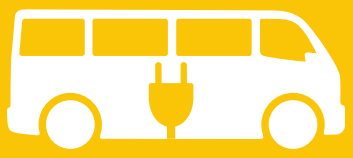

TRANSIT AND HEAVY-DUTY FLEETS

TRANSIT AND HEAVY-DUTY FLEETS

Heavy-duty fleet strategies are important for communities looking to reduce GHG emissions, eliminate harmful air pollutants from diesel fleets, and showcase their commitment to sustainability. Heavy-duty electric vehicles (EVs) are relatively new to the market compared to light-duty EVs and require a significant capital investment for both the vehicles and charging infrastructure. For this reason, it is very important for transit managers and other stakeholders to make informed decisions when investing in an electric heavy-duty fleet. This section outlines strategies for a targeted planning effort to map out the transition to electric buses or other heavy-duty vehicles.

This toolkit offers resources on heavy-duty electric vehicles, with a particular focus on electric buses, as they are widely available in the marketplace from several different manufacturers. Transit operators, school districts, and others across the country are already integrating them into their fleets. Other types of heavy-duty electric vehicles are developing, including refuse trucks and cargo vehicles, with more options anticipated in the next few years. Future toolkit updates may incorporate these additional vehicle types as their operational characteristics become better defined.

Note:
For heavy-duty fleets, the electrical charging infrastructure is much more substantial than for light-duty vehicles. If you are considering transitioning heavy-duty vehicles in your fleet, be sure to communicate with your Xcel Energy account representative early and often about your plans. See the section on Working with Xcel Energy for more information.

Who Are the Target Audiences for Strategies Included in This Focus Area?

- Transit agencies
- Community-based transportation providers
- School districts and supervisory unions
- School bus contractors
- Colleges and universities
- Nonprofits and other community organizations operating buses
- Refuse collection operators

Key Messaging

- Battery electric buses becoming readily available in the marketplace
- Reduced emissions of harmful air pollutants that negatively impact human health
- Quieter vehicles
- Reduced operating costs
- Potential to reduce maintenance costs
- Potential for lower and more consistent fuel costs (appropriate planning and controls required).

Typical Barriers

- Up-front cost of the vehicles
- Concerns about performance, including winter operations
- Confusion navigating charging infrastructure cost and logistics

What Are the Most Effective Outreach Channels for These Strategies?

- One-on-one meetings with fleet managers
- Peer-learning events

VEHICLES

Strategies in this area focus on assisting transit, school bus, and other fleets plan for, purchase, and deploy electric buses as part of their regular transportation services. Other heavy-duty EV options now available include refuse trucks and cargo vehicles, with more options anticipated to enter the market in the next few years.

Basic Information

This section focuses on two types of buses that are readily available on the market today: electric transit buses and electric school buses.

Electric Transit Buses

As of 2016, all major transit vehicle manufacturers produce electric transit buses. This includes the primary manufacturers of diesel vehicles: Gillig, New Flyer, Nova Bus, and COBUS Industries; and, manufacturers who entered the market specifically to make electric transit buses: Proterra, Build Your Dreams (BYD), and GreenPower Bus. The electric transit market is relatively mature, with many transit agencies across the country having made small initial purchases of electric buses. Electric bus models are available in a range of sizes, from smaller "cutaways" to the largest articulated buses. Pricing of electric buses varies depending on capabilities.

Battery range of buses can be tailored to meet the needs of transit operations. Short-range buses have smaller batteries with ranges up to 70 miles and can be recharged with fast chargers during daily service operations. Extended-range buses have larger batteries with ranges that can reach up to 350 miles before needing to be recharged (McCutcheon-Schour & Whitaker, 2017). Extended-range buses typically operate on routes during the day and are charged overnight. Typical ranges and charging times are included in Table 1 below.

Transit buses typically drive enough miles over the lifetime of the vehicle that much of the incremental up-front cost of the buses can be recovered in fuel and maintenance savings, particularly when funding programs help lower the initial purchase cost.

Table 1. Electric Transit Bus Technology Overview (McCutcheon-Schour & Whitaker, 2017)

40ft or 35ft Transit Bus	Short Range	Extended Range
Range (Miles)	20-70	150-350
Estimated Total Charging Time (from 0%-100%)	<1 hour	<4.5 hours

Electric School Buses

All major manufacturers of diesel school buses — including Blue Bird, Thomas, and IC Bus — are already producing electric school buses or have already announced plans to produce them. Other electric-only manufacturers include Lion Bus, Motiv Power Systems, and GreenPower Bus. Trans Tech exclusively produces Type A (small) buses and has an electric model. The electric school bus market is small but growing, due to increased interest and awareness sparked by the Volkswagen Clean Air Act Settlement Funds available, as well as by an increase in purchases from school districts, particularly in California, where financial incentives are available.

School buses are strong candidates for electrification because of their predictable and relatively short routes, significant down time which would allow for overnight or midday charging (potentially expensive fast charging is not typically needed), and the significant health benefits to children who ride the bus and are no longer are exposed to diesel exhaust fumes. However, up-front cost of the vehicles is still a significant barrier for cash-strapped school districts. At current price points, the lifetime cost savings offered by electric school buses are not enough to make up for the additional up-front cost, primarily because school buses tend to have low overall mileage. The Vermont Energy Investment Corporation compiled a list of all-electric school bus models available on the market in 2018.

First Steps and Quick Wins

Below are some of the strategies that can be used to raise awareness and educate transportation providers and the community about the benefits of electric buses. These strategies require some coordination but do not usually require significant financial resources to implement.

Network with Early Adopters

Reach out to regional municipalities or transit agencies that have purchased electric buses for information that can help inform decision-making. Be sure to ask about:

- Vehicle performance, especially in local extreme weather conditions
- Whether on-route charging was used
- Actual fuel and maintenance costs

Successes and lessons learned from early adopters can help streamline the transition to battery electric buses.

Hold Heavy-Duty EV Demonstrations

Invite vehicle manufacturers to demonstrate their buses in your community or region. Many of the electric transit and school bus manufacturers have one or more demonstration vehicles they use to showcase the technology. If you have a vehicle brought to the area, make sure to give mechanics and drivers a chance to "kick the tires," and invite stakeholders and the public for a ride so people can experience the vehicle firsthand. You could also invite the press to ride the bus to help spread the word. In conjunction with a demonstration, consider hosting an educational event for stakeholders in the region.

Demonstration vehicles are in high demand. It is important to plan ahead and to coordinate with the vehicle manufacturer well in advance. When planning your event, keep the needs of the manufacturer in mind. Consider whether there are opportunities for them to showcase the bus in other parts of the region or state. Is there an event with a built-in large audience that is attractive to them? Or can you coordinate with other communities to increase exposure to the vehicles?

Examples:

- Charge Up Midwest launched a four-state electric school bus tour in 2017 to raise awareness about electric school buses and the associated benefits related to air pollution.
- Green Mountain Transit in Vermont tested electric public transit buses in 2017.

Host Electric Bus Workshops

Host half- or full-day workshops to educate stakeholders such as school districts and transit agencies about battery electric buses. Clean Cities Coalitions are located in Colorado, Minnesota, and Wisconsin and specialize in convening events and educating fleet owners and the public about alternative fuel vehicles. Consider forming a partnership with your Clean Cities Coalition to host an educational workshop. This could be held in conjunction with a vehicle demonstration.

Suggestions for workshop content include:

- An introduction to the technology
- Benefits to the community and to the fleets
- Charging infrastructure and coordination with Xcel Energy
- Sources of funding

Examples:

- Wisconsin Clean Cities and Xcel Energy hosted an EV educational session and ride-and-drive event in 2019 that focused on light-duty vehicles but could be adapted for buses.

Larger Efforts and In-Depth Studies

Purchasing and deploying electric transit and school buses requires up-front planning to determine the suitability of the technology for the agency's regular transportation service. Prior to deployment, the following activities can be implemented to lay the groundwork for a successful EV project or for larger-scale investment in electric buses.

Administer a Fuel Assessment

Conduct a fuel assessment study to evaluate and compare various alternative fuel options (e.g., CNG, propane, electric). Establish the cost and benefits of adopting alternative fuels into the fleet. Identify steps needed to adopt alternative-fuel vehicles, including fueling infrastructure considerations. If a transportation provider is uncertain about which fuel type is appropriate, a full fuels assessment is a good first step.

Develop Bus Electrification Plans

Develop a plan for EV transition that considers routes, fueling, procurement options, and site modifications to accommodate chargers and other facility upgrades. This plan should provide a roadmap for initial adoption and scaling to a larger number of vehicles. Pilot programs can help the community and transit staff better understand the capabilities of EVs and how to best incorporate them into their heavy-duty fleet. An electrification plan should start with a pilot program with just a few vehicles and expand to a larger portion of the fleet following an assessment of the pilot program.

Equitable Electric Bus Routes: Because of historical racist housing policies like redlining, low-income neighborhoods and communities of color are often located near highways and arterial roads with commuter traffic, buses, and heavy duty vehicles that produce harmful vehicle emissions. As you electricity your bus fleet, prioritize routes in these disproportionately impacted communities.

Implement Electric Bus Pilots and Demonstrations

Design and implement a pilot electric school bus demonstration. Electric bus demonstrations have been implemented to build awareness about the technology; to gather information to validate costs, savings, and benefits of the technology; and to test the technology in a range of operating conditions such as cold weather and hilly terrain. A demonstration includes evaluation activities to collect data for a set period of time and, ideally, is compared with performance data from diesel vehicles in the fleet. Demonstrations can be a good initial activity to build buy-in and support of larger-scale deployments.

Examples:

- Great River Energy supported an electric school bus pilot project in 2017.
- Massachusetts Department of Energy Resources piloted an electric school bus project in 2016. The project is summarized in this report.
- White Plains Public School District in New York unveiled five electric school buses in 2018.

CHARGING OPTIONS AND INFRASTRUCTURE REQUIREMENTS

This section focuses on providing information about charging options for battery electric buses (BEBs) and requirements to support charging equipment. There are two types of charging systems currently used to support BEBs: 1) depot chargers that charge overnight, where vehicles are parked, after regular service operations and 2) on-route fast chargers that may be needed to support transportation operations during the day.

Basic Information

Electric Transit Bus Charging Options

In many cases, operations of electric transit bus can be supported with overnight depot charging with high-powered DC charging systems. Unlike school bus chargers, this equipment requires access to high voltage three-phase power. Some electric transit bus manufacturers may include the cost of depot equipment in the vehicles purchase price. Because transit buses often operate all day and for long hours, on-route fast charging may be needed to maintain service operations with BEBs. Two types of on-route chargers are currently available to support BEBs:

- **Overhead, or pantograph**: These chargers make contact with the top of the bus from a pole mounted system that deploys when the vehicle stops.
- **Inductive chargers**: These chargers provide power without making a physical connection to the vehicle. Typically, inductive chargers are installed in the pavement, and power is supplied to receiving pads on the bus.

On-route fast chargers are expensive systems to purchase and install — in some cases, they can cost as much as half the price of the vehicle itself. Each fast charging site requires its own custom design process, similar to the process for depot charging. Fast chargers also require additional planning — to understand and mitigate demand charges that may be incurred if buses charge during peak events, or at times of the day when electric demand is high. Therefore, it is important to assess the need for fast chargers and to consider what overall investment commitment the agency is willing to make for electrification.

Electric School Bus Charging Options

Currently, the majority of electric school buses use standard, Level 2 chargers with a higher amperage (80 amps) than a typical public station. With downtime in the middle of the day and at night, school buses are usually good candidates for slower depot charging. Charging typically happens at night or between morning and afternoon travel to and from school. As school districts adopt more electric school buses or consider full fleet electrification, DC fast chargers may be needed for buses that travel more during the day and exceed the battery range.

First Steps and Quick Wins

Initial steps for integrating BEBs into a community include strategies that educate and build awareness for the public and decision-makers. While these strategies do not require a great deal of community resources, such as staff time or budget, the resulting impact is fundamental for the success of BEBs.

Provide Electric Bus Workshops

Host an electric bus workshop. As discussed in the previous section, half- or full-day workshops are a way to educate stakeholders, such as school districts and transit agencies, about BEBs. Information about charging options and infrastructure requirements should be incorporated into these workshops to provide stakeholders with a high-level understanding of what is needed to support BEBs, as well as potential costs of charging equipment and installation.

Example:

- Wisconsin Clean Cities and Xcel Energy hosted an EV educational session and ride-and-drive event in 2019 that focused on light-duty vehicles but could be adapted for buses.

Incorporate EV-Ready Infrastructure in Transit Hub Development

Consider future charging needs in the design and construction of transit hubs or bus barns. Even if the city is not ready to purchase electric buses, incorporating additional electrical capacity and conduit in the construction of new transportation facility is significantly less expensive than retrofitting the facility. This is a good step a community can take to show its commitment to electrifying its heavy-duty fleet before it is technologically or economically feasible for the government to fully adopt heavy-duty EVs.

Larger Efforts and In-Depth Studies

Strategies that require additional planning, budgets, or research will benefit the integration of BEBs in the long term. Understanding how heavy-duty transit vehicles are currently used will allow for proper planning of the transition to alternative fuels and the associated needs for BEB charging locations.

Conduct a Route Analysis

Conduct an analysis to evaluate physical conditions of routes such as terrain, length of routes, and number of stops to determine whether transportation services can be supported by BEBs. A route analysis can also reveal whether on-route charging is needed to maintain current operations or if buses can be charged overnight with depot charging stations. Consulting firms are typically engaged to conduct route analyses for transit agencies. Vehicle manufacturers can also provide some support to transit agencies and school districts considering BEB purchases. For non-bus heavy-duty EVs, a similar analysis of usage patterns and range requirements is needed.

CHARGING CONTROLS

Strategies in this topic area guide operators regarding scheduling heavy-duty vehicle charging to optimize fuel rates and equipment operation.

Basic Information

Electricity is more costly to generate and deliver at certain times of day, especially during the hottest and coldest months of the year. Heavy-duty fleet operators can often cut charging costs in half by managing the times their vehicles charge. Heavy-duty EVs can usually be fully charged in about four hours. In most cases, the vehicle is off the road for more than four hours each day, so operators have flexibility in choosing exactly when to recharge the vehicle. The general practice of reducing costs by controlling charging is known as "managed charging."

Managed charging can be achieved by staff who manually connect vehicles to chargers at times when energy is less costly or by computer-controlled systems. The manual practice becomes labor-intensive and complex as EV fleets grow. Manually-managed charging may lead to costly errors (e.g., a single vehicle plugged in 15 minutes earlier than scheduled could add thousands of extra dollars to the month's energy bill). Computer-controlled systems are able to precisely control the timing of vehicle charging. With these systems, vehicles are plugged in at the end of the day, but the computer system prevents power from flowing to the vehicle until the time when energy costs are the lowest. The computer system can also limit the amount of power being consumed at any one time, which can reduce the need for costly investments in utility service upgrades.

First Steps and Quick Wins

First-step strategies for optimizing heavy-duty charging are based on altering charging habits. These small changes in charging control can have significant impacts on monthly energy bills and can reduce strain on the electric grid.

Set a Vehicle Charging Schedule

Develop a plan for when each vehicle should be charged to minimize electricity costs. This can be done by assigning staff to plug in vehicles at a particular time each night when energy demand and rates are lower or, if available, by using programmable controls on the vehicle or charging stations. Programmable controls can be used to allow the vehicle to plug in at any time but to limit the hours of the day that it draws power.

To determine the best hours to charge, check your utility rates or call your Xcel Energy representative.

Larger Efforts and In-Depth Studies

Strategies for long-term success and integration of heavy-duty EVs include larger efforts that require additional planning, budget, and resources. To ensure that the electrical grid can support the increased demands of heavy-duty EVs, optimizing times of charging through charging infrastructure controls in coordination with your utility will be critical.

Administer an In-Depth Charging Analysis

Install a heavy-duty fleet charging-management system. Especially as electric fleets grow, simple timer controls may not capture all potential cost savings, and a growing fleet could quickly max out the capacity of the existing utility service. More advanced control systems can limit the number of vehicles that charge at one time and can defer or avoid costly utility upgrades.

In some jurisdictions, smart connected charging controls may be able to unlock significant additional cost savings or revenue generation by starting and stopping charging automatically to help balance the wider electric grid. Many vehicles and charging station manufacturers provide some level of smart charging capabilities already or can provide these controls for an additional cost. In many cases, third-party control systems are the best way to maximize savings. Such controls often come with an up-front cost as well as a monthly or annual fee.

Before investing in additional control software, engage an energy engineering consultant to evaluate the potential for extra savings from more advanced controls; a detailed analysis of your fleet, electric rates, and existing infrastructure; and calculated cost savings. With this information in hand, evaluate the costs and benefits of smart charging systems available from vehicle or charger manufacturers and from third parties.

UTILITY COORDINATION

Communities can coordinate with Xcel Energy for mutually beneficial planning when considering electrifying heavy-duty fleets.

Basic Information

Heavy-duty EVs require significant amounts of electricity. An electric transit bus may consume as much electricity from the grid in four hours as a single-family home consumes in one month. This substantial and concentrated energy use usually requires upgrades to the site's electric service. These upgrades may take many months to design and implement and, in some cases, the selected locations and upgrades may be cost prohibitive. To avoid surprises, it is critical to engage with Xcel Energy early and to understand the cost implications of upgrades that may be required to serve the desired EV charging infrastructure at a site. The utility rate that is paid to charge the vehicle batteries can have a significant effect on operating costs. Be sure to work with your Xcel Energy account manager to optimize your charging schedule and location to be as cost effective as possible. Your account manager can also help you identity any applicable utility programs or incentives that may apply.

First Steps and Quick Wins

Fundamental strategies for utility coordination concerning heavy-duty EVs include establishing initial communication with Xcel Energy. Creating a partnership with Xcel Energy can be a simple task that requires little to no pre-planning or extra resources. Starting with an initial conversation and developing a partnership can result in success for the future.

Engage Xcel Energy

The earlier you engage Xcel Energy, the more likely a heavy-duty EV project can avoid pitfalls like higher-than-expected infrastructure costs.

Set up a preliminary meeting with your Xcel Energy representative to discuss:

- Potential scale of cost for infrastructure upgrades to serve the load
- Available electric rates and programs

Come prepared with some basic estimated numbers.

- **How many vehicles** will be charging in Year 1? How about in Year 5? Year 10?
  - **Example:** The transit agency will replace two diesel buses per year with electric buses for the next 10 years.
- **How much power** in kilowatts (kW) will each vehicle require while charging? Bring an example specification sheet for a heavy-duty vehicle charger.
  - **Example:** Two buses each require 150 kW. If both charge at once, they will use 300 kW.
- **How much energy** in kilowatt-hours (kWh) will each vehicle require daily or monthly?
  - **Example:** A bus that uses 2 kWh per mile and travels 100 miles per day would use 200 kWh per day. Add 25%, and plan on 250 kWh per day. For two buses, the total usage would be 500 kWh per day.
- **What times of day** can the vehicles be plugged in and charging?
  - **Example:** Buses typically return between 7 p.m. and 2 a.m. and typically depart between 4:00 a.m. and 10:00 a.m. Most of the buses are parked between 10 p.m. and 6 a.m.

- **Which site(s)** would be available and convenient for charging the vehicles?
  - **Example:** We would prefer to charge the buses at the parking lot near the maintenance garage, but we could also plan to charge them at the empty lot down the block.
- **Could on-route charging** be a part of the project? If so, where would it be most convenient?
  - **Example:** We would like to install in-route charging at a park-and-ride where the buses park for 30 minutes before continuing their route.

Larger Efforts and In-Depth Studies

Larger efforts and studies that are useful in planning and implementation stages of heavy-duty EVs include creating designs for charging infrastructure with the support and coordination of Xcel Energy. These strategies require additional planning, budget, resources, and time and will result in a smooth transition with open communication and understanding between the community and Xcel Energy.

Guide Engineering Designs for Charging Infrastructure

Once EVs and charging infrastructure are in the procurement process and a site has been selected, have an electrical engineer draw up plans for charging infrastructure at the site. These plans may need to be submitted to Xcel Energy. If the initial conversation with Xcel Energy indicated that significant upgrades would be needed to provide energy to the heavy-duty fleet, Xcel Energy will not be able to design those upgrades until they receive the plans from the engineer. This means a minimum of several months' work must be done before Xcel Energy can begin its work. The Xcel Energy design process can take several months as well. If Xcel Energy initially indicates that only minimal site upgrades would be needed, it is likely that Xcel Energy will only need to review and approve the engineer's drawings.

Key decisions will need to be made before plans can be drawn up. Will the EV fleet expand in the future? If so, does it make more sense to oversize the electrical infrastructure now, so that it does not need to be upgraded later? Where, exactly, will charging stations be located? Where will conduit run? Where will a new transformer be located? An electrical engineering firm can help you work with your operations staff to answer these questions.

Example:

- Xcel Energy developed a guidance document on the expected steps and timeline for installing EV charging infrastructure.

PROCUREMENT

Strategies for this topic focus on best practices for procuring heavy-duty EVs. With the high cost of heavy-duty EVs and charging infrastructure, it is important to plan accordingly and to incorporate transitions into the community budget. Various external funding sources are available to offset some of the up-front costs.

Basic Information

New funding sources and specifications will be required for procurement of the first EVs added to a fleet. These critical steps will require an investment of time, either in the form of staff time or by hiring consultants. Procurement of the first EV additions to a fleet is a substantial investment and important action. A poorly suited selection can unfairly tarnish the reputation of heavy-duty EVs in general, and an investment in a proprietary charging system can make it difficult to switch manufacturers later.

EVs can be eligible for incentives or grants from a variety of sources, all of which should be explored before beginning the formal procurement process. Without outside funding, purchase of heavy-duty EVs may not be feasible within existing budgets.

First Steps and Quick Wins

Initial strategies for procuring heavy-duty EVs include laying the groundwork for planning and purchasing through research into available funding sources as well as community needs.

Research Incentives and Grants

Most grant programs are competitive, and funds are limited. If staff resources are constrained, consultants can do most of the heavy lifting, from identifying funding sources to writing grant applications. Incentive programs often have a lower value than grants, but they may not be competitive in nature — potentially making them more reliable sources of funding.

Potential funding sources include:

- Federal Transit Administration Low or No Emission Vehicle Program
  The Low or No Emission Competitive program provides funding to state and local governmental authorities for the purchase or lease of zero-emission and low-emission transit buses as well as acquisition, construction, and leasing of required support facilities. $55 million per year is available until fiscal year 2020.
- Federal Diesel Emissions Reduction Act Program (DERA)
  U.S. Environmental Protection Agency administers the DERA program, which includes federal funding opportunities to support the purchase of electric school buses.
- State Diesel Emissions Reduction Act Programs
  States are also allocated funds from the DERA program and are responsible for selecting and awarding grants for projects including repowering or replacement of diesel school buses with electric buses.
- Congestion Mitigation & Air Quality Improvement Program (CMAQ)
  CMAQ is administered by the Federal Highway Administration and allocates $2.3 to $2.5 million annually to states to fund projects that reduce congestion and improve air quality in areas that do not meet federal air quality standards. Bus replacements are eligible for funding under this program.

- State Volkswagen Emissions Settlement Program
  The Volkswagen Emissions Settlement Program identifies 10 eligible mitigation actions, which generally focus on reducing NOx emissions through repowering or replacing older heavy-duty diesel vehicles with newer, cleaner vehicles (including EVs). Eligible activities include electric transit and school buses. Transit agencies, school districts, and contractors that provide transportation services for school districts are eligible for up to 100% funding, including the cost of charging infrastructure. While states have the flexibility to fully fund electric buses, it is up to each state to determine how the funds are allocated. States may choose to require cost-sharing to help stretch the settlement dollars. Each state administers its own application process used to identify and fund programs.

Larger Efforts and In-Depth Studies

Understanding the needs and desired specifications for heavy-duty EVs in a community can be instrumental in a comprehensive rollout of heavy-duty fleets. Strategizing the method and standards for heavy-duty fleet integration will require additional resources, time, and budget, but it will support the long-term success of the program and the community's goals.

Write Clear Specifications for Your EVs

Create specifications for your EV purchase. Generally, an existing specification for an ICE vehicle can be altered to create an EV specification. Body, chassis, and on-road performance characteristics generally do not need to be updated. All references to engines, fluids, fuel, starting batteries, cooling systems, transmissions, differentials, brakes, exhaust, etc. should be reviewed and removed or altered as necessary. Add any special considerations that come with EVs.

Battery

The battery is by far the most expensive component in an EV. Different manufacturers use different battery chemistries. All batteries degrade slowly over time, reducing the effective range of the vehicle. To effectively compare two EVs, it is critical to make a direct comparison of battery degradation. Carefully specify how to select battery manufacturers based on the structure of the battery degradation warranties. Replacement of a failed battery on a transit bus could cost $250,000. Battery warranty terms must be carefully compared between manufacturers. Battery leasing could be a good financial model and is offered by some manufacturers. Additionally, many manufacturers provide an extended battery warranty option that would cover expected vehicle life.

Charging infrastructure

Some manufacturers require proprietary charging systems, while others use off-the-shelf charging equipment. Some charging systems cost more up front but can scale easily to serve many vehicles at a lower cost per additional vehicle. For manufacturers that require proprietary charging equipment, be sure to request itemized costs of mandatory equipment in proposals. If you expect to receive proposals from manufacturers that use off-the-shelf charging systems, either require that they provide a quote for such a system or separately solicit budgetary estimates from charging system manufacturers before comparing vehicle proposals. The Charging Controls section of this document provides additional information about the importance of appropriate charging controls for most fleets. Different charging systems come with varying degrees of controllability, and some may even come with advanced control software — whether standard or as an add-on. To accurately compare charging systems, carefully evaluate control options.

Other EV-specific components

Be sure to request specifications and specific warranty terms for other EV-specific components like electric motors, inverters, heating systems, and AC-DC converters.

Training and Support

If maintenance staff do not have experience with EVs, provide manufacturer safety and diagnostic training. Dealerships may not have EV expertise to assist with repairs locally. Some EV-only manufacturers do not have existing dealer networks. Ask questions about exactly how long it will take each manufacturer to get a qualified service technician to your site.

Track Records

Heavy-duty EVs are becoming a mature technology, but some manufacturers have only been making them for a few years. Weigh each manufacturer's specific experience with EVs when you consider expected reliability and performance.

Range

Batteries are expensive. Extra range comes with extra cost. A route analysis, as described in the Charging Options and Infrastructure Requirements section, should inform your range needs. Keep battery degradation in mind when evaluating range, as the vehicle option with the best range today might have the worst range after five years. Range is highly dependent on the type of usage. For transit buses, test data from the Federal Transit Administration's bus testing facility in Altoona, PA, can be used to help estimate range under conditions similar to yours. Other heavy-duty EVs do not have their range independently certified, which can make comparisons difficult. Nearly every battery technology available suffers from reduced range in cold weather. Electric heating systems can cut range by 50% on the coldest days. If you will operate in cold weather, consider a fossil fuel auxiliary heater.

Resources

- The U.S. Department of Energy sponsors the Alternative Fuels Data Center, which contains various tools and information on alternative fuel vehicles on the market.
- The Vermont Energy Investment Corporation compiled an electric school bus charging equipment installation guide in 2017.
- Xcel Energy frequently publishes rate sheets based on service areas.