



# Electric School Bus Guidebook

## Guide 7: Bus O&M

(Operations & Maintenance)



NEW  
YORK  
STATE

NYSERDA



# Properly operating and maintaining ESB can maximize performance and reliability.

Electric school bus (ESB) operators and operators of diesel- and gasoline-fueled buses must adhere to the same federal and state safety requirements and follow similar maintenance recommendations. Generally, ESBs require less maintenance yet they require certain care regimens to ensure that they run safely and efficiently throughout their lifetimes.

This chapter of the *Electric School Bus Guidebook* answers these questions:

- What are the key differences between ESBs and diesel- and gasoline-fueled buses that impact operation and maintenance requirements?
- What federal and State operation and maintenance regulations do ESB operators need to follow?
- What are the operation and maintenance cost differences between ESBs and diesel- and gasoline-powered buses?

## ESB Maintenance

A diesel engine has approximately 2,000 individual parts, while an electric motor contains fewer than 100. With fewer moving parts, there is less routine maintenance needed and fewer major repairs, which decreases the amount of maintenance required over the lifetime of an ESB and can save operators between \$4,000–\$11,000 per ESB every year.<sup>1</sup> Although ESBs still require coolant, and wiper fluid, they do not use power steering fluid or engine oil. ESBs equipped with hydraulic brakes still require brake fluid. However, ESBs also use regenerative braking that significantly reduces brake wear and associated brake maintenance needs. Regenerative braking works by using the electric motors as a generator to produce electrical power as the vehicle decelerates. Figure 1 shows the primary components of an ESB powertrain.

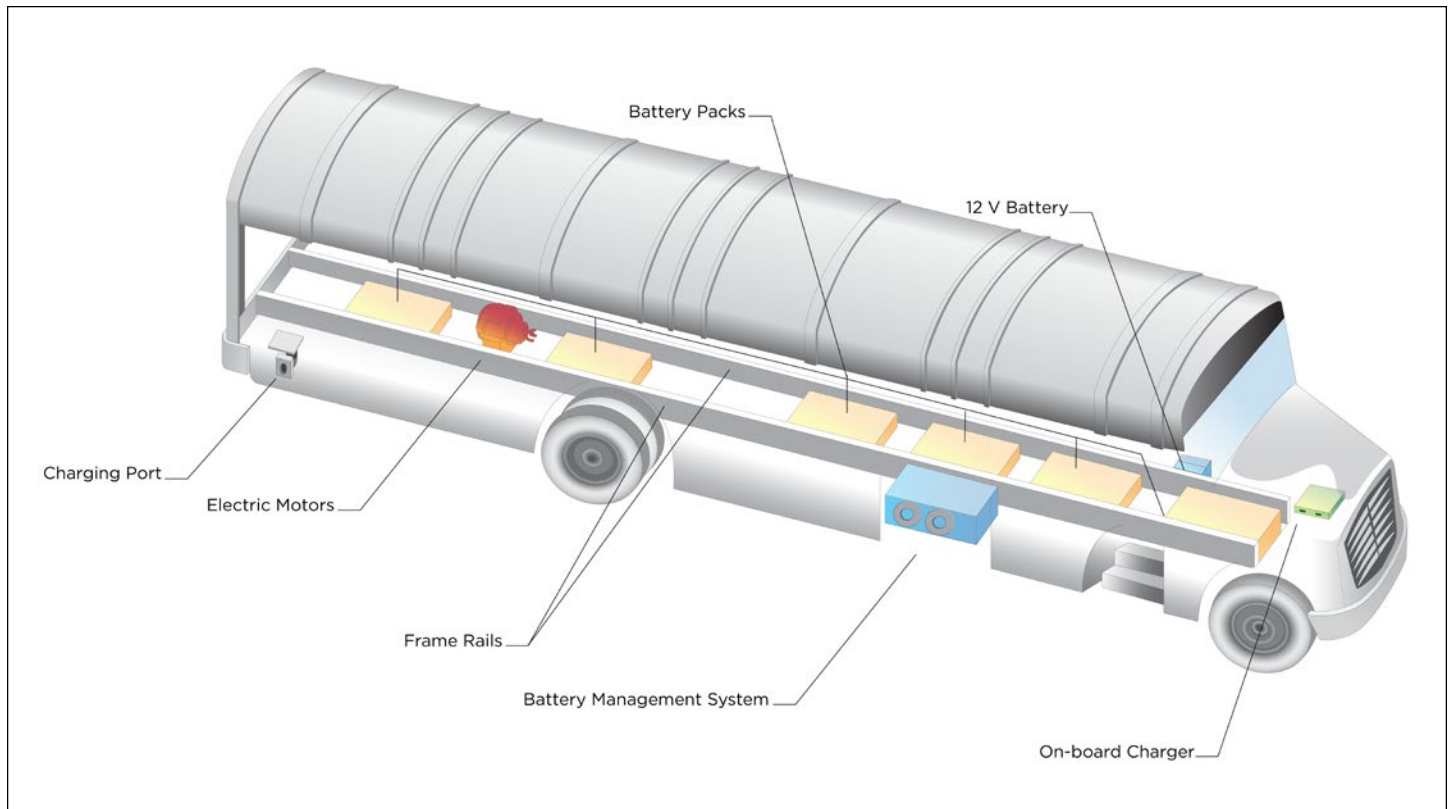


Figure 1: Schematic of an electric school bus

## Key Activities

Initial actions you can take after reading this chapter include:

- Adopt or create an electric school bus pre- and post-trip inspection checklist.
- Speak with your ESB vendor about available operation and maintenance trainings.
- Stay up to date with new State and federal ESB operation and maintenance requirements.

<sup>1</sup><https://afdc.energy.gov/files/u/publication/electric-school-bus-us-market-study-buyers-guide.pdf?da24b3ed9c>



## New York State Requirements

ESB operators are required to follow all State operation and maintenance requirements to ensure safe vehicle operation. Although the U.S. Department of Transportation's (USDOT) National Highway Traffic Safety Administration (NHTSA) does not regulate school bus use, they recommend that each state develop a comprehensive program for the safe operation of school buses.<sup>2</sup> New York State has several operation and maintenance requirements that must be followed by all ESB operators.

Currently, NYS ESB requirements do not differ from those for diesel and gasoline school buses, although this may change in the future as ESBs are more widely deployed. A brief summary of the requirements is outlined below, and a full list of New York State Department of Transportation (NYSDOT) requirements can be found in [N.Y. Comp. Codes R. & Regs. Tit. 17 § 720 - 722](#).

- **Maintenance Requirements** – School bus operators are required to inspect and repair school buses at set maintenance intervals. The maintenance program should include brake systems, steering mechanisms, and operating lights. Any issues identified must be repaired before the vehicle returns to operation.
- **Daily Inspections** – School bus drivers, who must all maintain a valid Commercial Driver License (CDL) with the necessary passenger endorsements, must conduct daily pre- and post-trip inspection reports. Any defects must be reported and fixed before vehicles are operated. In addition, drivers must review the previous day's reports and adhere to Federal Motor Carrier Safety Administration (FMCSA) safety and operation requirements. The NYSDOT provides CDL drivers with an example [vehicle inspection report](#).
- **Biannual Inspections** – NYSDOT requires school buses to undergo comprehensive maintenance and safety inspections every six months. These inspections are conducted by the State and require a passing grade for legal operation. A full list of inspection criteria can be found in Part 720 of the [N.Y. Comp. Codes R. & Regs. Tit. 17 § 720 - 722](#).

### The importance of pre- and post-trip inspection reports

Pre- and post-trip inspection reports are required by New York State to be completed by school bus operators daily. The inspection reports play a critical role in maintaining the safe operation of school buses. Pre-trip inspections help prevent deployment of ESBs with unnoticed damage while post-trip inspections help ensure that ESB operators and mechanics have ample time to repair damaged ESBs before the next use. In combination, these inspection reports can prevent maintenance down time and extend the life of an ESB. Visual inspections should note any leaking fluids or gases, similar to the way a visual inspection of a diesel- or gas-fueled vehicle would be conducted.

<sup>2</sup> <https://one.nhtsa.gov/nhtsa/whatsup/tea21/tea21programs/pages/PupilTransportation.htm>

## General ESB Maintenance

Most maintenance related to electric drivetrains is completed by the manufacturer or dealer. Generally, these types of repairs are covered under the bus's warranty; however, some types of maintenance might require a separate maintenance contract with the manufacturer and/or dealer. A typical manufacturer warranty covers electric drivetrains and batteries for five years or 100,000 miles, though some warranties are longer. Additionally, manufacturers often recommend purchasing additional towing coverage because a typical ESB warranty does not cover the cost of towing an ESB from the depot to the manufacturer's/dealer's repair facility when more extensive work is required. General bus maintenance not related to the electric drivetrain is similar to that for diesel- and gas-fueled buses and may be completed by in-house mechanics without additional training.

When an ESB requires maintenance attention, a manufacturer or dealer might send a mechanic to the bus depot to evaluate and/or perform the maintenance. To the extent possible, in-house mechanics should shadow the visiting mechanic during the length of the maintenance contract to learn best practices for recognizing and responding to maintenance issues.

## Operational Costs

ESB operational costs include fuel and energy costs and labor costs. Fuel and energy costs depend on ESB battery efficiency, auxiliary electrical loads in addition to vehicle charging, and the rate structure of the electric utility. Labor costs depend on the pay rates for drivers and other support staff, including technicians and the employees responsible for plugging in and/or moving ESBs.

## Fuel and Energy Costs

ESBs are, on average, nearly four times more energy efficient than their ICE counterparts.<sup>3</sup> Electricity can also provide greater cost certainty than liquid fuels.<sup>4</sup> Over the past two decades, the average retail price of diesel fuel has seen volatile cost fluctuations (Figure 2) whereas the cost of electricity has maintained a steady and moderate increase of about 4% per year.<sup>5</sup>

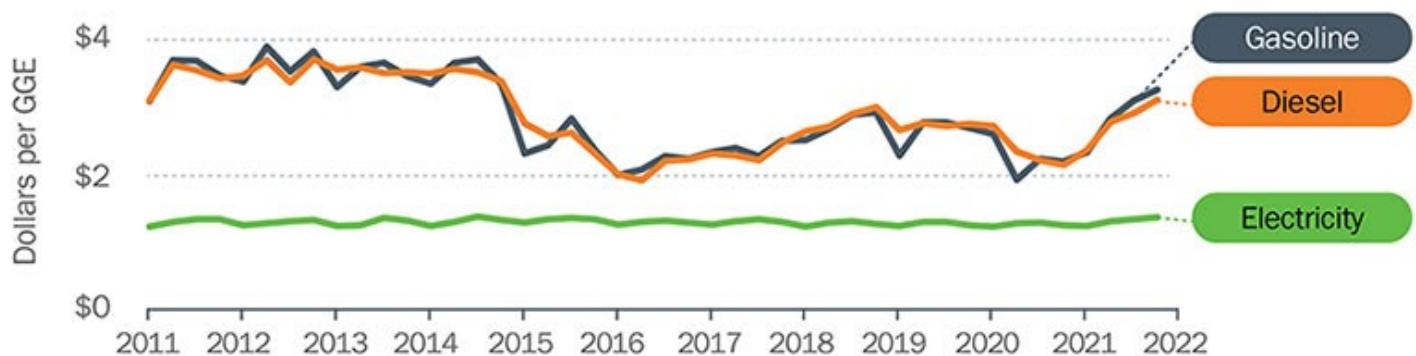


Figure 2: The average retail fuel prices in the United States.

Though electricity costs are not as volatile, electricity demand charges can significantly affect ESB operating costs. Depending on the rate structure set by the electric utility, charging ESBs during peak demand times may have an additional premium cost. To address the barrier to EV adoption created by demand charges, New York State requires investor-owned utilities to create a commercial tariff using alternative rates for EV charging with lower, or even no, demand charge.<sup>6</sup> These alternative rates, which the utilities are introducing in 2024, can significantly decrease the cost of charging for fleets.<sup>7</sup> You should work with your electric utility to understand how these demand charges are structured to avoid paying more than necessary.

## Maintenance Precautions

Before performing ESB maintenance work that involves potential contact with high-voltage systems, operators need to disengage the battery contactors and wait 15 minutes before performing maintenance. The high-voltage systems on ESBs can cause serious injury if proper safety precautions are not taken. Operators should always refer to the ESB service manuals provided by the manufacturers for model-specific operation and maintenance schedules and guidelines. Please see [Guide 9: Safety](#) for more details.

<sup>3</sup> "Operational Costs" [https://afdc.energy.gov/vehicles/electric\\_school\\_buses\\_p8\\_m2.html](https://afdc.energy.gov/vehicles/electric_school_buses_p8_m2.html)

<sup>4</sup> [https://afdc.energy.gov/vehicles/electric\\_fleets.html](https://afdc.energy.gov/vehicles/electric_fleets.html)

<sup>5</sup> <http://www.afdc.energy.gov/fuels/prices.html>

<sup>6</sup> <https://www.nysenate.gov/legislation/bills/2021/S3929>

<sup>7</sup> <https://www.utilitydive.com/news/can-used-batteries-be-the-key-to-unlock-ev-charging-profits/504820/>



“Smart charging” is an approach that can save bus operators money by reducing peak electricity demand that can lead to high demand charges. Smart charging involves the use of an electric vehicle charge management system, software that is integrated with chargers to manage vehicle charging. A smart charging system optimizes vehicle charging by determining when and how long to charge, based on how much each bus needs to charge, and adjusting the time and rate of charging for each bus to minimize the peak electricity demand. Some chargers may come with charge management systems already installed. If not, you may choose to purchase the software from a third-party vendor or have an outside contractor manage your charging for you.

## Federal Training Program

The U.S. Department of Energy’s (U.S. DOE) Alternative Fuels Data Center has published an educational resource called [Flipping the Switch on Electric School Buses](#). It includes several modules to educate and train ESB stakeholders on a variety of topics, and it includes a module on how to train drivers and technicians to conduct maintenance on ESBs. The training advises that creating a well-planned training program that incorporates your entire organization will lead to the successful integration of your ESB fleet and that establishing operator familiarity with new vehicles will improve safety, reduce maintenance issues, and reduce range anxiety. Modules of the training include:

Module	Audience	Topics
<b>Electric Vehicle Basics and Safety</b>	Operators, technicians, dispatch personnel, management, training personnel, area first responders	Overview of ESBs, high voltage safety, hazards of EVs, restrictions, and guidance sheets for first responders.
<b>Electric Bus Overview</b>	Operators, technicians, management, training personnel	Electric system orientation, start and shutdown processes, high voltage, and PPE, driving differences including regenerative braking, and dealing with on-road failures.
<b>Charging Infrastructure</b>	Operators, technicians, vehicle support staff, training personnel	Charging station basics, safety, and usage procedures, as well as charger maintenance and repair.
<b>Advanced Technology</b>	Technician, training personnel	Electrically driven components, battery systems, propulsion motor, and electrical systems.

ESB manufacturers and vendors provide service manuals with the sale of their ESBs. Drivers and technicians should familiarize themselves with these manuals to gain a thorough understanding of how to properly maintain their newly purchased ESBs. Dealers should provide familiarization training for technicians and operators at the time of delivery.

## Additional Resources

[New York State Department of Transportation \(NYSDOT\) Standard School Bus Safety Inspection](#) – The NYSDOT standard school bus safety inspection guidelines list the criteria that must be met to pass New York State school bus safety inspections.

[NYSDOT Bus and Passenger Vehicle Regulations](#) – A compilation of the NYSDOT bus and passenger vehicle safety regulations, school bus and school bus operator requirements, crash reporting requirements, and hours of labor for operators of motor buses.

[NYSDOT Bus and Passenger Home Page](#) – The home page for NYSDOT bus operation, safety, and maintenance requirements.

[US DOE Electric School Bus Education](#) – The U.S. DOE landing page for electric school bus education materials ranging from electric bus basics to operational consideration including maintenance.

