

Quick Start to Electrifying Your School Bus Fleet

Is electrification a solution for my fleet?

Data show that electric buses can meet most school district route requirements. Adding electric buses to your fleet can diversify fuel type, decrease tailpipe emissions, and reduce maintenance costs. The task of electrifying may seem daunting. With the help of federal funding, doing so will not only save your district on costs over time, but also create safer healthier rides for kids and help your community meet emissions goals. To begin, fleet managers must understand route requirements and energy needs, select preferred charging strategies, and identify infrastructure requirements to plan for a successful deployment.

Start by identifying the number of electric school buses you plan to add to your fleet, estimating the energy requirements to support those buses, and determining charging time periods. The next steps involve identifying your charging infrastructure requirements to support your electric bus fleet and working with your electric utility to understand the potential impacts to existing facilities and electrical systems.



Photo from John Gonzales, NREL 74748

Resources for School Bus Fleets driveelectric.gov/school-districts

Which electric bus model will work best for my routes based on power requirements?

First, identify power demands for the desired routes based on energy consumption. In-use vehicle performance data will help you understand key factors of fuel economy, energy use, miles traveled, etc. This information will help you choose the right electric school bus model for your fleet needs.



1 Understand Route and Energy Needs





Charging Strategies



How does cold weather impact range?

Cold weather reduces range because the electric bus requires energy from the high-voltage batteries to maintain cabin temperature and the battery system's temperature. In ideal conditions (55°F–60°F air temperature), electric school buses can use most or all the battery power for vehicle propulsion to achieve peak driving range.

A 2022 electric transit bus study **found that once temperatures drop 30°F below the optimal range, range decreased by approximately 33%** (nrel.gov/ docs/fy22osti/83038.pdf). However, best practices can mitigate some range impacts caused by drops in temperature. For more information on mitigating impacts from cold weather, check out the Joint Office Help Sheet: Cold Weather Impacts on Electric School Buses (driveelectric.gov/files/esb-cold-weather-helpsheet.pdf).

How to calculate total cost of ownership?

While the capital costs for electric school buses and charging infrastructure are greater than conventional fuel buses, electrifying your fleet also presents an opportunity to reduce your operation and maintenance costs. To understand the total cost of ownership, you'll need to consider the following factors:

- Bus purchase price
- Infrastructure purchase and installation
- Energy costs
- Utility upgrade costs
- Bus and charger operations and maintenance. Based on purchase information from Clean Cities in 2019 and 2020, the average price of an electric school bus was \$388,000.¹ However, three original equipment manufacturers (OEMs) are now showing price ranges of \$240,000-\$344,000 for Type A models (electricschoolbusinitiative.org/ sites/default/files/2022-09/electric-school-bus-usmarket-study-buyers-guide.pdf).



Photo from Brian Foulds,Concord-Carlisle Regional School District, NREL 60242

Infrastructure costs

Infrastructure costs will be impacted by the power level of the charger, port design, charging strategy, and installation requirements.

Network features of Level 2 (L2) chargers—which supply electricity at 240 volts—nearly double the cost compared to non-networked L2 units. Installation costs for 10-20 kilowatt (kW) L2 commercial chargers average between \$3,000 and \$6,000 per unit (rmi. org/insight/reducing-ev-charging-infrastructurecosts), with corresponding installation charges of approximately \$3,000 to \$5,000 per unit. A recent market analysis (nrel.gov/docs/fy23osti/82092.pdf) estimated between \$19,000 to \$26,000 per port for single direct current fast chargers (DCFC) of 20-30 kW with corresponding installation costs of \$21,000 to \$28,000 per port. Due to installation costs per unit being cheaper when multiple units are installed at once, considering near-term plans for electric fleet expansion is recommended.

Charger type	Power level	Charge costs	Installation costs
Networked L2	10-20 kW	\$3,000 to \$6,000 per unit	\$3,000 to \$5,000 per unit
DCFC	20-30 kW	\$19,000 to \$26,000 per port	\$21,000 to \$28,000 per port

¹ In 2019 and 2020, Clean Cities data on vehicle and infrastructure costs indicated that the average price of an electric school bus was \$388,000 and the median price was \$390,000. Data are representative across manufacturers.

Electricity costs

The cost to charge your fleet will depend on utility rates and when the buses are charged. An early conversation with your utility will help you understand the costs associated with both installing and powering the charging stations, and the actual cost of charging. During this initial conversation, you can also schedule a site assessment to learn if your existing electrical infrastructure can support your charging requirements, which are determined by the number of electric buses in your fleet, the bus battery capacity, and your overall charging strategy. If your needs cannot be met, this assessment will help to inform you on the necessary facility and grid upgrades.

Operation and maintenance costs

Based on electric transit bus data, the majority of operation and maintenance (O&M) costs come from energy and labor, including driver and support staff payment. Overall, once fleets, drivers, and technicians have adjusted to the technology's learning curve, maintenance costs are lower for electric school buses compared to conventional fueled buses.

During the transition period, maintenance that could add to O&M costs include:

- Accelerated tire wear
- Electric maintenance tools and personal protective equipment
- Training expenses
- High-cost parts (traction motor, air compressor, low-voltage batteries, etc.) that failed post-warranty period.

Outside of these issues, O&M costs are reduced with the implementation of electric buses due to a lack of after-treatment systems and engine oils, fewer moving components, the ease of access to components, reduced wear on braking system, and eventual reduced labor costs (post-learning curve). Fleet operators are likely to incur costs for charging units over time, but exact cost data are limited.

How do I train my technicians and drivers?

When drafting your OEM contract, you can include driver and technician requirements for low-voltage systems and clarification on how the manufacturer plans to provide high-voltage maintenance and repairs along with which services are covered by the warranty. This is important, as few, if any, manufacturers currently provide training on their high-voltage systems. Instead, these repairs are made by internal technicians.

What are my greenhouse gas emission impacts?

The electricity to power electric school buses produces half the annual greenhouse gas emissions compared to compressed natural gas, propane, diesel, and biodiesel fuels.²

For additional technical assistance resources, please consult DriveElectric.gov/school-districts. If you would like detailed help or assistance, please contact the Clean School Bus Technical Assistance team at DriveElectric.gov/contact.



Find the help you need at DriveElectric.gov

² afleet.es.anl.gov/afleet. Assumptions: Five fuels for school buses: electric, compressed natural gas, propane, diesel, and biodiesel. Utilizing various electricity mixes for electric school buses and North American natural gas for compressed natural gas. 15,000 miles per bus per year.



About the Joint Office of Energy and Transportation

The Joint Office provides technical assistance and expertise to a multitude of stakeholders and programs that seek to deploy a network of EV chargers, zero-emission fueling infrastructure, and zero-emission transit and school buses. Contact us at **DriveElectric.gov/contact**.

DOE/GO-102023-6135 · December 2023