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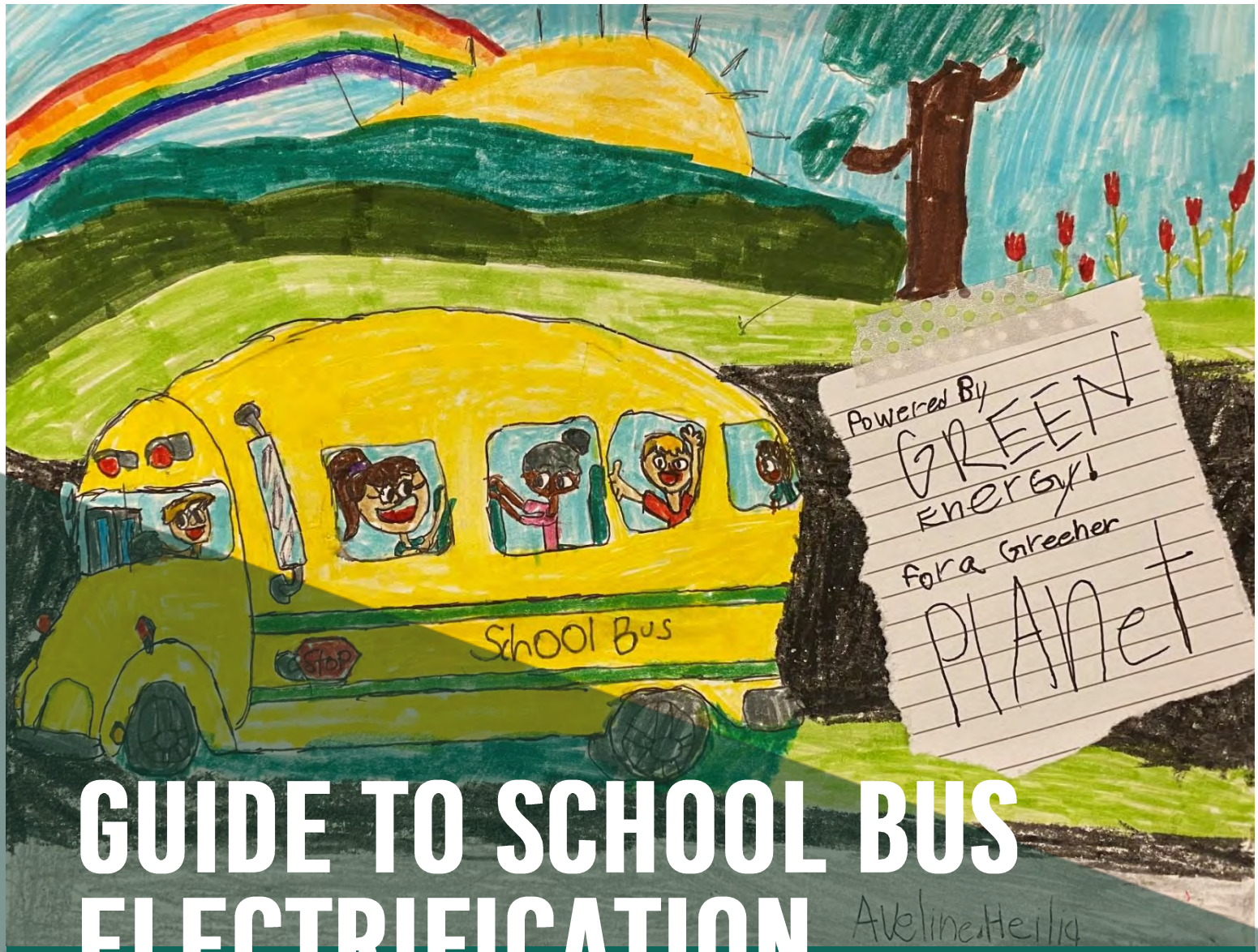

GUIDE TO SCHOOL BUS ELECTRIFICATION

Aveline Marie Heilig
Kinnaman Elementary

Presented by:

ODOE's Planning & Innovation Division

With support from:

Oregon Department of Transportation, Department of Environmental Quality, and Zero Emission Vehicle Interagency Working Group

Acknowledgments

Special thanks to ODOT, whose Guide to Transit Electrification offered much inspiration and content in support of the creation of this guide. The authors also thank transportation staff at Beaverton School District, Reynolds School District, Salem-Keizer School District, Portland Public Schools, Newberg School District, Bend-La Pine School District, Eugene School District 4J, Twin Rivers Unified School District, Concord Public Schools, and Zeeland Public Schools for sharing their knowledge and experience, which form the core of this guide. Thanks to ODOT, DEQ, ODE, Oregon's Federally Recognized Tribal Governments, Western Bus Sales, Schetky NW, Lion Electric, Cummins, Portland General Electric, Pacific Power, Sacramento Municipal Utility District, The Environmental Center, Electric Bus Learning Project, Forth, Vermont Energy Investment Corporation, and World Resources Institute for their insights and draft review.

Electric Bus Art Contest

A big round of applause for the Beaverton School District students that submitted the electric school bus artwork featured throughout this guidebook. Special thanks to Ellen Mickle, ODOE's 2021 Electric School Bus Guidebook Development Intern, and Melissa Larson, BSD's Communications Specialist, for creating such a wonderful contest and collaboration.

Cover Art Winners

Front Cover: Aveline Marie Heilig
Kinnaman Elementary

Back Cover: Arushi Mazumder
Jacob Wismer Elementary

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PURPOSE OF THE GUIDE

This guide is designed to provide Oregon's school districts with information and recommendations for vehicle electrification.

In 2017, Governor Brown issued Executive Order 17-21, which directed state agencies to accelerate zero emission vehicle adoption in Oregon to reduce greenhouse gas emissions. A Zero Emission Vehicle Interagency Work Group was formed to coordinate and take actions to support reaching the EO's bold EV adoption targets. Participating agencies include the Oregon Department of Energy, the Oregon Department of Transportation, the Public Utility Commission, the Department of Environmental Quality, and the Department of Administrative Services.

One of the goals identified in the Executive Order is "providing partners with information on electric vehicle use and functionality." The Executive Order directs ODOE to work with ODOT, PUC, DEQ, and the Department of Education to "develop tools and provide information to assist school districts in making decisions about zero emission vehicle bus options when replacing school buses."

This guide accompanies a quantitative tool to analyze different fuel types for school buses: The Electric and Alternative Fuel School Bus Lifecycle Cost Analysis Tool.

In addition to the guide, ODOE, ODOT, and DEQ have created the Electric and Alternative Fuel School Bus Lifecycle Cost Analysis Tool (referred to as "Cost Analysis Tool" going forward). To use the Cost Analysis Tool, a school district inputs information about its fleet and the tool provides a summary of the estimated costs for different alternative fuel buses—including electric, propane, natural gas, and different types of diesel.

The tool icon flags information about the ***Alternative Fuel School Bus Lifecycle Cost Analysis Tool*** throughout the guidebook.

The Electric and Alternative Fuel School Bus Lifecycle Cost Analysis Tool is available on ODOE's [Business & Government Fleets webpage](#).

This guide covers battery electric buses, but future guides will cover other alternative fuels.

This guide supports the Cost Analysis Tool by synthesizing insights from school districts in and outside of Oregon that have already piloted or have begun the process of procuring electric buses. Future guides will cover other lower carbon emission fuels, such as propane, renewable diesel, and natural gas.

Shivam Patani
Sato Elementary

This guide addresses battery electric buses, which are propelled by electric energy stored in batteries and periodically recharged. Other types of electric buses, such as hydrogen fuel cell buses, may be introduced in the future. As these technologies advance and become more widely available, future guides may include these buses.

All public school districts in Oregon have access to the funding covered in this guide (except certain utility programs), including schools on Tribal land.

Some of the funding opportunities identified in this guide are limited to school districts within a specific electric utility's service territory, but others are available to all school districts in the state. Transportation for school readiness programs such as Head Start and youth programs is not the focus of this guide, though these programs may be eligible for some or all of the same funding covered in the "Funding" section, in addition to other resources not covered in this guide (such as Head Start grant funding and Tribal funds).

KEY RECOMMENDATIONS WHEN CONSIDERING ELECTRIC SCHOOL BUSES[1]

- **Engage stakeholders.** Involve the wider school community—including transportation and facilities management staff, parents, and the school board—as you implement this new technology and have a point person driving the project.
- **Find funding.** Currently, all school districts with electric buses in Oregon are using at least one grant to help offset the higher upfront costs of electric buses.
- **Coordinate with your electric utility.** Your utility can help estimate the impact to your bills and the type of charger your site can accommodate. Many utilities offer technical assistance to identify the most cost-effective options for upgrading electrical infrastructure as well as installing, maintaining, and operating the charger.
- **Consider your needs.** Develop technical specifications for selecting a bus dealer or manufacturer and charger based on your needs—including route length, elevation change, and climate—through talking to other school districts, your utility, and organizations listed in the "How to Get Started" section of this guide.
- **Consider equity and social justice in your electrification efforts.** Consider prioritizing deployment of electric buses to Title I and low-income schools, in light of the higher exposure of communities of color, tribal communities, and low-income communities to air pollution from highways and industrial facilities.[2] Such actions also further the Oregon State Board of Education's 2020 Black Lives Matter resolution, which renewed its commitment to equity and anti-racism.[3]

Sadie Jeanne Swenson
FLEX Online School

CONTENTS

Annarose Mumbo
Oak Hill Elementary

1. ELECTRIC SCHOOL BUSES: AN EMERGING TECHNOLOGY

School districts around the country are now using electric school buses.

Of the roughly 480,000 school buses transporting 25 million children to school every day in the U.S., 95 percent are diesel[4] and—while estimates vary—about 550 are estimated to be electric in 2021.[5] In 2020, Oregon Governor Kate Brown signed a joint Memorandum of Understanding with 14 other states and Washington, D.C. committing to a goal that 100 percent of new sales for medium- and heavy-duty vehicles will be zero emission by 2050, with an interim target of 30 percent by 2030.[6] With seven electric school buses currently deployed in Oregon, meeting this target will constitute a substantial shift for student transportation in the near future. With school buses representing over 90 percent of the U.S. bus market, and those in operation estimated to average 11 years of age, school bus manufacturers see the business opportunity and are ramping up electric bus production to meet increasing demand.[7]

Six school districts in Oregon have already deployed or are in the process of procuring electric school buses.

As of August 2021, six school districts in Oregon have deployed or are in the process of procuring electric school buses (Table 1).

Table 1: Oregon School Districts with Electric School Buses in 2021

School District	Utility	Time of Deployment	Bus	Type of Charger
Beaverton	PGE	Spring 2021	2 x Blue Bird Type D	Nuvve 19-kW Level 2
Reynolds	PGE	Spring 2021	1 x Blue Bird Type D	OpConnect 19-kW Level 2
Salem-Keizer	PGE	Fall 2021	1 x Micro Bird Type A	Enel X 19-kW Level 2
Portland Public Schools	PGE/PAC	Fall 2021	1 x Lion Electric Type A	Enel X 19-kW Level 2
Newberg	PGE	Fall 2021	1 x Blue Bird Type C	Nuvve 60 kW DCFC
Bend-La Pine	PAC	Fall 2021	1 x Lion Electric Type C	Nuvve 19-kW Level 2

Note: PGE = Portland General Electric; PAC = Pacific Power.

These six school districts have experience working with two different electric bus manufacturers. Newberg School District will be installing a DC fast charger, while the others have opted for Level 2 chargers (see "Selecting and Installing Chargers" for more information about charging infrastructure). The pilots were funded in part with grants from their respective utilities, and Beaverton, Reynolds, and Bend-La Pine also used additional funds provided by the Public Purchase Charge and DEQ grants (see more on these programs under the "Funding" section). All of these school districts operate their own fleets[i] except Newberg, which uses a contractor for its full fleet. This guide compiles advice and lessons learned from each of these Oregon school districts, as well as longer-running pilots outside of Oregon (Table 2).

Table 2: Electric School Bus Pilot Case Studies Consulted

State	School Districts	Began	# Buses Aug 2021	Manufacturers
California	Twin Rivers Unified (Sacramento)	2016	42	Blue Bird, IC/Navistar, Lion Electric, TransTech, Thomas Built
Massachusetts	Amherst, Cambridge, Concord	2016	4	Lion Electric
Michigan	Zeeland, Ann Arbor, Gaylord, Kalamazoo, Oxford, Roseville, Three Rivers	2017	18	Lion Electric, Thomas Built

Oregon can benefit from early school bus electrification, but electric buses remain an emerging technology, with factors to consider and obstacles to overcome.

School districts considering electrification are breaking new ground. Electric buses are an emerging technology, and school districts should be prepared for technical and logistical challenges on the road to electrification. At the same time, early adopters can reap the benefits of switching to electric buses, gain valuable experience in an emerging field, and contribute to the growing body of knowledge on school bus electrification. Given time and experience, electric buses can successfully meet student transportation needs.

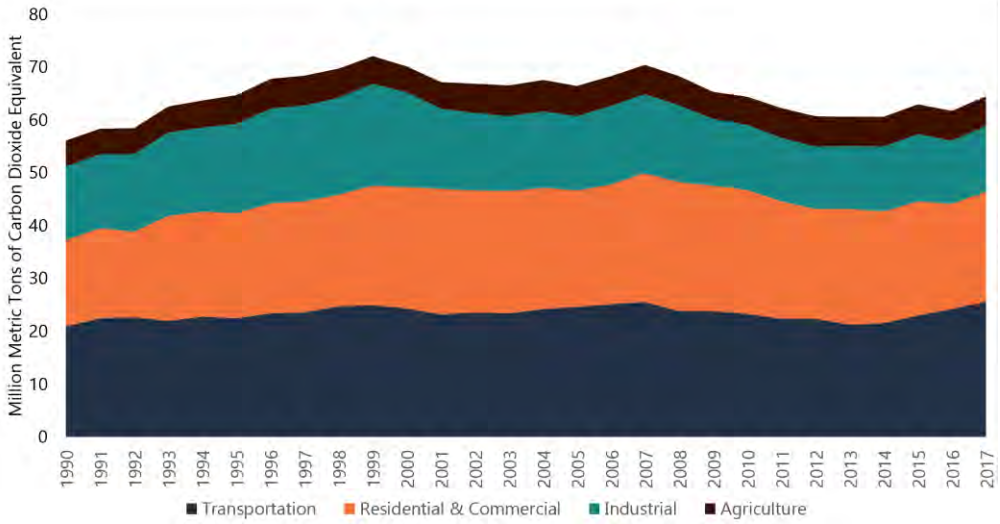
[i] Portland Public Schools uses a contractor for some of its fleet, but their electric bus was acquired for its self-managed operations.

2. BENEFITS AND CHALLENGES OF ELECTRIC BUSES

Electric buses reduce greenhouse gas emissions.

Transportation accounts for 40 percent of Oregon's greenhouse gas emissions, more than any other sector, and emissions from this sector are on the rise, up from 35 percent in 2014[8] (Figure 1). To reach GHG reduction goals, Oregon must address emissions from the transportation sector.

Figure 1: Oregon Greenhouse Gas Emissions by Sector Over Time



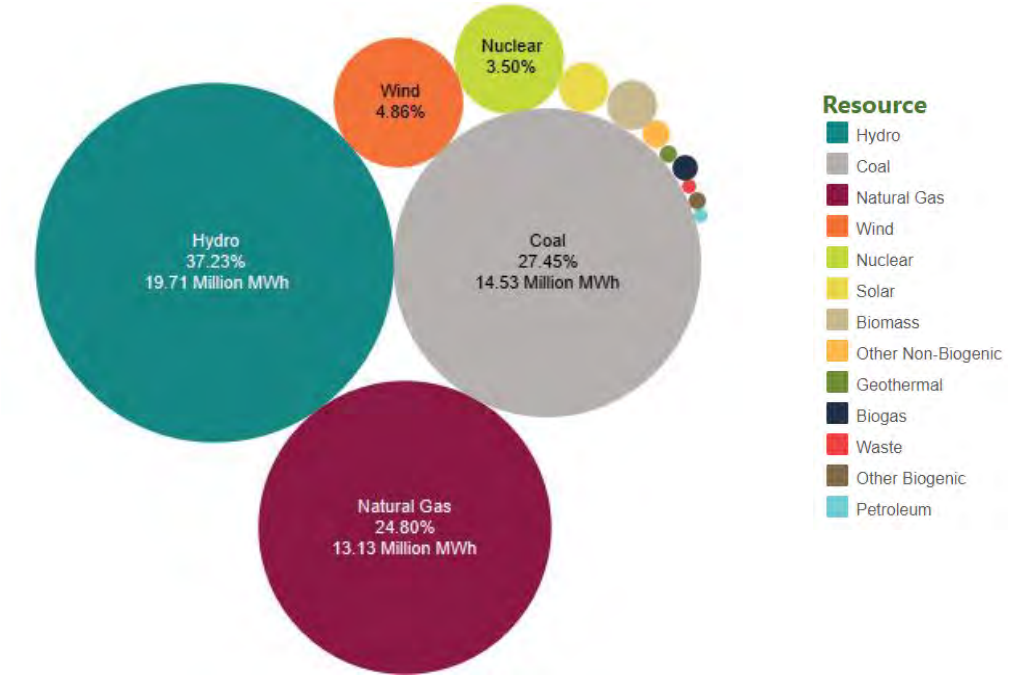
Source: ODOE 2020 Biennial Energy Report [9]

Mass transit options, such as school buses, can help reduce a community's carbon footprint regardless of fuel source, through their lower per capita GHG emissions compared to personal vehicles.[10] As school districts transition to electric buses, the GHG emissions reductions benefit of student transportation will only increase—the U.S. Public Interest Research Group estimates "transitioning to all-electric school bus fleets would avert 5.3 million tons of GHG emissions each year."[11]

The extent of reductions in GHG emissions from school bus electrification depends on the sources of electricity that supply a school district's utility. In Oregon, over half of our electricity comes from clean, zero-emission resources, such as hydropower, solar, and wind (Figure 2). The precise mix of renewable and non-renewable sources varies by location and utility, and even year over year—but as the electricity sector continues to decarbonize, driving electric vehicles will continue to produce fewer emissions.

For information about the sources of electricity in your area, see ODOE's webpage on Oregon's electricity mix or contact your local utility.

Figure 2: Sources of Electricity Used in Oregon, 2019



Source: ODOE

Electric buses are healthier for students, employees, and the community.

In addition to having lower GHG emissions, electric buses have zero tailpipe emissions—which represents a significant health benefit at the local level. Diesel exhaust is classified as a potential cancer agent by the U.S. Environmental Protection Agency and is linked to respiratory diseases and the exacerbation of existing conditions like asthma.[12] These risks are higher for children, who breathe in more air per body weight and do not have fully developed respiratory systems. Risks are also higher in communities of color, Tribal communities, and low-income communities, as they are already disproportionately affected by air pollution and their resulting health impacts.[13] [14]

Elliott Kim
Sato Elementary

Electric buses reduce noise pollution.

A study on transit buses by King County Metro in Washington found noise pollution for electric buses ranged from 65-66 decibels during acceleration, versus 76-81 for diesel buses.[15] Given that the EPA identifies a 24-hour exposure level of 70 decibels as the acceptable limit for preventing hearing loss over a lifetime, electric buses offer a meaningful reduction in noise exposure for students, drivers, and residents along routes.[16] The students in the Twin Rivers Unified School District in Sacramento have reported that they like being able to hear their friends better while on the bus.

Electric buses may reduce fuel costs.

Fuel costs are both a benefit and a potential challenge for electric school buses. Electric buses are expected to have lower fuel costs than buses that rely on other fuel sources—though some pilots across the country have found higher fuel costs for electricity due to demand charges. Electricity prices are less volatile than diesel prices, even when factoring in that electricity prices can vary based on time of day, season, and utility provider. See the "Costs" section of this guide and connect with your utility early in the process about ways to keep electricity costs low.

Electric buses may reduce maintenance costs.

Most light-duty electric vehicles are easier and less expensive to maintain than their gasoline-powered counterparts, and while there is not as much existing data on the maintenance costs for medium- and heavy-duty EVs yet, they are expected to have similar benefits. One of the main reasons is because EVs have fewer moving parts that need service or replacement. They don't need engine oil, spark plugs, air filters, or many other parts—and due to their regenerative braking function, they require less brake maintenance.

Maya Hall
Sato Elementary

Electric buses may have other community benefits.

- Some school districts emphasize the educational value of their electric buses, such as the Newberg School District, which plans to use their vehicle-to-grid (V2G) pilot for field trips. Electric bus pilots are valuable opportunities for students to learn about EVs, the grid, and clean energy resources that address GHG emissions. They can benefit post-secondary learning as well—the Twin Rivers Unified pilot in Sacramento is working with a local community college to implement electric bus technical training.
- Electric school buses are also good for the economy. ODOE's 2020 Biennial Energy Report found that "Oregonians send about $5.4 billion of our transportation dollars each year to other states and countries where the extraction, processing, and refining of fossil fuels for transportation occurs," but shifting to electricity as a fuel source will retain more fuel dollars in the state and help expand the state's existing 10,053 jobs in electric power generation.[17] Transitioning fleets to electricity will also add jobs at existing domestic electric bus and drivetrain[ii] manufacturing facilities, and potentially stimulate further investment and employment opportunities in the growing EV market.[18]

[ii] A vehicle's powertrain includes the engine, the transmission, axle shafts and joints, etc. A vehicle's drivetrain includes all of the powertrain elements *except* for the engine.

- Given the summer and mid-day downtime for school buses, there has been interest in using electric school bus batteries as a backup power source during grid outages via "vehicle-to-building" technology, or even as a revenue stream via V2G—which enables schools to sell energy back to the grid when buses are idle. For instance, Newberg will be the first to pilot V2G in Oregon, and the organizations Forth, Hacienda Community Development Corporation, and the Electric Bus Learning Project have acquired a planning grant to explore opportunities for creating a resilience hub with V2G electric school buses and PV solar in Portland. Keep an eye on these pilots and discuss this possibility with your utility if interested—but consider that V2G and V2B technology are in the very early stages of development and may not be widely adopted in the near future.

Derek Chen
Hope Charter School

There are challenges associated with adding electric school buses to fleets.

Even though electric school buses present several benefits for school districts, students, and communities, they are an emerging technology and still present challenges for those wishing to deploy them, including:

- **Higher upfront costs for buses and charging infrastructure**. The upfront cost of an electric bus can be two to three times higher than that of a diesel bus,[19] Though reductions in operating costs will offset some of the difference, incentives from federal, state, or utility programs have played a critical role for school districts who have purchased electric buses.
- **Fuel cost savings may require careful planning.** Working with your local utility is critical to identifying the most cost-effective solutions to manage charging and overall electricity costs.

- **Performance variability.** Early in its pilot program, one of Beaverton School District's electric buses required five weeks of maintenance at the dealer. Experts advise planning for as much as a year of trial and error when piloting these buses, and specifying the support to be provided by the dealer or manufacturer at time of purchase (more on this under the "Selecting an Electric Bus Manufacturer" section).[20]
- **Range variability in very cold and hot weather has been observed in some electric transit bus pilots**.[21] The first cold-climate test of electric school buses in Massachusetts "saw a steady increase in bus range above 20° F, from about 60 miles at 20° F to over 80 miles at 75° F," though driver consistency was also a possible factor impacting variability in range.[22] The transportation director for Zeeland, Michigan—an area with 120-150 inches of snow per year and single digit temperatures in the winter—reported no impact on range due to cold temperatures.
- **With average ranges of 100 miles, electric buses won't be able to serve all current school transportation needs**, but it is estimated they could cover about 80 percent of existing school bus routes—90 percent if re-charged mid-day.[23]
- **Possibly longer waits for buses and parts.** Lead times on electric bus orders for Oregon school districts have ranged from eight months to a year, compared to the typical 120-180 day timeframe for diesel—though it should be noted that Oregon school districts were procuring their buses in the midst of the COVID-19 pandemic, at a time when diesel bus lead times have actually been closer to six to nine months. Waits for parts can be longer, with equipment supply chains still maturing. Also, electric buses require collaborating with more partners, potentially leading to longer deployment timelines as everyone navigates the new technology.
- **Lack of staff familiarity with EVs, chargers, and electricity pricing**, which will require education—often provided by the dealer or manufacturer, utilities, and, where applicable, transportation contractors.

Aaliyah Degante
FLEX Online School

3. HOW TO GET STARTED

Use the Cost Analysis Tool to calculate potential costs and savings.

The Cost Analysis Tool can offer a general idea of the expected level of investment and allows you to compare two different bus fuel types at a time, providing a valuable starting point for understanding the potential lifetime costs of electric buses compared to other buses.

Reach out to others with experience and expertise.

Reach out to other school districts who are further along in the process, particularly those with a similar climate or daily range to learn from their experiences. For instance, Bend-La Pine School District contacted a school district with experience using electric buses in a colder climate.

State agencies and other organizations can offer technical assistance as well (contact information under "Resources" section). For instance, the Columbia-Willamette Clean Cities Coalition helped Salem-Keizer school district with their successful application for an Electric School Bus Fund grant from Portland General Electric.

- Oregon Department of Education can connect you with school districts using different alternative fuels buses, including electricity, to learn more about their experiences. All six school districts offered to share their experiences and lessons learned with other school districts considering electric school buses. School districts also need to coordinate with the Department of Education to ensure compliance with state-required standards listed in the "Resources" section.
- The Oregon Department of Environmental Quality administers programs that can help fund school bus electrification, including grants to assist with diesel emissions reductions and the Clean Fuels Program (discussed in the "Funding" section). Reach out to them with questions and/or assistance with grant applications.
- The Oregon Department of Energy can help with questions or feedback regarding the Cost Analysis Tool and provide information about funding opportunities such as the Public Purpose Charge Program, covered in the "Funding" section.

- The Environmental Center's Electric Bus Learning Project provides technical assistance to school districts across Oregon and resources such as webinars and an Electric School Bus Newsletter.
- The Clean Cities Coalition Network, a program of the U.S. Department of Energy, has coalitions in the Columbia-Willamette and Rogue Valley regions. Check out these Oregon coalitions listed on their Coalition Contact Directory page and reach out to the coordinator listed to see if they can help with grant writing or other technical assistance.
- World Resources Institute offers technical assistance to some school districts nationwide via their Electric School Bus Initiative—reach out to the contact listed on their webpage for the initiative for more information.

Contact your electric utility for technical assistance early in the process, before making any investments.

Raymond Cui
Findley Elementary

Your local electric utility will be the fuel provider, so it's important to build a relationship with them early in the process. Discuss the electrification process with them before making any financial commitments and ask for their assistance in planning your pilot. A checklist of questions to ask your utility is available in Appendix A.

Your electric utility may be able to help determine the best charger type and where to install it, and may also be able to advise on technical and permitting requirements. They may even have programs to assist with funding school bus electrification (discussed in the "Funding" section). The utility's work schedule may affect your plans, so coordinate with them as you develop a timetable.

Consider how your buses are used, including regular routes and hours of services, as well as transportation for extracurricular activities or special events.

As mentioned in the "Benefits and Challenges" section, with ranges at or above 100 miles (depending on climate and season), electric school buses can cover most regular student transportation needs, but districts should consider plans for any necessary mid-day charging (consult with your utility). At some point you may want to invest in faster chargers to support usage for field trips. For example, Twin Rivers Unified School District in Sacramento is procuring DC fast chargers to assist with charging electric buses for these longer trips.

Incorporate equity and social justice into plans for electrification.

In Oregon and across the U.S., low-income families and people of color are more likely to live in areas with disproportionately high concentrations of air pollution. Consequently, people in these communities are also more likely to suffer from pollution-related health complications, including chronic illnesses such as asthma and life-threatening conditions such as cancer. Switching to electric buses reduces local air pollution and results in better health outcomes for these communities and they should be prioritized for deployment.

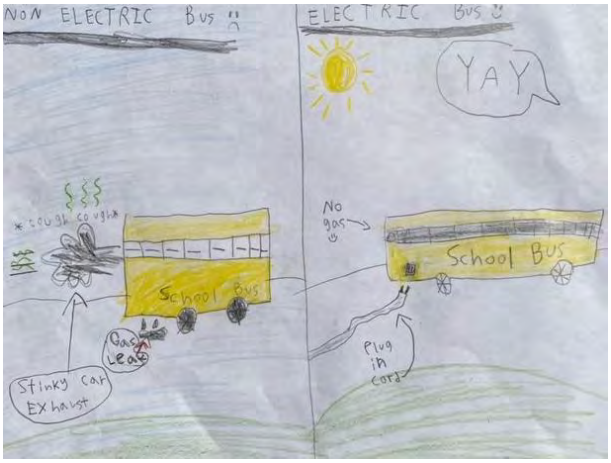
For example, the two Oregon school districts with buses already in deployment as of summer 2021, Beaverton School District and Reynolds School District, have prioritized their electric buses for Title I schools. Demonstrating how your use of electric buses will further equity and social justice is a requirement for some funding sources available for school bus electrification—such as PGE and Pacific Power grants—and institutions offering these programs may offer coaching services to help with this aspect of your plan.

Plan to receive the buses and test the chargers at roughly the same time.

Try to install chargers around the same time or before receiving your electric buses so you can use the buses and test the charging time. (For information on ensuring your buses and chargers are interoperable, see the section on "Selecting and Installing Chargers").

Build time into your procurement schedule for training drivers, maintenance workers, and other staff.

Many electric bus dealers or manufacturers will offer introductory training for drivers and maintenance staff as part of the bus purchase agreement, but plan for additional time to train staff and build familiarity with the new systems. For drivers, regenerative braking is one key difference from non-electric buses, and skillful operation can greatly increase vehicle efficiency. For maintenance staff, it is essential to invest in appropriate training and adopt best safety practices because they will be working with high-voltage electrical equipment. In some cases, drivetrain companies offer training for high voltage-certified maintenance staff.



Lilah Sabraw
Ridgewood Elementary

Sakruti Gunturu,
Elmonica Elementary

If you have a union workforce, reach out to your union representatives about the potential need to update the tasks that drivers and/or other personnel need to perform, such as responsibilities associated with the charging process.

In addition to fleet and facility managers, drivers and maintenance staff, other personnel may also need time to train for a new system. For example, if your district doesn't have a process for tracking electricity consumption, you may have to develop one (more on this under the "Selecting and Installing Chargers" section).

Engage and involve stakeholders as needed throughout the process.

As mentioned under "Key Recommendations," engaging all necessary stakeholders throughout the process—in addition to staff that will be working directly with the electric buses—will be essential to the success of your electric school bus pilot. For example, the Portland Public Schools facilities manager flagged the need to invest in a lift upgrade to support their electric bus that is heavier than its diesel counterpart due to the weight of its battery. Another consideration is that school boards must approve any uses of funding, including grants—and in some cases, even the decision to apply for a grant.

Seek fellow champions of electric buses, such as teachers who see them as a real-world way for students to learn about clean energy and transportation. Environmental justice groups concerned about air quality, such as Chispa, have been organizing to raise awareness and mobilize resources for school bus electrification.[24] Parent support—for instance—in Concord Massachusetts, has helped school districts secure funding for buses beyond the initial pilot bus.

4. COSTS

Logan Truong
Kinnaman Elementary

Definitions:

- kWh: kilowatt-hour, a unit of measure for electrical energy; same idea as gallons of diesel[25]
- time-of-use rate plans: cost of electricity varies based on the time of day and season in which it is used[26]
- demand charge: typically based on the maximum amount of power drawn during a billing cycle, this is designed to encourage businesses to spread their electricity use throughout the day

Electric buses have higher upfront costs, and savings on maintenance and fuel costs may not currently offset the costs of these buses—though that should change over time.

Electric buses have higher purchase costs than other options but their price is expected to decrease over the next few years, in large part because battery costs are expected to continue to decline—but also due to economies of scale as production increases. At this time, grant programs are critical for helping offset the higher costs of transit electrification and are covered under the "Funding" section. You can use the Cost Analysis Tool to input parameters specific to your operation (such as your local utility, and participation in the Clean Fuels Program) to estimate the cost differences for your school district.

You will need to invest in charging infrastructure.

Initial infrastructure costs include charging equipment, supporting electrical hardware, infrastructure installation, and employee retraining. The total infrastructure costs will depend on the type of charger you choose and the scale of your pilot or deployment. Part of the infrastructure build-out will need to be completed by the utility.

Switching to electric buses may lower your fuel costs, but this may require managed charging and collaboration with your utility.

In general, electricity has a lower per-mile cost than other fuel options—and indeed, both Oregon school districts with electric school buses currently deployed are spending less on fuel for their electric buses than they do for their diesel buses—but you may need to carefully structure charging schedules to maximize the cost savings. Talk with your utility ahead of time to assess how electrification might affect your electricity costs. It may be helpful to reach out to your utility or Energy Trust of Oregon to see what is available for energy audits and/or feasibility studies to see if you can reduce energy usage and prepare for any added EV charging load. [27][iii]

[iii] Public Purchase Charge Program (discussed in "Funding" section) funds can be used to conduct energy audits for educational facilities but not maintenance or administrative buildings where fleets are kept.

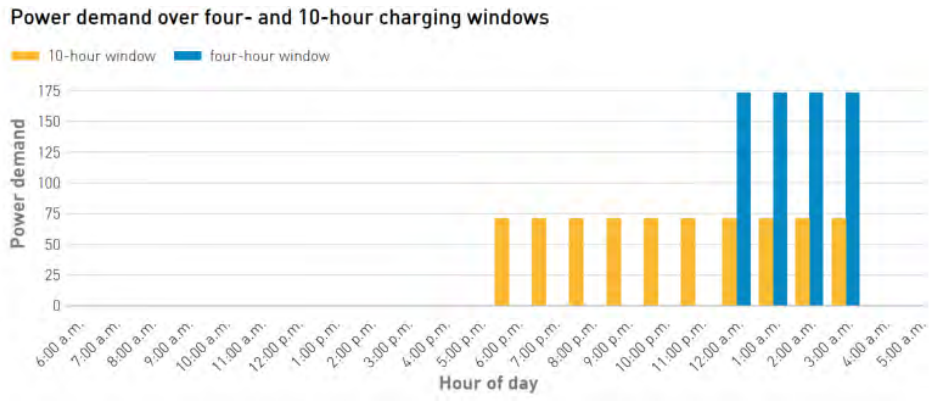
Your utility bill will include a consumption charge based on the amount of electricity (kWh) you use during the billing period. The utility may charge you a higher rate per kWh during peak hours, so consider scheduling buses to charge during off-peak hours. Overnight charging is typically the least expensive option, but as Oregon's electric grid evolves to incorporate more solar-generated electricity, mid-day electricity rates may also be low-cost. Ask your utility about time-of-use rates that offer lower rates during off-peak hours in exchange for higher rates during peak hours. Some utilities may have EV-specific time-of-use rates designed for customers with electric fleets.

Your bill may also include demand charges based on the maximum amount of power that you use during a billing cycle, which can have a big financial impact on your pilot. The Massachusetts pilot spent more on charging their buses in their first year than they would have on diesel, and demand charges were a big part of that—though in the years since, the school districts have been able to better manage demand charges, with Concord Public Schools currently seeing a 70 percent reduction in fueling costs for electric. When multiple buses need to be charged, especially when using higher-powered DC fast chargers, fleet managers can reduce demand charges by staggering individual charging sessions for each bus, or by reducing the rate of charge to all buses, thereby reducing total energy consumed at any given time.

Shanaya Sharma
FLEX Online School

For example, Figure 3 illustrates the difference in power demand for a fleet charging its vehicles over a four-hour window, which would require 175 kW of peak power, as opposed to a 10-hour window, which would require 75 kW of peak power.[28]

Figure 3: Power Demand in kW Over Four- and 10-Hour Charging Windows for a Fleet



Source: PG&E, Guidebook for Fleet Electrification and Infrastructure

Some charger manufacturers offer software that can help manage charging for you by regulating and capping the total electricity draw while still ensuring buses are fully charged for their next route. There are also charge management companies you can hire to assist with finding the cheapest charging schedule. The Twin Rivers Unified School District in Sacramento hired a charge management company when they started out with their initial 16 electric buses and have estimated a fuel cost reduction of 75-80 percent.[29]

Maintenance costs may be lower.

Studies on light-duty EVs have found maintenance costs to be 40-50 percent lower than their internal combustion engine counterparts, and heavy-duty EVs such as buses are expected to have lower maintenance costs as well.[30] [31] School bus pilots in Michigan reported decreased maintenance costs due to fewer brake jobs, no oil changes, and other factors—and Twin Rivers Unified School District in Sacramento estimates their costs to be 60 percent lower.

SeungJae Lee
Sato Elementary

By reducing air pollutants and GHG emissions, electric buses reduce negative health and economic impacts to your community and the entire state of Oregon.

Moving to alternative fuels decreases tailpipe emissions, which are associated with many detrimental health impacts. By mitigating local air pollution, electric buses reduce a community's environmental and healthcare costs.

GHGs also have negative consequences for society: more frequent and intense heat waves, wildfires, and droughts; more destructive coastal and inland flooding; and water and food shortages. These climate change impacts have already resulted in significant costs to society, and the costs of emerging impacts can be quantified. The "social cost of carbon" represents the cumulative costs of impacts associated with the emission of each ton of carbon dioxide.[32] [iv] A growing number of states are factoring in the social cost of carbon when evaluating public sector investments and policies, which helps support a transition to a cleaner economy.

5. FUNDING

Public Purchase Charge (SB 1149) Schools Program

Senate Bill 1149 (1999) directed PGE and Pacific Power to collect a "public purpose charge" from their customers. Since 2002, the first 10 percent of these funds collected have gone to public schools in the utilities' respective service territories to complete energy audits and implement energy efficiency measures.[33] SB 1044, which passed in 2019 and took effect on January 1, 2020, enabled the funds to also be used for fleet audits, electric vehicles (including buses), and charging infrastructure.

[iv] Social cost of carbon values are a conservative estimate of the true cost of emitting GHGs, given the difficulty of quantifying some impacts, such as respiratory illnesses resulting from increased wildfire smoke. The Cost Analysis Tool estimate for the social cost of carbon is based on estimates for a new, post-2010 engine, and may be lower than the SCC of your diesel bus if it is an older model.

Discuss plans for these funds internally with the facilities and business managers at your school district and reach out to ODOE to check your estimated remaining funds. If there is interest in using these funds toward a bus and/or charging infrastructure, start by submitting a fleet audit and forms for vehicle/charger type to ODOE. School districts are reimbursed for eligible costs after purchasing their EVs and/or equipment. For more information about the PPC program and the specific eligible costs, visit ODOE's website.

Joscelynnn Craib
Bonny Slope Elementary

Utility Grant Programs

Some utilities have developed grant programs supporting school bus electrification from Clean Fuels Program credits they receive as an "aggregator" of home EV chargers in their service territory. Not all utilities have access to enough credits in their area to make grants available, so check with your utility to find out what kind of assistance is available. If you are a PGE or Pacific Power customer, check out their grant programs and application deadlines:

- PGE Electric School Bus Fund: covers the differential cost of an electric bus versus diesel, and 100 percent of charging infrastructure. Additionally, PGE provides technical assistance with charger selection and other planning.

- Pacific Power Electric Mobility Grant Fund: covers up to 100 percent of eligible costs for electric transportation projects (includes vehicles other than buses). Technical assistance is offered as well, including coaching services for the grant application process. They also offer matching funds for external grants, such as a joint grant awarded to Portland Public Schools, whose routes are mostly in the PGE service territory, but whose charging location is in the Pacific Power service territory.

Kira Jhaveri
Sexton Mountain Elementary

DEQ Programs

Oregon DEQ runs an array of programs to assist fleet owners with reducing emissions from diesel engines. All programs require decommissioning of the bus being replaced, which should be accounted for in your plans if you are using an electric school bus to replace a diesel bus.

- Diesel Emissions Mitigation Grants: in 2021, DEQ announced this additional source of grant funding for reducing diesel emissions using money from the settlement against Volkswagen for cheating on federal emissions standards. School districts may apply to receive reimbursement for up to 100 percent of the cost of a diesel vehicle replacement, or match with other funding sources. The plan is to award $8 million in funding annually for five years, 2021-2025. Check the deadline for applications, and the DEQ webpage for the program, which includes resources such as a comprehensive user guide for the grant application. Vehicles eligible for replacement must be model year 2009 or older.
- School Bus Replacement Program: check with DEQ to see if funds remain from this program using VW settlement funds, started in 2018, targeting vehicles 2007 and older. The program caps grant amounts at $50,000 per bus. See the DEQ webpage for the program.
- Diesel Emissions Reduction Act (DERA) State Grants—check the webpage for coverage and application deadlines, which vary year to year.

Not ready to go electric just yet? DEQ funds and Clean Fuels Credits can also be used to upgrade to a newer diesel engine or transition to another alternative fuel—which offer significant benefits in reduced localized air pollution. See webpages linked for each program for more information.

Aria Harter
Cedar Mill Elementary

Clean Fuels Credits

Just as many Oregon school districts currently generate credits through DEQ's Clean Fuels Program for using lower-carbon fuels like propane, schools may generate credits by installing chargers for fueling electric buses. The Cost Analysis Tool gives you the option of factoring in Clean Fuels credits, based on the current value of $128, though the value is subject to fluctuation due to market forces.

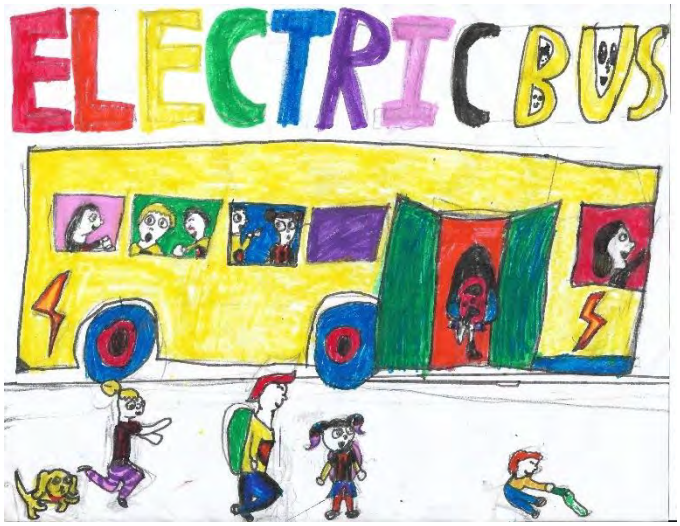
DEQ also offers "advance crediting," which advances up to six years' worth of Clean Fuels credits when the first EV is placed into service. This helps with covering the upfront costs of investment in electrification (though there are no restrictions on what funds from the sale of these credits can be used for), compared to the typical schedule where credits are awarded quarterly. However, if you receive utility funding for charging infrastructure, the utility may claim the Clean Fuels credits generated for a length of time—for instance, PGE collects for ten years and Pacific Power for the entirety of the project life. Discuss this with your utility at the outset.

For more information about how to participate in the Clean Fuels Program, visit DEQ's webpage.

Oregon Department of Education Reimbursement Student Transportation

As with a diesel bus, the Oregon Department of Education will reimburse school districts for the purchase of an electric school bus—at the same 70, 80, or 90 percent bus cost level (depending on school district costs per student), paid over ten years per Oregon administrative rules for "Approved Transportation Costs for Payments from the State School Fund."[34] If any other grants are used, reimbursement would only apply to the remaining cost of the bus.

Federal Programs



Ishika Singh
FLEX Online School

Throughout the year of this guide's publishing (2021), there has been an increased and sustained federal interest in deploying electric school buses. On November 15, 2021 President Biden signed into law the Infrastructure Investment and Jobs Act (H.R. 3684). It establishes a clean school bus program to award funds for the replacement of existing school buses with zero-emission buses or alternative fuel school buses. The program has $5 billion for electric and low-emission school buses for fiscal years 2022-2026, with at least 50 percent of that funding going toward zero-emission school buses. This new program, when established, may also receive additional funds this year through a spending bill (a budget reconciliation bill) that is under consideration in the House and Senate. This program will provide substantial funding for electric school buses and advances alongside other federal programs/mechanisms related to clean vehicles and school infrastructure that can support electric school bus deployment.

In addition to the grants mentioned above, school districts may apply for Federal-level DERA Rebates—check the webpage for coverage and application deadlines, which vary year to year.

6. SELECTING AN ELECTRIC BUS MANUFACTURER

Follow your usual procurement process as defined by your funding source, and remember the industry is still developing.

The process for procuring an electric bus is similar to that for procuring any other kind of student transportation equipment: conduct industry research and develop a spec, work with dealers or manufacturers to arrange demonstrations, and determine whether a request for proposal would be appropriate. Make sure the dealer or manufacturer is committed to improving their product, provides a solid warranty, and will continue to provide parts and technical support after the sale.

The first pilots of electric school buses in Oregon represent two manufacturers, however CALSTART's Zero-emission Technology Inventory Tool reports that there are 11 manufacturers producing electric school buses for the North American market. The Vermont Energy Investment Corporation, which consulted on the Massachusetts pilots, maintains spec sheets on the different electric school buses available among other "Electric School Bus Resources" on its website. While retrofitted buses were used in some of the very first electric school bus pilots in the country, this option is not common today among electric school bus deployments.[35]

Define your technical specifications and negotiate for them.

You should negotiate with dealers or manufacturers on performance requirements for buses. Technical requirements should include general "bus" components, such as air conditioning and the number and condition of seats, as well as "electric bus" components, including the battery, electric motor, and the cabin heating system.

The most important electric bus feature to look for is range, or the miles the bus can travel before needing to recharge. Range can vary based on temperature, route characteristics (such as elevation), and passenger load, so check with dealers or manufacturers on range under conditions relevant to your context.

An "electric bus" component that Beaverton School District found they needed to add was a second 12-volt battery to help run bus functions other than the motor (such as heat and air conditioning, fan, and lights). School districts in cold climates may also want to consider adding an auxiliary heater for cabin heating, since heaters powered by the battery system impact vehicle range. As of this writing, auxiliary heaters are fuel-fired and may not be allowed under all grant programs.

Irene Aguilar
Sprinville Elementary

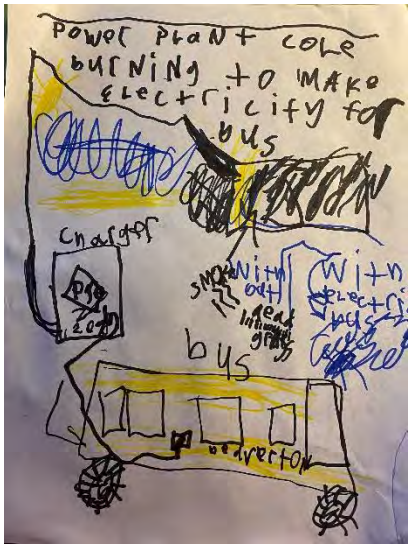
Other important performance requirements to establish are:

- Charging times and energy consumption, including variations based on temperature and charger capabilities.
- Compliance with Oregon Department of Education Minimum Standards for Oregon School Buses, with potential added safety features, such as noise generators when traveling at slower speeds (to alert pedestrians, given the quietness of electric buses). Coordinate with the department to ensure added safety features are compliant with state standards. Portland Public Schools experienced a delay in getting their electric school bus because they were navigating meeting state safety requirements with a Canadian manufacturer.
- Charge port location: if you back-in to park your school buses, make sure to order your electric bus with a charge port at the rear of the bus to align it with the charger. If you park head-in, order your electric bus with the charge port at the front of the bus.

Look at the fine print.

Thoroughly compare costs and support offered by the different dealers or manufacturers. For example, you may have to purchase additional tools or data collection software to support and monitor your electric buses and chargers. Or some dealers or manufacturers may charge extra for training. The Zeeland, Michigan transportation director recommended specifying the desired hours of training for bus technicians.

Compare warranties, including for electric batteries (see Appendix B for a list of things to consider when comparing warranties). Just as diesel buses typically have a separate warranty for the engine versus the body/chassis, electric buses typically have a separate drivetrain warranty, which includes the battery. Dealers interviewed for this guide reported longer warranties for drivetrains—eight years—compared to five years for a diesel engine. In many cases EV batteries have outperformed expectations, as in the Twin Rivers Unified School District's pilot in Sacramento, reporting only 2 percent degradation in their batteries after five years of use.



Ellis Read
Raleigh Hills K8

Establish an end-of-life plan for the electric batteries.

Recycling of batteries, including lithium-ion—the most common EV battery type—is a regular option today, and it is expected that markets and options will only continue to grow with greater EV deployment. You can also check with your dealer or manufacturer to see if they will assume responsibility for battery disposal at the end of its useful life.

It is possible that batteries no longer suitable for vehicle use may also be repurposed for other applications. For example, used batteries could be paired with solar panels to expand grid capacity. The batteries could store power generated during off-peak hours and help meet increased demand during peak usage periods.

7. SELECTING AND INSTALLING CHARGERS

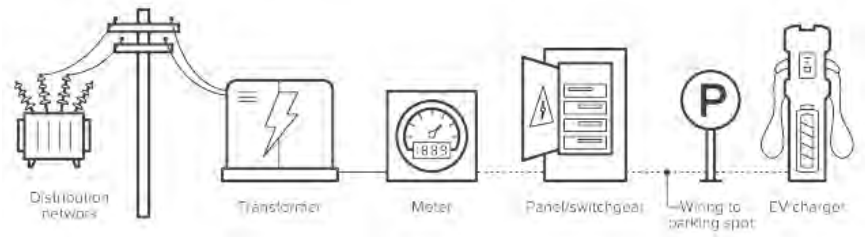
Definitions:[36]

- kW: kilowatts, the unit of measure for electrical power; power is how quickly energy is delivered
- voltage: electrical force created by a difference in electrical potential
- amperage: a measure of the rate of flow of electrical charge
- charge rate: the rate at which a battery can charge, measured in kW
- duty cycle: the hours per day, proportion of time or distance that a vehicle is operated per day

Charging infrastructure required may include:

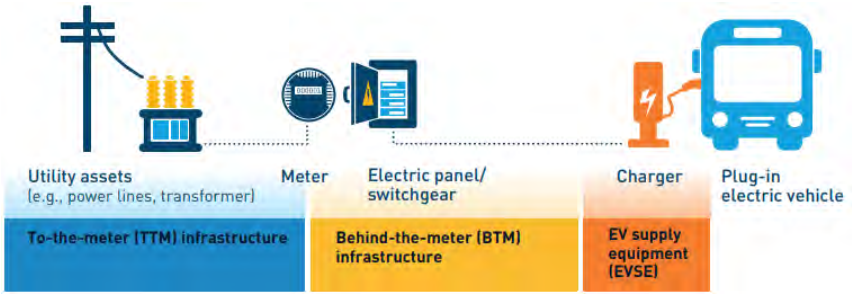
- Charger(s)
- Site preparation (trenching, conduiting)
- Upgrading transformers and switchgear
- Hardware and software to manage electricity consumption (software licenses for a certain number of years often included with the charger purchase agreement)

Figure 4. Infrastructure Supporting EV Readiness



Source: PGE "Benefits of Electric School Buses"[37]

Figure 5. Infrastructure Breakdown



Source: PG&E "A Guidebook to Fleet Electrification and Infrastructure"[38]

Understand your options for chargers.

The need to install charging infrastructure is the primary difference between procuring an electric bus versus a bus that runs on any other type of fuel. You have two main options for chargers, or Electric Vehicle Supply Equipment (EVSE):

- **Level 2 chargers**: Take longer—typically 8 hours—to fully charge a bus battery but are less expensive in terms of upfront costs and reduced exposure to demand charges due to their lower power (see "Costs" section for more on demand charges). Because school buses often have time between routes and at night to charge, Level 2 chargers meet the needs of many school districts. For instance, after examining their route lengths, Bend-La Pine School District determined a Level 2 charger would meet their needs if they planned for a mid-day charge.
- **DC fast chargers:** Charge the battery faster, typically in 2-4 hours. This is possible because they convert AC (alternating current) grid electricity into the DC (direct current) electricity needed to charge batteries, while lower-level chargers require the buses to convert electricity on-board, limiting their power levels (AC chargers typically max out at 19 kW). DC fast chargers also enables bi-directional interaction with the grid, required for V2B/V2G technology. DC fast chargers requiring connection to 480V power increase installation costs. The units themselves are also more expensive than Level 2 chargers, and they can contribute to higher demand charges given their higher power demands.

Table 3: Electric School Bus Charging Infrastructure Options

	Level 2	DCFC
charging rate	Up to19 kW rating (19 kW is most common)	Up to 150 kW rating[v] (50-60 kW is most common)
supply voltage	208 or 240V single phase	208V 3-phase or 480V 3-phase
supply amperage	Up to 80 amp	Depends on voltage and charge rate
charging time	6 hours	2 hours
cost	$3-7K	$30K-50K for 60 kW

Choosing a charger level.

For school buses that travel less than 100 miles a day and have 10 or more hours to recharge, Level 2 charging is usually sufficient. For school buses with longer routes, or for V2G projects, DC fast chargers might be advantageous. For those interested in calculating energy needs, perhaps for a future fleet conversion scenario, your utility may be able to help you with these estimates, in addition to resources such as the "Calculate Your Energy Needs" walk-through in PG&E's Guidebook to Fleet Electrification and Infrastructure.

Ensure chargers are interoperable with your buses.

Ask your electric school bus dealer or manufacturer which chargers have been tested with their buses and ask your charger manufacturer which buses have been tested with their chargers to ensure interoperability. Also, ask if the charger complies with the Open Charge Point Protocol, which allows the charger to work with different network management systems. One of the primary benefits of this is the ability to configure to a different network, should the network your charger is connected to go out of business.[39]

[v] DC fast chargers rated over 150 kW exist but not currently for the school bus market.

Choose a networked charger, if possible.

Networked chargers, also called "smart chargers," connect to the internet to relay information from the charger to the network provider's cloud platform. Fleet owners can access this information by logging into a dashboard managed by the network provider. This information helps fleet owners understand how much (electric) fuel is being used by each charger and when. Often, fleet owners can use this dashboard to schedule charging to off-peak hours to reduce their electricity costs.

Networked chargers can connect to the internet in three different ways:

- Cellular – Many chargers contain a cellular modem that uses a cellular data connection (just like a smartphone) to connect to the internet. This makes it easy to set up, but typically comes with cellular data fees on a monthly or annual basis. Also, make sure it comes with a 5G modem, so it has the latest technology and won't need to be upgraded for a while.
- Wi-Fi – Many chargers come with the option to connect to a local Wi-Fi network instead of connecting to a cellular network. This means you can often avoid the cellular data fees, but you must ensure you have a reliable Wi-Fi connection. Strong Wi-Fi is not common in the middle of a school bus yard, so this may involve additional IT infrastructure to set up.
- Ethernet – Some chargers allow connection to the internet through ethernet/fiber optic cables connected to your organization's network. This involves much more infrastructure and involvement from your IT department but gives you the most reliable and most cybersecure connection, which may be worth it in the long run.

Avoid using non-network chargers if possible. Even though they're less expensive, they won't have the features that fleet owners will want and need to manage a fleet of electric vehicles. Plus, most utility programs require networked chargers to be eligible for rebates/incentives.

Place chargers strategically.

For examples of charger site arrangements, see Appendix C. Factors to consider and steps to take in your charger installation include:

- Coordinate and plan with your Facilities Management Department and utility about the best place to install the chargers in relation to the location of the transformer and electrical gear, and to ensure that you have sufficient power capacity on site. Ideally,

place the chargers at the head of the parking space and protect them with bollards or wheel stops.

- Wall-mounted chargers are generally less expensive to install than pedestal-mounted.
- If you're planning on adding more chargers later, doing the trenching and conduit for those additional chargers while installing your first charger(s) will help reduce costs of installation for future expansion. For instance, Beaverton School District did the trenching and laid conduit for eight chargers when installing their first two; Portland Public Schools set up for six when installing their first. Also consult with your utility about the possibility of increased demand if you plan to add electric buses to your fleet.

Figure 6. Pedestal (Reynolds School District) and wall mount (Beaverton School District) chargers at Oregon electric school bus pilots

Source: PGE

Ensure that you can accurately track the electricity consumption of your electric buses.

You will likely need to distinguish electricity consumed by buses versus electricity consumed by other facilities. Tracking them separately has two advantages: it gives you more accurate data collection and measurements of key performance indicators and is required for registration for any federal or state incentive program, like the Oregon Clean Fuels Program. Installing a separate meter for chargers is a common way to do this, but it is also possible to develop methods of tracking electricity consumption and allocating expenses without a separate meter. Discuss your options with your Facilities department, local utility, and bus/charger manufacturers.

Additional resources on installing charging infrastructure can be found under the "Resources" section.

8. PUTTING ELECTRIC BUSES INTO OPERATION

Engage with first responders before putting electric buses into operation.

Additional dangers for first responders to accidents involving EVs include "electrocution and the possibility of the car turning on accidentally while work is being performed."[40] Contact local first responders prior to deployment to discuss safety measures and training. Some electric bus dealers or manufacturers provide their own first responder training or guides—contact them for more information about their safety training.

Ensure buses and infrastructure are on time and operational before conducting public outreach.

Wait to publicize your plans until you are certain when the buses and chargers will be fully tested and operational. Announcements about electric buses have generated public interest and excitement, but you only get one chance to make a good first impression with the public.

Ian George
Nancy Ryles Elementary

Encourage bus drivers to practice energy-efficient driving.

The range of an electric bus depends on many factors, but one of the most important is the

behavior of the driver. Encourage your bus drivers to drive more economically and maximize regenerative braking, which will save electricity and extend the range of the bus. Electric bus pilots around the country have referenced the friendly competition among drivers to see who can be the most energy efficient in their vehicle operation.

Your drivetrain installer likely tracks performance data on your batteries, referred to as "telematics," and you may be able to access this information to aid your efforts toward greater efficiency—for instance, Beaverton School District reached out to their dealer to gain access to this data.

Collect data as your pilot evolves and consider your future strategy.

You may need to track miles driven, fuel costs, maintenance costs, and performance (for example, proportion of time spent receiving repairs) to comply with a grant or funding requirement—but having this information will also be valuable if you scale up your electric fleet, and to other school districts navigating this new technology.

Looking ahead, transitioning your fleet to electric beyond the first few pilot buses becomes a new and different—and exponentially larger—project. Some school districts have hired consultants to help create transition plans for them. Hopefully, as electric school bus deployment increases, more resources and knowledge will become available to help school districts navigate this phase of the fleet transition.

9. RESOURCES

Funding

How to Fund an Electric Bus webinar recording
Electric Bus Learning Project, July 2021

Links to Programs:
Public Purpose Charge (SB 1149) Schools Program
PGE Electric School Bus Fund
Pacific Power Electric Mobility Grant Fund
DEQ Diesel Emissions Mitigation Grant
DEQ School Bus Replacement Program
Diesel Emissions Reduction Act (DERA) Grants State and Federal
Clean Fuels Program

State Agency Contacts

Oregon Department of Education
Safety features, connecting with other school districts piloting alternative fuel buses:
buslicense@ode.state.or.us

Oregon Department of Environmental Quality
Questions and assistance with grant programs: dieselgrants@deq.state.or.us
Questions about Clean Fuels Program: OregonCleanFuels@deq.state.or.us

Oregon Department of Energy
Questions on Cost Analysis Tool, Public Purpose Charge program:
askenergy@energy.oregon.gov

Oregon School Bus Safety Standards

OAR 581-053-0240 Minimum Standards for School Buses
OAR 581-053-0650 Minimum Standards for All-Electric School Buses

Information on Manufacturers and Chargers

Electric School Buses Available for Purchase
Vermont Energy Investment Corporation

Electric School Bus Charging Equipment Installation Guide
Vermont Energy Investment Corporation, 2017

Electric School Bus Webinar Series: Charging Infrastructure
Center for Transportation and the Environment, 2020

Guidebook to Fleet Electrification and Infrastructure
PG&E, 2019

Other Resources on School Bus Electrification

Electric Buses and Equity: Six Principles For Combining Them
Alison Wiley, Electric Bus Learning Project, February 2021

Accelerating the Transition to Electric School Buses
Ethan Evans and Morgan Folger, U.S. PIRG Education Fund, Environment America Research & Policy Center, February 2021

Electric Buses in America: Lessons from Cities Pioneering Clean Transportation
James Horrox and Matthew Casale, U.S. PIRG Education Fund, Environment America Research & Policy Center, Frontier Group, October 2019

Electric School Bus Pilot Project Evaluation
Vermont Energy Investment Corporation, April 2018

Making Yellow School Buses a Little More Green
Ellen Rosen, New York Times, January 2020

Electric Yellow Schoolbus Will Try To Make Vehicle To Grid Power Work
Brad Templeton, Forbes, July 2021

Electric Vehicles Resources Page
Twin Rivers Unified School District

Oregon Emissions Data
2020 Biennial Energy Report, "Energy by the Numbers"
Oregon Department of Energy, 2020

Appendix A: Utility Questions Checklist

While not comprehensive, following is a list of questions developed by World Resources Institute to ask your utility, some of which may affect the timeline of installing your charging infrastructure:

- How many service meters are there?
- What are the account numbers?
- What is the existing electrical consumption?
- Is there a chance or opportunity to convert existing service bays to charging areas?
- For DCFC/V2G, do you have 3 phase power at the site already?
- Does the site exist in a special district that requires additional permitting (flood, tsunami, historic etc.)?
- What is also involved in site building permitting such as electrical inspections and approvals (sometimes the county or city needs to inspect and approve as well as the utility)?
- Does your utility require equipment with UL listing (may not be available if trying out new technology)?

Appendix B: Considerations for Comparing Bus Warranties

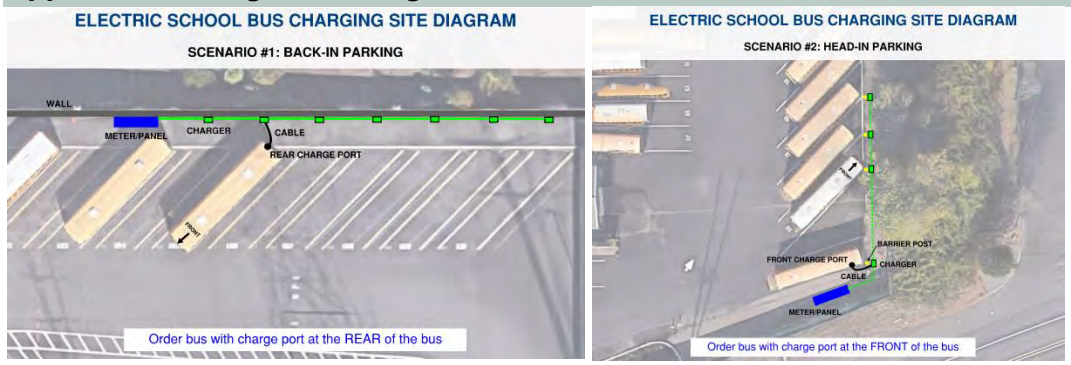
Keep the following considerations in mind when comparing warranties. Note, if you have selected a preferred bus but have concerns about the warranty, you might be able to negotiate with the dealer or manufacturer for changes to the warranty.

- Does the warranty ensure the bus maintains the range in the original specifications?
- Does the warranty ensure the battery must retain 70-80 percent of its original capacity?
- If you are considering V2B/V2G technology, is the drivetrain warrantied for throughput, or the total energy a battery is expected to deliver in its lifetime, in addition to years?[41]

For instance, the Massachusetts pilot warranties were for five years or 160,000 kWh, whichever came first.[42]

- Determine how to test the battery capacity and range. Can you test the bus yourself or does the dealer or manufacturer need to be involved in the testing?
- If a warrantied bus is no longer performing to standards, is the dealer or manufacturer required to restore the bus to its original capacity or to an acceptable capacity, such as 70-80 percent?

Appendix C: Charger Site Diagrams



Source: PGE

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