Preparing To Plug In Your Bus Fleet

10 THINGS TO CONSIDER

A GUIDE TO WORKING WITH YOUR ELECTRIC COMPANY

Prepared by the Edison Electric Institute in collaboration with the American Public Power Association, the National Rural Electric Cooperative Association, and the American Public Transportation Association

December 2019

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Executive Summary

Introduction and Purpose

Electric companies and public transit agencies have a shared interest in preparing for widespread electric bus adoption. Transit bus electrification brings numerous benefits. As more public transit agencies consider electrification, agencies and their electric companies have an opportunity to partner to ensure that these benefits are realized.

Powering buses with electricity is different than using traditional fuels. The purpose of this guide is to identify some of the key areas where electric companies and public transit agencies can work together to streamline the bus fleet electrification process.

This guide is organized around 10 key things that public transit agencies that are considering plugging in their bus fleets should know about electric companies and fleet electrification.

1) Engage with Your Electric Company Early and Often.

Public transit agencies and electric companies should begin working together early in the process of planning for electric bus deployment.

2) Key to Success: Minimizing Fuel Cost.

At present, electric buses require greater initial investment than traditional technology. However, a key benefit of electrification for public transit agencies is the potential for fuel cost savings. Managing the cost of electricity will be an important factor in the total cost of ownership.

3) Electricity Is Delivered in Real Time. What Does That Mean for Electric Bus Fleets?

The energy grid is ready for electric bus fleets today, but the infrastructure needed to provide electricity to a given location is highly site-specific.

Electric rates are designed to encourage efficient use of the energy grid, and public transit agencies can manage their charging to use this to their advantage.

4) Your Electric Bill Depends on How You Charge.

The cost of electricity depends on the fleet charging profile. In general, managing when the electric buses charge, at what power level, and for how long will lower the cost.

5) Work with Your Electric Company to Get Your Facilities Ready for Charging.

The extent of service upgrades that may be needed will depend on a host of factors, including how many electric buses will be charging concurrently and at what power level. Work with your electric company to evaluate what is needed.

Plan ahead to ensure vehicle procurement aligns with the timing of any service upgrades.

6) Before Buying the Electric Bus, Plan How to Charge It.

Electric companies can help public transit agencies make a holistic evaluation of their electricity supply costs and any infrastructure upgrade costs prior to embarking on a fleet electrification project.

7) Choose Charging Solutions That Meet Your Needs.

Public transit agencies should consider rightsizing, interoperability, site design, and charging layout when evaluating charging infrastructure options.

8) Electric Bus Fleets Require Cooperation Across Multiple Departments Within the Public Transit Agency.

Many departments within public transit agencies will need to work together to support fleet electrification; this collaboration should begin early in the planning process.

9) Electricity as a Fuel Means Thinking About Fuel Availability in New Ways.

The energy grid is highly reliable. Public transit agencies can plan for new and different approaches to managing their fuel supply.

10) Public Transit Agencies Have Many Options to Manage Costs.

Public transit agencies can manage their costs by optimizing their fleet operating profile and managing their charging.

Electric companies increasingly are offering programs that reduce the cost of deploying charging infrastructure and are offering rate options that may be well-suited for public transit agencies.

Conclusion

Bus electrification will require public transit agencies to think about their operations in new ways. As the electric bus market accelerates, close coordination between electric companies and public transit agencies is essential to ensuring that the benefits of electric buses are realized as quickly and as seamlessly as possible.

Introduction and Purpose

Electric companies, public transit agencies, and a wide range of stakeholders are interested in accelerating transportation electrification. Electric buses emit no tailpipe emissions, which reduces carbon dioxide (CO_2) and improves local air quality.[1] Electric buses also reduce noise for riders, drivers, mechanics, and residents who live near transit routes. And, perhaps most important for public transit agencies, electric buses offer the potential for operational cost savings.

Among the factors that are driving public transit agencies to consider electrific fleets are:

- **Operating cost savings:** The potential to reduce fuel and maintenance costs and to realize lower vehicle lifecycle costs.
- **Sustainability:** Reducing the footprint of fleet operations to help meet CO_2 reduction goals, to improve local air quality, or to meet other environmental goals.
- **Policy and regulation:** Leveraging government incentives designed to encourage adoption and complying with zero-emission mandates or targets.

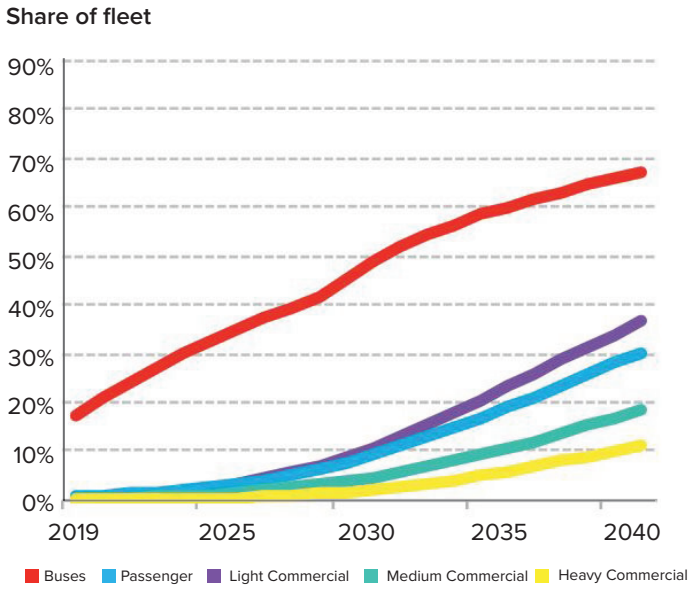
This guide is a collaborative effort of the electric power industry—the Edison Electric Institute (EEI), the American Public Power Association (APPA), and the National Rural Electric Cooperative Association (NRECA)—and the American Public Transportation Association (APTA), which represents public transit agencies. The guide is intended to help educate public transit agencies on some of the basics about electric companies and to identify areas where public transit agencies and their electric companies can work together to streamline the bus electrification process. It is intended for transit agencies that are considering fleet electrification or that already are heading down this path.

The pace of electric bus adoption is expected to surpass passenger vehicles and other vehicle segments on a global basis (see Figure 1). Many public transit agencies are committing to 100 percent zero-emission bus deployments within the next two decades.[2] Given this growth, it is in the interest of both transit agencies and electric companies to prepare for widespread electric bus adoption.

[1] See, e.g., Electric Power Research Institute and Natural Resources Defense Council, *Environmental Assessment of a Full Transportation Portfolio: Volume 3: Air Quality Impacts.*

[2] See, e.g., California's Innovative Clean Transit rule that requires large transit agencies in the state to purchase only zero-emission buses starting in 2029.

Figure 1: Global Electric Share of Bus Fleet Projected to Outpace Electrification of Other Vehicle Segments[3]



1) Engage with Your Electric Company Early and Often.

Public transit agencies and electric companies should begin working together early in the process of planning for electric bus deployment.

While electric bus adoption is still in an early stage, now is the time to prepare. Fleet electrification requires public transit agencies to think about their fuel in new ways, including consideration of electric rates and infrastructure upgrades. Electric companies, in partnership with transit agencies, can enable fleet electrification by advising on electric rates, helping to evaluate infrastructure needs, and identifying other solutions. Early engagement with electric companies will help public transit agencies achieve their fleet electrification goals efficiently and cost-effectively by better understanding the capabilities, roles, and responsibilities of each project partner.

Public transit agencies are encouraged to begin communicating with electric companies early in the process of planning their electric bus deployment, both to help with developing an effective overall charging strategy and to ensure that the infrastructure and bus deployment timelines are aligned. Keeping the electric company informed about potential future electric bus deployments, even if they are not imminent, can help to smooth the process of charging infrastructure planning and to manage cost.

Public transit agencies that are considering adding electric buses to their fleets are encouraged to contact their electric company through their customer service representative. Some electric companies may have dedicated staff to handle electric transportation-related requests or programs designed for electric buses.

[3] Bloomberg New Energy Finance, *Electric Vehicle Outlook 2019.*

Electric companies in the United States vary in terms of structure and size. The U.S. energy grid is built, operated, and maintained by approximately 125 investor-owned electric companies, 2,000 public power utilities, and 900 electric cooperatives. Each entity has a defined service territory. In this respect, electric companies are similar to public transit agencies, which also have defined service territories and must be able to provide service to customers within that area. As a result, transit agencies with operations that span multiple electric service territories may have to manage relationships with different electricity providers.

2) Key to Success: Minimizing Fuel Cost.

At present, electric buses require greater initial investment than traditional technology. However, fuel cost savings can be significant. Managing the cost of electricity will be an important factor in the total cost of ownership.

Public transit agencies typically use metrics about the total cost of ownership (TCO) or lifecycle cost to compare different technology paths. The fuel cost is often the second largest factor affecting the lifecycle cost after vehicle cost. Operating on electricity generally is less expensive than other fuels. Electric buses can offer fuel cost savings that help the overall business case for choosing an electric bus, but the cost of electricity depends on multiple factors, including local electric rates and charging behavior. Public transit agencies can partner with their electric companies to manage these factors to help make the electric option as competitive as possible.

The electric transportation market is still in an early stage. The upfront price premium that electric buses command today is expected to decline over time, but early-mover transit agencies should consider the availability of incentives, as well as electric company rates and programs, in their overall business case.

3) Electricity Is Delivered in Real Time. What Does That Mean for Electric Bus Fleets?

The energy grid is ready for electric bus fleets today, but the infrastructure needed to provide electricity to a given location is highly site-specific.

As electricity increasingly becomes a fuel for transportation, it helps to understand some of the differences between electricity and conventional fuels—and what this means for public transit agencies that seek to operate electric bus fleets.

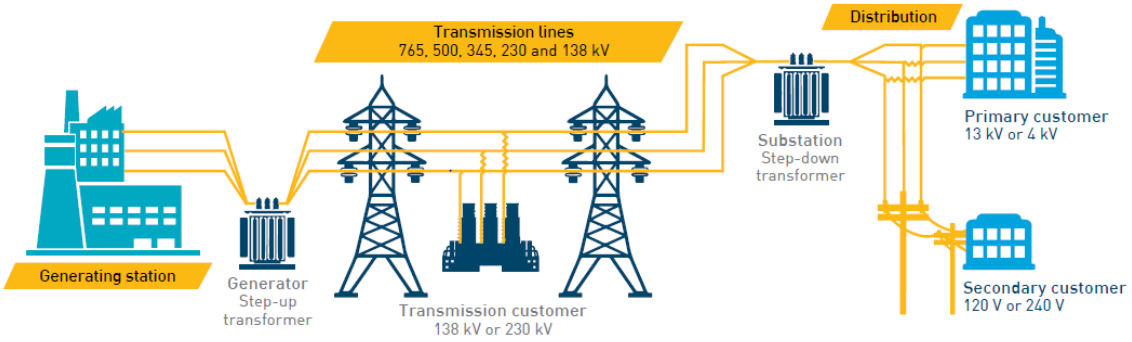
The amount of electricity that can be delivered to a customer in real time is a function of the size and type of infrastucture used to connect that customer to the energy grid. In addition, while conventional fuels can be stored in large quantities for extended periods of time, electricity is delivered in real time (or, in some cases, stored in a battery at a customer location). As a result, the energy grid is designed so that the largest amount of electricity that is required at one time (i.e., peak demand) can be met. These factors have important implications for electric bus fleets, particurlarly how much it costs to bring (or expand) service to a facility and how much the public transit agency pays for electricity.

In general, the energy grid today has sufficient available capacity at the generation and transmission levels to meet the needs of the additional electricity usage expected from electric fleets. At the local distribution level (where the electricity is delivered to the customer), additional upgrades may be

needed to serve particular locations for electric bus charging to address the increased demand for electricity. This is why early engagement with electric companies is critical.

The local distribution grid is comprised of circuits that are scaled to meet the needs of the customers they serve (see Figure 2). For example, a circuit designed to serve a large industrial customer may have a higher carrying capacity than a circuit in a residential neighborhood.

Figure 2. The Energy Grid: Generation, Transmission, and Distribution[4]



In some cases, a particular circuit may have sufficient available capacity for electric bus charging. In other cases, upgrades may be needed to serve the additional demand for power, such as re-conductoring the line, extending a new circuit to that location, or upgrading the transformer that serves the customer. This all depends on where the electric bus charging occurs on the energy grid.

The grid can expand as needed to accommodate the needs of any customer, but the time and resources needed to make the required upgrades are highly dependent on the specific facility and the circuit that serves it.

Electric rates are designed to encourage efficient use of the energy grid, and public transit agencies can manage their charging to use this to their advantage.

Electric rates recover the costs of building, operating, and maintaining the energy grid. All customers who use the energy grid share in these costs. Therefore, the price of electricity (the electric rate) includes the cost of the electricity itself, as well as the costs of delivering electricity to customers over the energy grid.

Electric rates for commercial customers (which generally include public transit agencies) typically include a fixed charge, an energy charge, and a demand charge:

- The fixed charge recovers costs that do not change over time and is a flat monthly charge.
- The energy charge recovers costs that vary with a customer's energy usage (i.e., kilowatt-hours, or kWh).
- The demand charge recovers costs that vary with the capacity needed to serve the highest or peak power demand (i.e., kilowatts, or kW). A demand charge reflects the cost of building the

[4] Graphic: Pacific Gas and Electric Company, *Take Charge: A Guidebook to Fleet Electrification and Infrastructure.* Used with permission from Pacific Gas and Electric Company.

energy grid capacity needed to serve a customer's peak demand. An electric fleet's operating profile (e.g., when the electric buses charge, at what power level, and for how long) affects the peak demand and, thus, the overall electric bill.

The cost of electricity to charge electric buses may depend not only on the energy used, but also on the total amount of electricity being used at one time (the peak demand), and, if the rates are time-varying, the time of day when the charging occurs.

4) Your Electric Bill Depends on How You Charge.

The cost of electricity depends on the fleet operating profile. In general, managing when the electric buses charge, at what power level, and for how long will lower the cost.

The cost of electricity depends on a number of factors, including the charging power required and the overall energy consumed. As discussed previously, electricity rates for commercial customers generally include three parts: a fixed charge, a demand charge, and an energy charge:

$$\begin{aligned} electric\ rate = {} & fixed\ charge\ (fixed\ fee\ per\ month) \\ & + energy\ charge\ (\$\ per\ kWh\ consumed\ in\ the\ month) \\ & + demand\ charge\ (\$\ per\ kW\ of\ peak\ demand\ in\ the\ month) \end{aligned}$$

Within this paradigm, electric companies typically offer multiple rate options and always are evaluating new rate options to meet the needs of particular customers, including specific electric vehicle (EV) charging rates. Public transit agencies should work with their electric companies to understand the rate options available and which rate is the best option.

To illustrate how a public transit agency's fleet operating profile may impact its electric bill, consider the two hypothetical scenarios shown in Figure 3.

- In both scenarios, four electric buses drive 150 miles per day and consume 2 kWh per mile.[5] This requires 1,200 kWh of energy each day. The buses drive 20 days per month, for a total energy usage of 24,000 kWh each month.
- In both scenarios, the buses charge overnight. However, the power level and duration of the charging are different:
    - In Scenario 1, the four buses charge concurrently from 9 p.m. to 11 p.m. at a power level of 150 kW each, resulting in a peak power demand of 600 kW.
    - In Scenario 2, the four buses charge concurrently from 9 p.m. to 3 a.m. at a power level of 50 kW each, resulting in a peak power demand of 200 kW.
- In both scenarios, the electric rate is the same, as shown. Note: this electric rate is for illustration purposes only.

$$\begin{aligned} electric\ rate = {} & fixed\ charge\ (\$25.00\ per\ month) \\ & + energy\ charge\ (\$0.07\ per\ kWh\ consumed\ in\ the\ month) \\ & + demand\ charge\ (\$12.00\ per\ kW\ of\ peak\ demand\ in\ the\ month) \end{aligned}$$

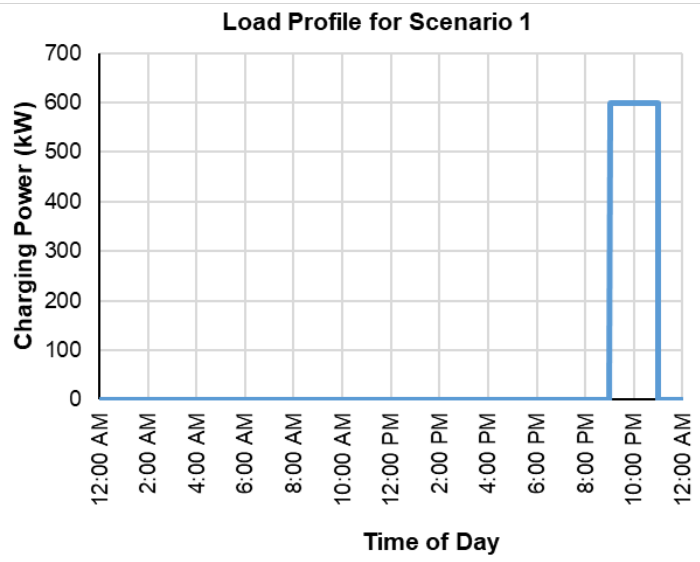
[5] This efficiency rating is for a hypothetical electric bus and actual efficiency will vary.

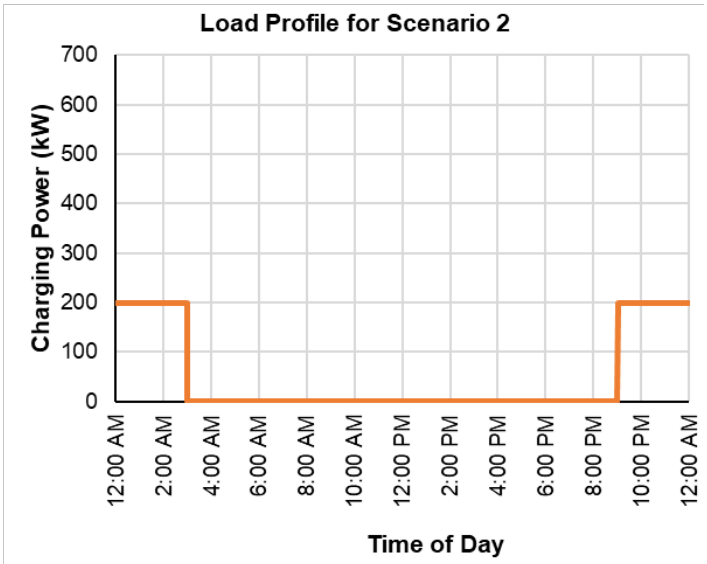
- The two transit agencies have very different electric bills due to their different fleet operating profiles:
    - The transit agency in Scenario 1 pays a monthly electric bill of $8,905 for an effective electric rate of $0.37 per kWh.
    - The transit agency in Scenario 2 pays a monthly electric bill of $4,105 for an effective electric rate of $0.17 per kWh.

The significant difference in the two electric bills is due to the difference in peak demand resulting from the different fleet operating profiles. Figure 3 shows the load profiles (the power demand over the course of a day) resulting from these two scenarios. Note: for ease of computation, only the electric bus charging is considered (e.g., not the electricity usage of the depot building), and the load profiles are simplified.

This example illustrates how a public transit agency can manage its bill by adjusting its fleet operating profile, namely when the buses charge, at what power level, and for how long. This example is most applicable to a scenario in which buses park and charge at a depot overnight. Public transit agencies also are implementing on-route charging solutions that deliver energy at higher power over a much shorter duration at stops along the buses' daily routes. Transit agencies may choose on-route charging to augment depot charging and enable longer routes, or as the primary charging opportunity (which allows for a smaller battery). However, the same principle applies. Since on-route chargers are used to deliver short bursts of high power, they should be deployed as part of an overall charging strategy aimed at managing costs. Whether charging at the depot or on route, spreading energy costs—Including demand charges—over more charge events will help lower overall costs.

Figure 3. Load Profiles Resulting from Two Different Fleet Operating Profile Scenarios





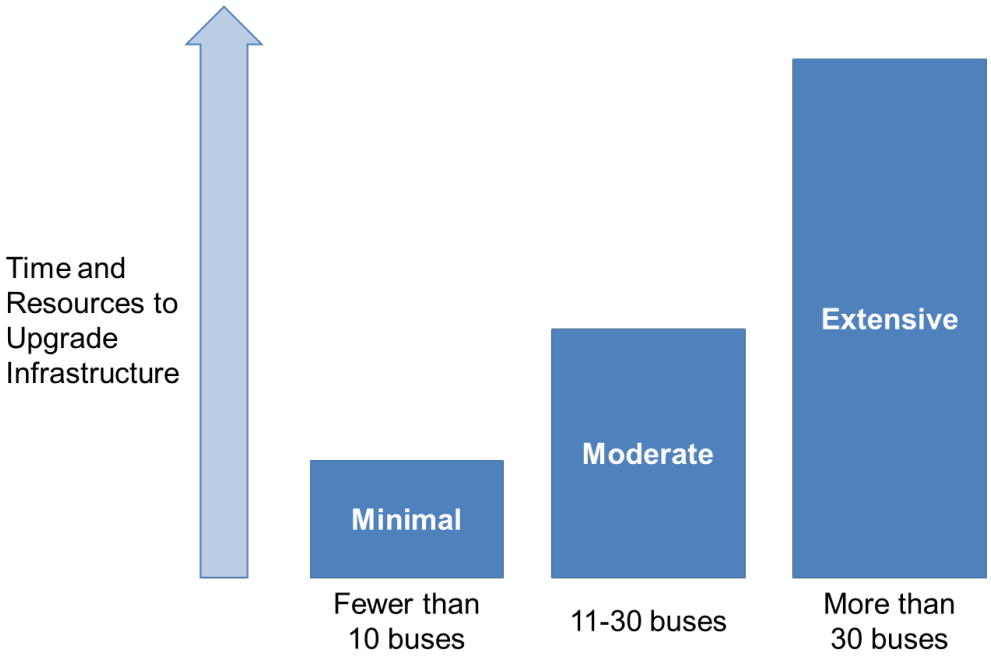
Scenario 1	Scenario 2
4 electric buses charging at 150 kW	4 electric buses charging at 50 kW
Charge for 2 hours (9 p.m. to 11 p.m.)	Charge for 6 hours (9 p.m. to 3 a.m.)
Peak demand: 600 kW	Peak demand: 200 kW
Daily energy delivered: 1,200 kWh	Daily energy delivered: 1,200 kWh
Monthly electric bill: $8,905	Monthly electric bill: $4,105
Effective electric cost: $0.37/kWh	Effective electric cost: $0.17/kWh

5) Work with Your Electric Company to Get Your Facilities Ready for Charging.

The extent of service upgrades that may be needed will depend on a host of factors, including how many electric buses will be charging concurrently and at what power level. Work with your electric company to evaluate what is needed.

It is the electric company's role to build the energy grid to meet the needs of its customers. The time and investment needed to accommodate new electricity usage on the grid is highly dependent on the existing distribution grid in that area, as well as the needs of the customer. As shown previously in Figure 4, the fleet charging profile impacts the peak demand of the facility where the electric buses charge and, thus, could affect the extent of the infrastructure upgrades needed.

Figure 4. The Extent of Infrastructure Upgrades Increases as a Step Change as More Electric Buses Are Added (Illustration Only)



New electricity usage may trigger the need for upgrades.The non-linear nature of distribution upgrades is illustrated conceptually in Figure 4. For this illustration, the electric buses are assumed to charge concurrently at 100 kW each. For example:

- **Minimal:** Upgrades to the customer facility may be required for a small electric bus deployment [e.g., fewer than 10 electric buses, or 1 megawatt (MW) of peak power demand].
- **Moderate:** Upgrades to the customer facility may be required. Some upgrades to the distribution system, such as construction of new lines into the facility that may require the electric company to obtain a right-of-way (e.g., 10-30 electric buses, or 1-3 MW of peak power demand), also may be needed.
- **Extensive:** Upgrades to the customer facility may be required. Major construction further upstream on the distribution grid, such as an upgrade to a substation (e.g., more than 30 electric buses, or 3 MW of peak power demand), also may be needed.

As shown in Figure 4, the infrastructure upgrades increase as a step change: for example, the upgrades needed to serve the 11th electric bus would be much more extensive than the upgrades needed to serve the first 10 electric buses. For this reason, it is important that public transit agencies work with their electric companies early to evaluate the upgrades that may be required to support their electric bus fleet and to determine the time and any costs associated with these upgrades. Moderate and extensive upgrades may require a much longer lead time to complete. For example, design and construction of a new transformer may take two to three months, while design and construction of new distribution lines or substation upgrades could take six months or longer. Early small-scale bus deployments may require only minimal infrastructure upgrades, but a large number of buses may require upgrades to electric equipment and infrastructure on site and on the energy grid at each phase of the project. Be sure to discuss this phasing with the electric company as early as possible in the project.

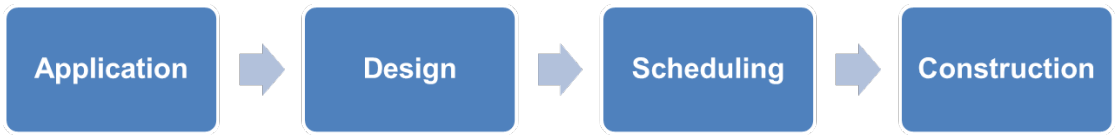
Plan ahead to ensure vehicle procurement aligns with the timing of any service upgrades.

The policies and processes for upgrading infrastructure to serve new electric bus fleets will vary by electricity provider and will depend on factors specific to a public transit agency's facility. In addition, the timing for any infrastructure upgrades relative to the timing for vehicle procurement and installation of charging stations at the facility should be considered in advance. Proper planning will ensure that the electric bus delivery schedule aligns with the schedule for charging station installation and energization. Early and frequent engagement with the electric company will provide a clear view of options, costs, and timing.

Public transit agencies that are considering adding electric buses to their fleets typically can request an informal estimate from their electric company before proceeding with a formal application for new or upgraded service. This process varies by electric company, but customers generally receive an evaluation of their existing service and the extent of upgrades that may be needed. For these evaluations to yield useful information, it is important that public transit agencies provide their electric companies with all relevant information. The Appendix contains an "Electric Service Evaluation Template for Electric Fleets" that transit agencies can use to capture the information that may be useful in this process.

Once a public transit agency decides on the scope and parameters of its fleet electrification process, it can apply for new or upgraded service with its electric company. This process varies by electric company, but a general outline of the steps is shown in Figure 5. This process is familiar to developers planning new building construction, but may be unfamiliar to fleet managers.

Figure 5. Electric Company Process to Provide Upgraded Electrical Service



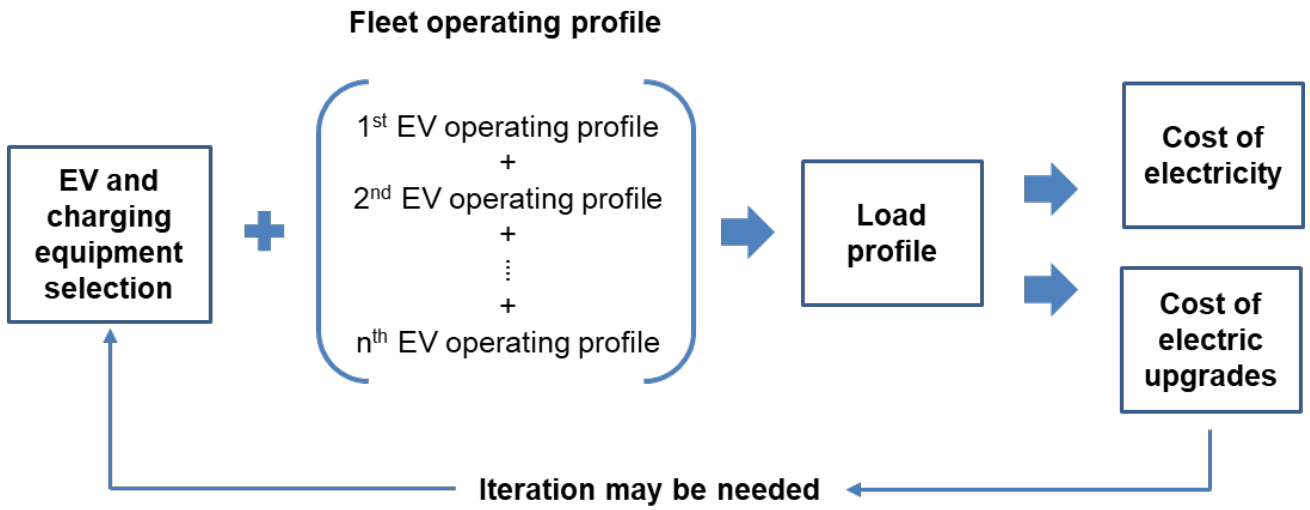
It is important for public transit agencies to provide as much information to the electric company as possible about its future fleet electrification plans. For example, even if a transit agency plans for a large bus electrification project that will take a long time to complete, the project could be done in phases so that a small number of electric buses can be accommodated in parallel to the larger build-out. This also allows electric companies to build in the capacity needed for future expansion, which will save costs in the long run.

6) Before Buying the Electric Bus, Evaluate and Plan How to Charge It.

Electric companies can help public transit agencies make a holistic evaluation of their electricity supply costs and any infrastructure upgrade costs prior to embarking on a fleet electrification project.

For conventionally fueled fleets, the unit price of fuel is independent of how the vehicles operate. A public transit agency that operates diesel-fueled buses may be able to buy diesel at $3.00 per gallon, for example, regardless of whether the agency has two buses or 20 buses and regardless of when the buses refuel. Fleet electrification is a new paradigm: the fuel costs (in this case, the cost of electricity) and the upfront infrastructure costs are highly dependent on the fleet operating profile, specifically when the electric buses charge, at what power level, and for how long.

Figure 6. How to Evaluate the Cost of Electricity and Electric Infrastructure Upgrades



In order to estimate the costs of electricity and electric infrastructure upgrades associated with a fleet electrification project, a public transit agency first will need to determine how its electric buses will charge. Figure 6 illustrates how to step through this process, which is described in more detail below.

- **EV and charging equipment selection:** EVs (in this case, electric buses) and charging equipment, also known as electric vehicle supply equipment (EVSE), are evaluated to meet the public transit agency's operating requirements. While this guide does not address how to select vehicles or charging equipment in detail, electric companies may be able to help with these choices.
- **Fleet operating profile:** Each electric bus in the fleet will have its own operating profile (e.g., miles driven per day, hours of operation, hours available to charge). The aggregate of each of the individual electric bus operating profiles at a given location is the overall fleet operating profile. Electric companies are interested in the fleet operating profile because it will determine how the electric buses will charge at the facility, including when the electric buses charge, at what power level, and for how long.

- **Load profile:** The electric bus and EVSE choices and the fleet operating profile (specifically, how the electric buses will charge) together will determine the load profile at the facility (the electricity usage over time). See Figure 3 for an example of a load profile. Electric companies will use the load profile to estimate the cost of electricity for charging and the cost of any electric infrastructure upgrades. Public transit agencies may not be familiar with load profiles, but they can work with electric companies to translate their fleet operating profile into a load profile.
- **Cost of electricity:** Public transit agencies can apply their load profile to the electric rate options provided by their electric company to estimate their cost of electricity. The cost of electricity is a critical piece of ongoing operation costs and the TCO.
- **Cost of electric infrastructure upgrades:** Public transit agencies can work with electric companies to evaluate the electric service they will need at their facilities and to estimate the costs of any electric infrastructure upgrades, if needed.
- **Iteration may be needed:** This may not be a one-time, linear process. As public transit agencies work with their electric company to evaluate electricity and upgrade costs, they may discover ways to adjust their fleet operating profile to reduce their costs, which may impact electric bus and EVSE choices. Transit agencies should allow for some iteration in this process before procuring vehicles or charging equipment.

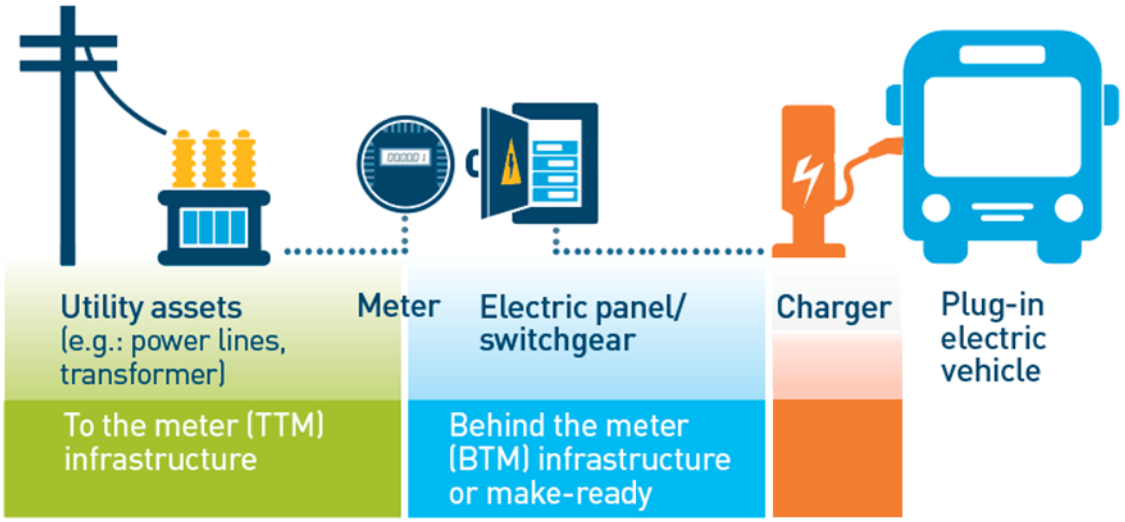
Completing this evaluation generally requires input from the electric company. To help public transit agencies capture the information needed to complete this evaluation, see the “Electric Service Evaluation Template for Electric Fleets” in the Appendix.

7) Choose Charging Solutions That Meet Your Needs.

Public transit agencies should consider rightsizing, interoperability, and site design when evaluating charging infrastructure options.

The energy grid brings electricity to the meter at a customer location. In Figure 7, this is shown as the “to the meter” infrastructure. The electrical panel and wiring “behind the meter” are generally the responsibility of the public transit agency. The charging equipment (also known as the charger or charging station or EVSE) is the device that plugs into the electric bus to deliver electricity to the vehicle’s battery. In some electric company programs, the electric company may own or offer a rebate toward some of the infrastructure behind the customer meter.

Figure 7. Diagram of Charging Infrastructure[6]



Some of the considerations to keep in mind when procuring charging equipment include:

- **Matching power levels to meet operational needs:** The peak power at which an electric bus may be charged is a function of both the vehicle's battery management system and the charging station that is supplying the electricity. Charging stations should be rightsized to meet the operational needs of the fleet, which may not be the maximum power the electric bus can accept.
- **Future-proofing with interoperability:** Standardization between vehicles and charging connectors is still evolving, as are communication protocols between charging stations and back-end networking services. Interoperability is a factor to consider, as it may give public transit agencies optionality in the future to interchange electric buses, charging stations, and charging network services from different vendors.
- **Designing the site for vehicle and electricity infrastructure access:** Where the buses park in a depot may not be near an existing electrical panel, potentially requiring additional behind-the-meter investments. Furthermore, space constraints may influence the choice of charging equipment and how it is arranged at the site. The placement and layout of chargers can have a significant impact on installation and operating costs (e.g., managing bus parking, cleaning, and charging). Careful consideration should be given to the location and placement of chargers.
- **Consideration of needs for on-route charging:** Agencies may opt for on-route charging rather than depot-based charging, or on-route charging may be used in combination with depot charging. As on-route chargers utilize higher power levels, this will impact peak demand costs and total fuel costs. Public transit agencies also will need to work with electric companies on siting on-route charging and ensuring sufficient power is available.

[6] Graphic: Pacific Gas and Electric Company, *Take Charge: A Guidebook to Fleet Electrification and Infrastructure.* Used with permission from Pacific Gas and Electric Company.

8) Electric Bus Fleets Require Cooperation Across Multiple Departments Within the Public Transit Agency.

Departments within public transit agencies will need to work together to support fleet electrification.

Public transit fleet electrification will require organizations to work across traditional silos. When adopting electric buses, agency decisions about fleet operations could have large impacts on overall electricity costs and energy usage. Transit agencies will need to bring together a team from their planning, scheduling, procurement, operations, maintenance, and training departments in the early planning stages of electrifying their fleets.

These cross-functional teams can help the agency work effectively with the electric companies early in the process so electric companies can help public transit agencies understand their costs, the impact that additional electricity usage may have on their existing energy bill, and how to develop a holistic charging strategy to achieve fuel savings. This cross-functional cooperation also will help manage operating costs related to charging, such as labor costs for plugging or unplugging buses, or the additional time needed for on-route charging.

Finally, bus operators with rail systems may wish to look internally to leverage experience from high-voltage electrical staff and for help with procuring energy.

9) Electricity as a Fuel Means Thinking About Fuel Availability in New Ways.

The energy grid is highly reliable. Public transit agencies can plan for new and different approaches to managing their fuel supply.

An important concern for any fleet operation is how to prepare for, and manage, potential fuel supply disruptions and to operate in emergency situations. Electricity is no different, but it does introduce some new considerations.

The energy grid is highly reliable, with average uptime greater than 99.9 percent.[7] While disruptions do occur on occasion, it is important to distinguish between different outage types. Short-duration outages (e.g., 15 minutes or less) are not likely to cause a major disruption to fleet operations that have a multiple-hour window in which to charge. Longer-duration outages, such as those that may occur following a severe weather event like a hurricane, could be disruptive to operations. In these situations, long-duration outages often lead to shortages of traditional fuels as well.

Public transit agencies can introduce risk mitigation and emergency preparedness into their operations in multiple ways:

- Public transit agencies can determine the electric bus charging capability needed in a long duration outage. Traditional operations may cease in a hurricane evacuation, for example, so a transit agency may not need to plan for 100 percent charging capability in a multi-day outage situation.

[7] See, e.g., Massachusetts Institute of Technology, *The Future of the Electric Grid*, which states that customers in the United States can expect to experience between 2 and 8 hours each year without power.

- Public transit agencies can take steps on their side of the meter, including storing energy in a battery and on-site generation, though these solutions will add cost.
- Public transit agencies also can work with their electric companies to identify solutions. For example, electric companies may be able to supply redundant feeds to locations, which can reduce outage risk but increase project cost.

10) Public Transit Agencies Have Many Options to Manage Costs.

Public transit agencies can manage their costs by optimizing their fleet operating profile and managing their charging.

Understanding the full cost of using electricity as a fuel is complex, but provides new opportunities for public transit agencies to manage their fleet operations and reduce their costs.

Public transit agencies can optimize their fleet operating profile to minimize electricity costs. Some options include:

- **Route planning:** Public transit agencies may want to consider their routes and use cases. For example, staggering the depot return times of electric buses so that their charging windows begin at different times may be less expensive from an electric rate perspective than charging all the vehicles at the same time.
- **Distributing electric buses across multiple locations, rather than a single location:** Utilizing on-route charging or distributing electric buses across multiple depot locations may be an alternative to building out potentially costly infrastructure for many buses at a single location. Dispersing electric buses geographically could reduce the overall charging infrastructure cost and provide for some redundancy.
- **Maximize available charging time:** As discussed earlier, a fleet operating profile that maximizes the time available to charge (e.g., charging at lower power over a longer duration) generally will reduce electric costs.
- **More than one vehicle per charging station:** Alternatively, a single, higher-power charging station (that reduces the time to charge each vehicle) could charge multiple electric buses sequentially. From an electric rate perspective, this is like each bus getting its own lower power charging station, but the cost of infrastructure may be lower.

Public transit agencies also can manage their charging to reduce costs. Some options may include:

- **Isolating electric bus charging from the depot building:** Initial small-scale projects may integrate electric bus charging into the overall building infrastructure. For larger bus deployments, a separate meter that isolates the bus charging from the building depot's energy usage may be useful to get accurate estimates of the cost of bus charging.
- **Manage charging station power:** Charging station management systems can modulate the power demand of individual charging stations. Such a system can be programmed so that the maximum power demand of an individual charging station, or a group of charging stations, does not exceed a certain threshold, for example.

- **Supplement grid energy with on-site generation or energy storage:** A fleet charging station installation can be integrated with on-site generation or on-site energy storage. These systems can reduce the net energy peak that the electric company sees at the meter, for example. While these systems add upfront cost to a project, they potentially could add value in other ways, such as providing backup power.

Electric companies increasingly are offering programs that reduce the cost of deploying charging infrastructure and are offering rate options that may be well-suited for fleets.

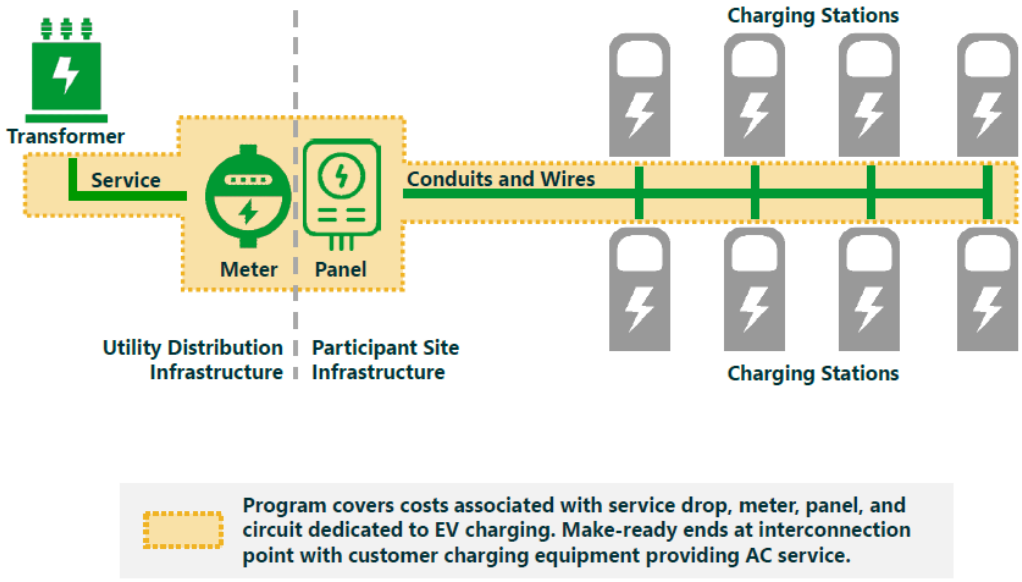
Electric transportation has widespread benefits, including increased utilization of the energy grid that can put downward pressure on electric rates for all customers. Electric companies increasingly are offering programs designed to encourage electric transportation. Public transit agencies should check with their electric company to see what program offerings may be available.

Some electric companies are offering hands-on advisory services for fleet customers. For example, National Grid in Rhode Island can assist customers with fleet electrification studies.[8]

Some electric companies provide charging infrastructure programs. These can take different forms, but, in general, are intended to reduce the cost to the customer to deploy charging infrastructure at its facility. An example is Southern California Edison's (SCE's) Charge Ready Transport program.[9] As shown in Figure 8, through this program SCE will provide a new service connection to serve the charging stations, as well as install and own the infrastructure at the customer facility up to the charging stations.[10] The customer then procures its own charging stations. This structure essentially extends the electric company's capital investment all the way to the charging station, significantly reducing the upfront infrastructure costs for the customer.

[8] https://www.nationalgridus.com/RI-Business/Energy-Saving-Programs/Electric-Vehicle-Charging-Station-Program.
[9] https://www.edison.com/home/innovation/electric-transportation/charge-ready-a-plan-for-california.html.
[10] Graphic: Southern California Edison, *Charge Ready Transport Program Handbook*. Used with permission from Southern California Edison.

Figure 8. Southern California Edison's Charge Ready Transport Program



Other electric company charging infrastructure programs may take different forms, such as offering rebates to offset the costs or allowing customers to pay for the cost of the infrastructure over time on their electric bill.

Electric companies may offer different rate options for fleet customers, including public transit agencies. While existing commercial rates are designed to be fair and equitable for all customers, electric companies recognize that the unique use profile of electric fleets may not be well-matched to existing rates. Electric companies are exploring new programs and rate options to help their customers streamline the adoption of EVs into their fleets, such as:

- Rates that phase in the demand charge over time, giving customers time to evaluate and adjust their operations. One example: SCE's EV rates for business customers.[11]
- Pilot rates that are designed for customers that operate electric fleets. One example is Hawaiian Electric Company's pilot rate for electric bus charging.[12] Alameda Municipal Power offers an EV charging discount for certain fleet vehicles.[13]

Input from public transit agencies is important to help inform these programs as they continue to evolve. Public transit agencies are encouraged to collaborate with policymakers, vehicle manufacturers, charging infrastructure companies, and electric companies to accelerate fleet electrification.

[11] https://www.sce.com/business/rates/electric-car-business-rates/business/rates/electric-car-business-rates.
[12] https://www.hawaiianelectric.com/puc-approves-special-rates-for-electric-buses.
[13] https://www.alamedamp.com/environment/electric-vehicles/ev-discount.

Appendix

Electric Service Evaluation Template for Electric Fleets

- This template is intended for customers that are embarking on a fleet electrification project and are ready to begin evaluating their electric service needs. Filling out as much of the information as possible will help your electric company evaluate the electrical service needs for your project.
- You may evaluate multiple locations with a single form if the planned fleet operating profile is the same at each location and the locations are served by the same electric company. If additional space is needed for any question, please attach additional sheets.
- This template is NOT intended to replace the standard service request form of any given electric company. Additional paperwork may be required to initiate a formal service request.
- This template may be updated periodically. Please check for the latest version here: https://www.eei.org/issuesandpolicy/electrictransportation/Documents/ElectricServiceEvaluationTemplate.pdf

Contact Information

Customer. The customer is typically the organization named on the electric bill.

Name of organization:	
Electric company serving the customer:	Service agreement number:
Customer project lead or primary point of contact:	
Title:	
Phone number:	Email address:

Vendor or manufacturer. If you are a vendor, manufacturer, or design consultant filling out this form on behalf of a customer, please fill out the following information. NOTE: a customer must authorize its electric company to share customer information with third parties. This form does not constitute authorization.

Name of company:	
Vendor primary point of contact:	
Title:	
Phone number:	Email address:

Location Information

Location(s) to be evaluated. If evaluating a single location, fill out Location 1 and leave the other locations blank. If more than 3 locations are to be evaluated, please attach an additional sheet. NOTES: Leased properties may require additional coordination with the property owner. If a location is served by a different electric company, a separate form will be needed.

<table>
<tr><th colspan="4">Location 1</th></tr>
<tr><td colspan="3">Street address:</td><td rowspan="2">If multiple sites are being evaluated, what is the priority for evaluation of this site? (circle)
HIGH MEDIUM LOW</td></tr>
<tr><td>City:</td><td>State:</td><td>ZIP:</td></tr>
<tr><td>Does the customer lease this site? (circle)
YES NO</td><td>If leased, what is the term (years)?</td><td colspan="2">If leased, who is the property owner?</td></tr>
<tr><th colspan="4">Location 2</th></tr>
<tr><td colspan="3">Street address:</td><td rowspan="2">If multiple sites are being evaluated, what is the priority for evaluation of this site? (circle)
HIGH MEDIUM LOW</td></tr>
<tr><td>City:</td><td>State:</td><td>ZIP:</td></tr>
<tr><td>Does the customer lease this site? (circle)
YES NO</td><td>If leased, what is the term (years)?</td><td colspan="2">If leased, who is the property owner?</td></tr>
<tr><th colspan="4">Location 3</th></tr>
<tr><td colspan="3">Street address:</td><td rowspan="2">If multiple sites are being evaluated, what is the priority for evaluation of this site? (circle)
HIGH MEDIUM LOW</td></tr>
<tr><td>City:</td><td>State:</td><td>ZIP:</td></tr>
<tr><td>Does the customer lease this site? (circle)
YES NO</td><td>If leased, what is the term (years)?</td><td colspan="2">If leased, who is the property owner?</td></tr>
</table>

Site diagram: Please attach to this form a site diagram for each location to be evaluated that identifies where the vehicles are expected to charge. This can be a simple aerial photo (e.g., Google maps) with markings added to indicate parking/charging location.

Vehicle and Operating Profile Information

Operating profiles of vehicles planned to charge at this location. Please complete a row for each of the unique daily operating profiles for the vehicles that will charge at this location.

	Vehicle Make and Model	Battery capacity (kWh)	Quantity	Est. Driving Start and End Time(s) (e.g., 9 a.m. to 5 p.m.)	Est. Parking Start and End Time(s) (e.g., 5 p.m. to 9 a.m.)	Est. Charge Duration (hrs.)	Est. Daily Mileage (mi.)
1							
2							
3							
4							
Total vehicles charging at this location							

Procurement plan. For each of the vehicles that will charge at this location, please specify the anticipated timing of delivery.

Vehicle Make and Model	Quantity	Order placed? (YES or NO)	Anticipated delivery date (mm/dd/yyyy)

Procurement plans within the next 5 years. If you are planning to procure additional vehicles to charge at this location over the next 5 years, please describe the type, quantity, and anticipated timing for delivery of these vehicles below.

Vehicle Make and Model	Quantity	Estimated timing for delivery (month or year)

Sustainability goals. Does your organization have any longer-term sustainability or environmental goals that may lead to procuring more electric vehicles in the future? If so, please describe below.

Charging Information

Charging equipment. If you know the type of charging equipment that will be used at this location, please identify the charging equipment and associate it with the operating profile(s) from Question 4. Each operating profile should have at least one charging equipment type.

Charging Equipment Make and Model	Maximum Rated Power (kW)	Quantity	Operating profile(s) from Question 4 for which this equipment will be used (e.g., 1, 2, 3, or 4)

Charging profile. If the vehicle manufacturer and/or charging equipment vendor has provided an expected charging profile (or "load profile") for the vehicle(s) and operating profile(s) described on this form, please attach it to this form.

Separate service for charging. Are you considering connecting your vehicles to the existing building electrical service, or dedicating a separate electrical service to vehicle charging? NOTE: The electric company may have a recommendation or requirement based on the electrical service needed.

Service preference? (circle)

CONNECT TO EXISTING BUILDING SERVICE | NEW ELECTRIC SERVICE FOR VEHICLE CHARGING | NOT SURE/NO PREFERENCE

Managed charging. Are you planning or interested in scheduling or otherwise managing vehicle charging at this location? If so, please briefly describe the approach below.

Self-generation and storage. Are you planning or interested in integrating on-site electricity generation (e.g., solar) and/or energy storage at this location? If so, please briefly describe the approach below.

The **Edison Electric Institute** (EEI) is the association that represents all U.S. investor-owned electric companies. Our members provide electricity for about 220 million Americans, and operate in all 50 states and the District of Columbia. As a whole, the electric power industry supports more than 7 million jobs in communities across the United States. In addition to our U.S. members, EEI has more than 65 international electric companies, with operations in more than 90 countries, as International Members, and hundreds of industry suppliers and related organizations as Associate Members.

Organized in 1933, EEI provides public policy leadership, strategic business intelligence, and essential conferences and forums.

For more information, visit our Web site at www.eei.org.

The **American Public Power Association** is the voice of not-for-profit, community-owned utilities that power 2,000 towns and cities nationwide. Since 1940, it has represented public power before the federal government to protect the interests of the more than 49 million people that public power utilities serve, and the 93,000 people they employ. It advocates and advises on electricity policy, technology, trends, training, and operations. Its members strengthen their communities by providing superior service, engaging citizens, and instilling pride in community-owned power.

Learn more at PublicPower.org.

The **National Rural Electric Cooperative Association** is the national trade association representing more than 900 local electric cooperatives. From growing suburbs to remote farming communities, electric co-ops serve as engines of economic development for 42 million Americans across 56 percent of the nation's landmass. As local businesses built by the consumers they serve, electric cooperatives have meaningful ties to rural America and invest $12 billion annually in their communities.

The **American Public Transportation Association** (APTA) is a nonprofit international association of more than 1,500 public and private sector member organizations. Benefits to our members include advocacy for federal funding and policies, research, technical expertise, workforce development programs, and educational conferences and seminars. APTA is the only association in North America that represents all modes of public transportation, including bus, paratransit, light rail, commuter rail, subways, waterborne services, and intercity and high-speed passenger rail. More than 90 percent of people who use public transportation in the U.S. and Canada ride APTA member systems.

Learn more at apta.com.

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