

Fires typically occur only under extreme conditions, such as severe vehicle collisions that puncture the battery or rare cases of extreme environmental factors like flooding. Even in these situations, multiple built-in safety mechanisms work to prevent overheating, making thermal runaway—a rapid temperature increase beyond 300°C per minute—highly unlikely.[27] When fires do occur, they are more often the result of external factors, such as improper charging cable use or external fires spreading to the vehicle.

Despite the low fire risk, it is still considered best practice to monitor and maintain ESB battery management systems and other safety mechanisms to minimize the risk posed by fires. Battery management systems are an additional safety mechanism put in place to monitor the health of the battery, and they are included standard with all ESBs. Battery management systems track the battery's current, voltage, and temperature to ensure the system is functioning properly. They

[22] **UN Model Regulations Rev. 23 (2023) | UNECE**
[23] **UN Model Regulations Rev. 23 (2023) | UNECE**
[24] **All About Electric School Bus Battery Safety | Electric School Bus Initiative**
[25] **https://nimonik.com/solutions/industry-standards-subscription-platform/ul/**
[26] NYDERDA: Electric School Bus Guidebook 9: Safety
[27] Vehicle Fires, NFPA page 11: https://www.nfpa.org/education-and-research/research/nfpa-research/fire-statistical-reports/vehicle-fires

also flag any issues that arise. The systems use an automated cooling system to prevent batteries from overheating, ensuring that batteries will run safely and effectively.[28]

By following the best practices in maintenance and safety training, fleet operators can ensure ESBs continue to provide safe, reliable, and clean transportation for students. Equipping staff with proper protocols and response training further enhances safety, reinforcing that ESBs are a secure and sustainable choice for school transportation.

How can I train and educate staff around ESBs?

To successfully use ESBs, school districts need to properly train and educate all fleet staff, including bus drivers and mechanics. Schools should set aside dedicated time and budget to train staff on ESB basics before deploying any buses. Training topics should focus on operational functions, including a detailed explanation of regenerative braking, battery state of charge indicators, charging procedures, battery maintenance, electrical systems, inspections, emergency procedures, first aid and fire extinguisher techniques, and software and telematic training.

Districts should work with bus drivers and technicians to ensure they are ready to maintain ESBs. Typically, district bus dealers or original equipment manufacturers (OEMs) offer free resources and ESB trainings for drivers and mechanics. Additionally, because bus drivers are essential to successfully transitioning to ESBs, districts should consider providing opportunities for drivers to test drive ESBs before they are officially in use. This will allow drivers to adjust, get comfortable navigating ESBs, and address any concerns or challenges.

Additional resources

As ESBs become more widely available, the technology is likely to evolve. It's important to stay up to date and keep track of changes in the market. There are several resources, programs, and certifications that specifically support training for ESBs operations, maintenance, and safety. Here are some helpful resources:[29]

1. **Electric School Bus Education**: U.S Department of Energy: Alternative Fuels Data Center
2. **Overview for Electric School Bus Operators**: Joint Office of Energy and Transportation
3. **Electric School Bus Funding and Financing Opportunities**: Electric School Bus Initiative

[28] **All About Electric School Bus Battery Safety | Electric School Bus Initiative**

[29] For a comprehensive list of ESB resources visit the EPA Clean School Bus Workforce Development and Training Resources webpage **here**

3. **Electric School Bus Training Standards**: World Resource Institute
4. **Electric Drive Vehicle Automotive Technician Training**: National Alternative Fuels Training Consortium (NAFTC)
5. **Battery Electric Bus Familiarization**: Transit Training Network