PG&E

Take Charge:

A Guidebook to Fleet Electrification and Infrastructure

EV fleet

Who is this book for?

Fleet managers and decision-makers at all levels will find this entire handbook helpful. Sections that have focus for readers in specific fields are represented with icons in the top right of each page:

- Fleet management
- Executives
- Sustainability leads
- Finance

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Executive Summary

Executive summary

According to the California Air Resources Board (CARB), in 2018 the transportation sector accounted for the largest portion of total statewide greenhouse gas (GHG) emissions (39 percent), and the medium- and heavy-duty truck sector accounted for 23 percent of those emissions.[1]

Reducing emissions from medium- and heavy-duty fleets has a major impact on our environment and plays a vital role in creating a more cost-efficient and cleaner energy future right here in California.

That's the promise and potential of fleet electrification being realized today.

Spurred by the introduction of new technologies, infrastructure improvements and emission reduction legislation, fleet operators have begun to embrace electrification in earnest. In fact, organizations around the world are evaluating their needs to determine where electrification can fit into their operations.

A recent study found that 83 percent of large company fleet operators cite environmental benefits and 64 percent cite the lower total cost of ownership as top motivations for electrifying fleets.[2]

In the short term, fleet electrification can reduce major top-line expenses such as maintenance and fueling costs, especially for medium- and heavy-duty fleets with fixed routes and charging locations. In the long term, fleet electrification can be a significant step toward creating legislative compliance as well as delivering the environmental benefits outlined above.

The backbone of any electric fleet is the charging infrastructure—the physical network that transfers electricity from the grid to the vehicles themselves. In this guidebook you'll learn the basics of charging: how it works, selecting the right charging option and more.

You'll also get important information on how PG&E can help with charger selection, site planning and design. You'll also learn about financial incentives from PG&E and others that can cover much of your infrastructure conversion costs.

Together, we can realize a cleaner, more sustainable future that benefits us all. Now is the time to drive electric.

[1] California Greenhouse Gas Emission Inventory–2018 edition, California Air Resources Board:
https://ww3.arb.ca.gov/cc/inventory/data/data.htm

[2] Curve Ahead: The Future of Fleet Electrification, a 2018 UPS/GreenBiz Research Study:
https://sustainability.ups.com/media/UPS_GreenBiz_Whitepaper_v2.pdf

Introduction

Introduction

There's never been a better time to make the move to electric for your medium- and heavy-duty fleets. Not only have manufacturers dramatically expanded their production of fleet-ready electric vehicles (EVs), but the necessary charging infrastructure has also grown to include several reliable, cost-effective options designed to reduce the overall cost of ownership and ongoing fleet operations. Additionally, companies transitioning to an electric fleet gain advantages of being sustainable leaders ready to meet California's clean energy goals.

In the following pages, you'll get helpful advice on how to best select, install and maintain the right charging solution to help you electrify your fleet. It's our goal to provide you with the information you need to:

- Estimate your fleet's baseline energy needs and charging time periods
- Identify the charging equipment options that meet your electric fleet's needs in terms of charger type, charge speed and cost
- Develop charging station configurations that work with your facility's existing space, support current and future operations, maximize equipment lifecycles and control costs
- Speed up and simplify your project design, permitting and construction
- Discuss the essential details of your electric service and electricity price tiers
- Find funding opportunities to reduce your total project costs

Sample calculations, average costs and key term definitions are included with supporting graphics for your general reference. However, as you develop your own charging solution it's important to consult your vehicle manufacturer, PG&E, local jurisdiction(s) and other relevant entities for project-specific guidance.

Visit **pge.com/evfleet** to learn more and fill out an **inquiry form** to connect to a PG&E EV specialist. If you're already connected, contact your EV specialist to discuss the findings herein and take the next step toward electrifying your fleet.

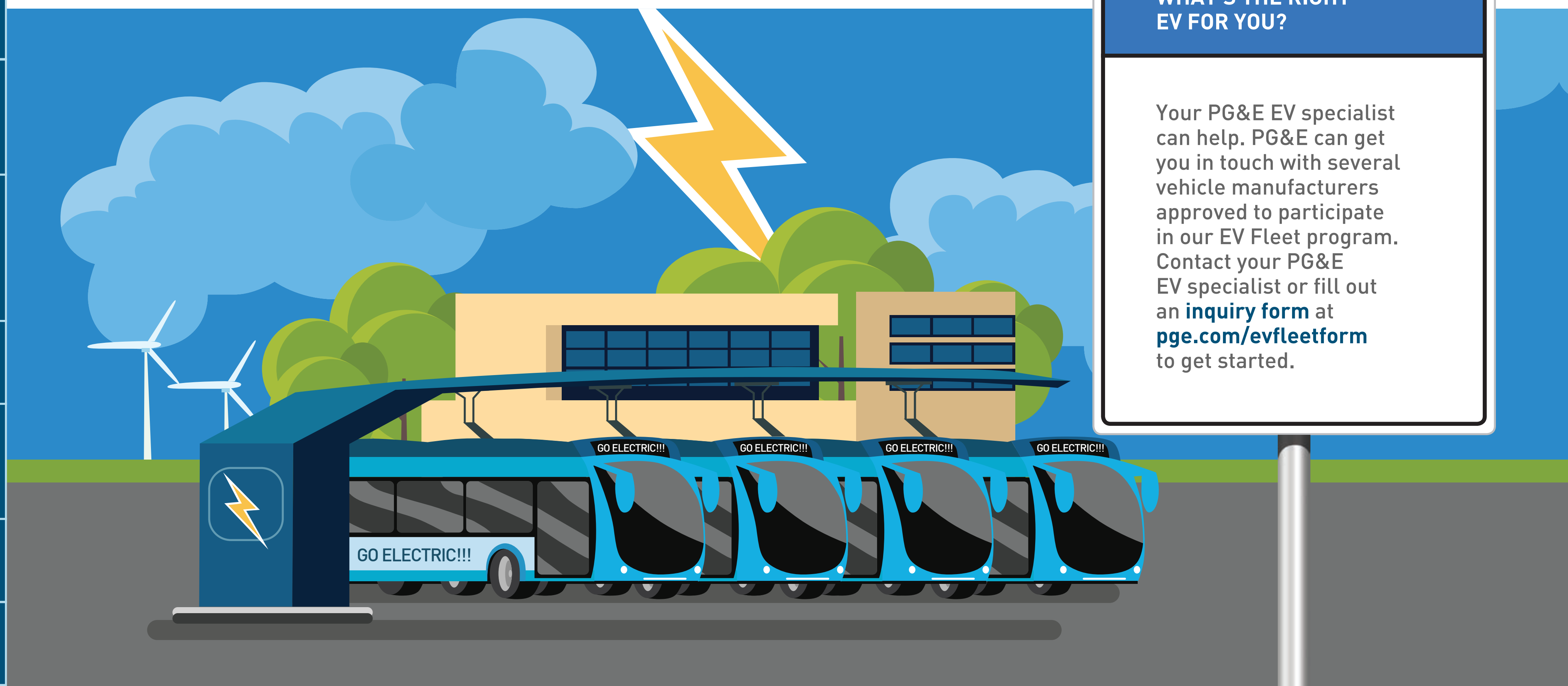
Want to learn more about the electric grid and how you get electricity? Check out this **additional resource** in the **Appendix**.

Transitioning to electricity for your fleet

Transitioning to electricity for your fleet

If you are considering transitioning your fleet from conventionally fueled vehicles (gasoline and diesel) to battery electric vehicles (i.e., EVs), then there are several important infrastructure-related factors to address. Some of these factors involve familiar issues and decisions you already know from operating conventionally fueled vehicles. Others introduce new concepts that are unique to EVs, such as the installation of a charger, also referred to as electric vehicle supply equipment (EVSE).

Regardless of your fleet's specific needs, every project should start by clearly defining the charging requirements for the EVs you are planning to deploy. This exercise allows you to build all other project components around properly charging the selected EVs to support implementing them in a way that best fits your fleet's bottom-line characteristics and most common use (duty cycles). This section provides guidance for evaluating your fleet charging needs, charging equipment options and site feasibility.



WHAT'S THE RIGHT EV FOR YOU?

Your PG&E EV specialist can help. PG&E can get you in touch with several vehicle manufacturers approved to participate in our EV Fleet program. Contact your PG&E EV specialist or fill out an **inquiry form** at **pge.com/evfleetform** to get started.

Choosing the right EV charging infrastructure for your fleet

The first steps in developing your charging infrastructure are to determine how much energy each vehicle will need over the course of an average day (load profile) and the time it will take to deliver that energy (charging window). Knowing the answers to these questions will help you select the equipment you'll need to fuel your vehicles in a timely and cost-effective manner and forecast the cost of your electricity. Figure 1 below illustrates which pieces of information you will need and how they relate to your load profile; the examples on the following pages walk you through the actual calculations to complete the process.

TERMS YOU NEED TO KNOW

Average power: The average amount of power that your fleet requires at any given time while charging

Charge rate: The rate at which a battery can charge, measured in kilowatts (kW)

Charging window: The period of time in your fleet's duty cycle when vehicles can charge, measured in hours

Duty cycle: The hours per day or proportion of time that a vehicle is operated per day

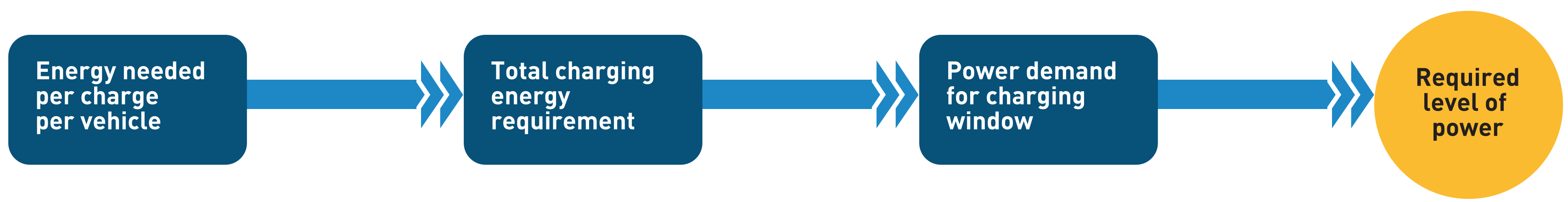
EV or BEV: Electric vehicle, sometimes referred to as battery electric vehicle

EVSE: Electric vehicle supply equipment to charge electric vehicles (i.e., the charger)

kWh: Kilowatt-hour, the unit of measure for electrical energy

Load profile: The amount(s) of power that your fleet requires on an hourly basis over the course of a day

FIGURE 1:
Components and process for developing your load profile

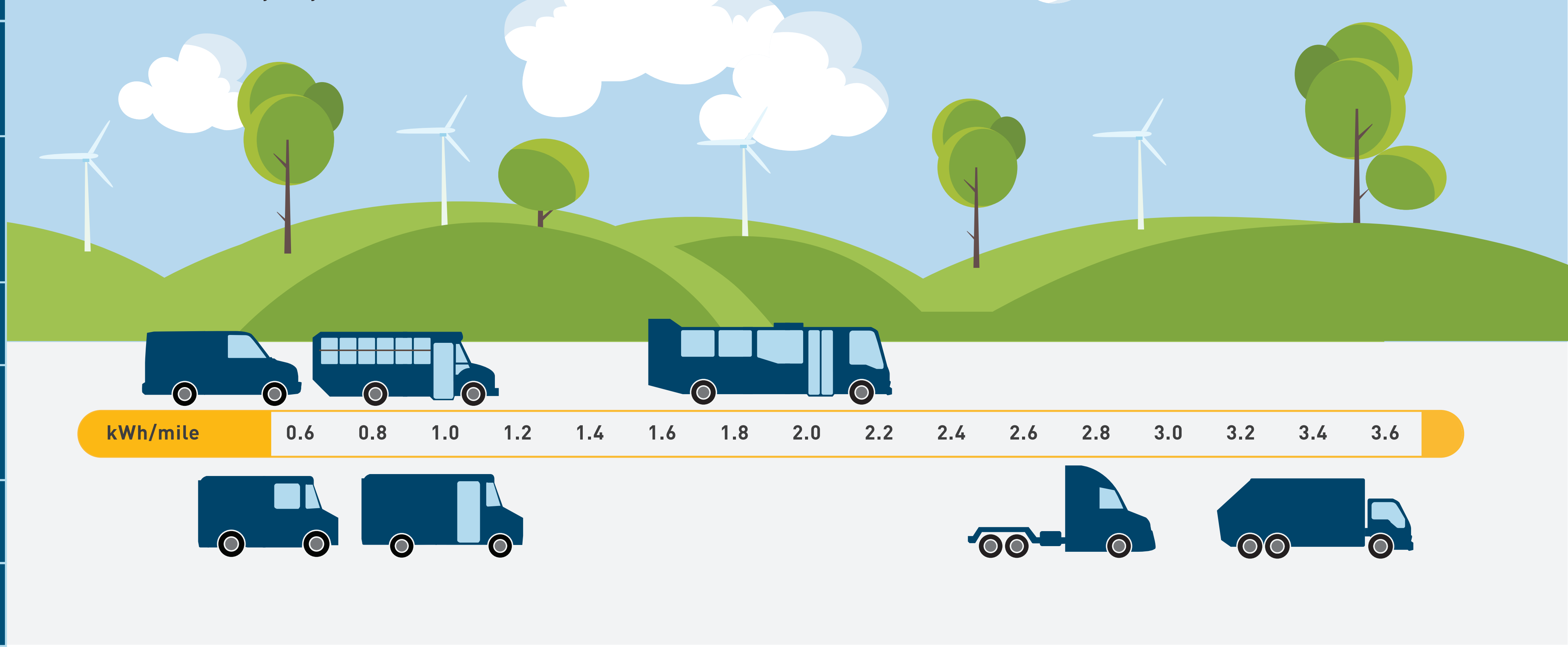


Choosing the right EV charging infrastructure for your fleet (continued)

A good place to start is to work with your vehicle manufacturer to estimate your EV's energy consumption in your specific operations. Energy is calculated in terms of kWh per mile (or kWh per hour for some vocational fleets). Note: While traditional fuel economy is better when the miles per gallon figure is higher, with electricity, economy is better when the kWh per mile is **lower**. In other words, the lower your kWh per mile, the more you save because the vehicle is drawing less power for each mile traveled. View some typical energy consumption rates below:

> Your PG&E EV Fleet specialist can help at any stage of your electrification process. Go to **pge.com/evfleetform** and fill out an **inquiry form**, or if you have an EV specialist already, contact them directly.

FIGURE 2:
Typical EV energy consumption rates for medium and heavy duty vehicles



Choosing the right EV charging infrastructure for your fleet (continued)

Once you have estimated your EV fleet energy consumption rate, you can use the following steps to determine your basic load profile.

1. To start, you'll want to calculate how much energy will be needed per charge for each EV you purchase. This will be the EV's energy consumption rate (kWh per mile) multiplied by the miles traveled between charging events.
2. The total charging energy requirement for the fleet is simply the sum of the energy requirements for each vehicle during that charging window.
3. Next, determine when the vehicles are available for charging, including any in-route charging opportunities throughout the day. For example, if all the vehicles at the fleet yard are only available for charging between 6 p.m. and 4 a.m., then there is a 10-hour charging window available to deliver the required electricity to the vehicles. The average power required to charge these vehicles is calculated in the third step in the calculation example.

CALCULATE YOUR ENERGY NEEDS

1 ENERGY NEEDED PER CHARGE

Charging energy requirement (kWh/charge) = VMT (vehicle miles traveled between charges) x EV energy consumption rate (kWh/mile)

2 TOTAL CHARGING ENERGY REQUIREMENT

Total charging energy requirement (kWh/charge) = Charging energy requirement: Vehicle 1 + Vehicle 2 + Vehicle 3

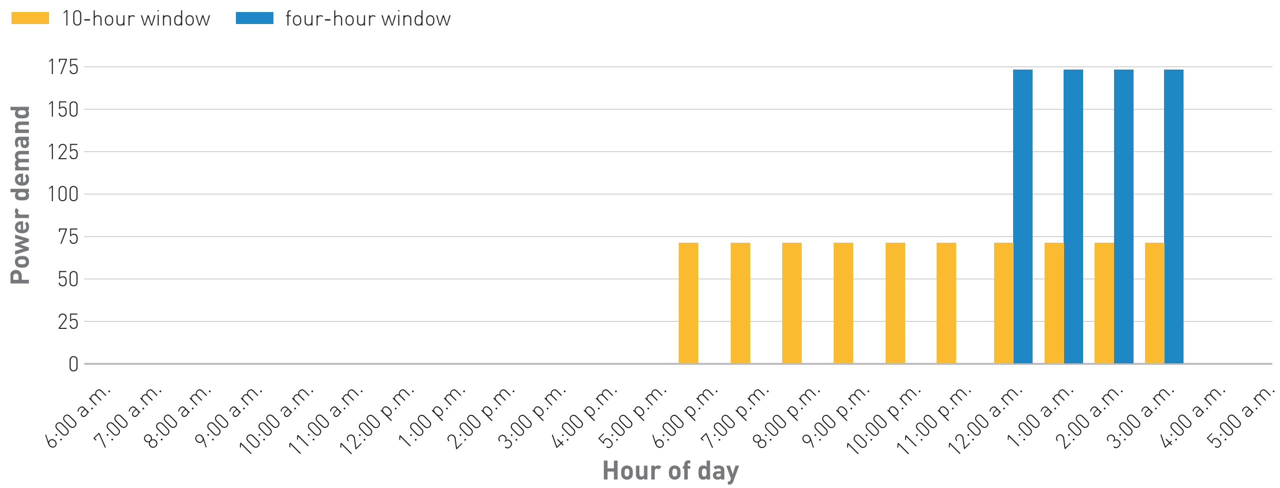
3 AVERAGE POWER REQUIRED TO CHARGE

Average power demand (kW) = Total charging energy requirement (kWh/charge) ÷ Charging window (hours)

Choosing the right EV charging infrastructure for your fleet (continued)

Vehicles that are only available for short time periods will require faster charging speeds to deliver the same amount of energy as those vehicles that can be charged over longer periods of time. Faster charging is typically more expensive because it requires a higher power demand on the grid, so using the maximum practical time period for charging each vehicle can reduce costs. Figure 3 illustrates the difference in power demand when vehicles are charged over a four-hour window (requiring 175 kW peak power) versus a 10-hour window (requiring 75 kW peak power).

FIGURE 3:
Power demand over four- and 10-hour charging windows

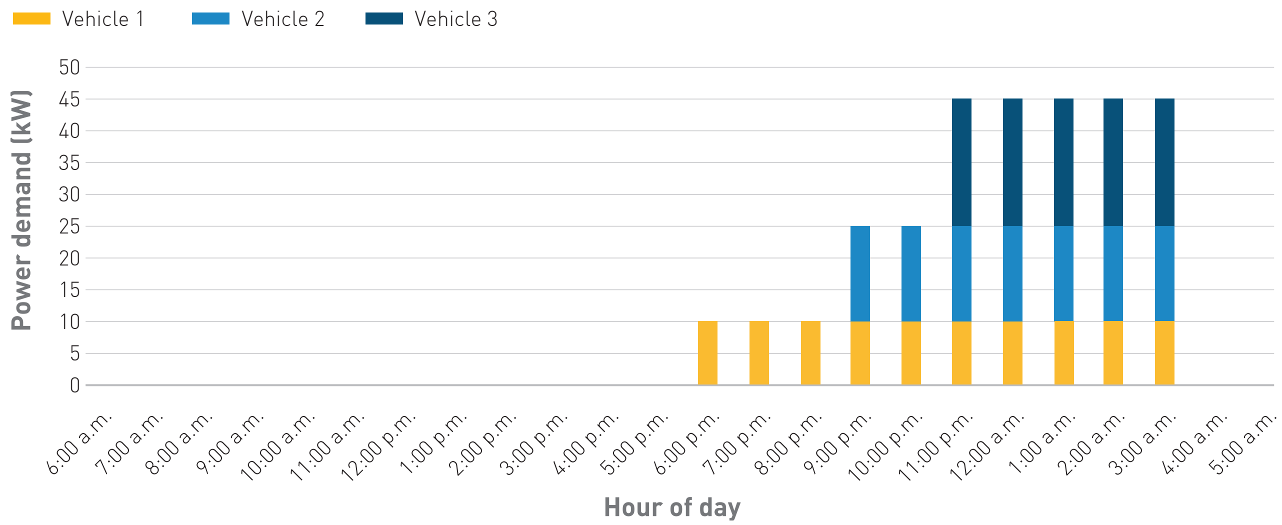


The above is an illustration of an EV fleet's charging window and its load profile. In this case, the load profile is a simple constant power level because all the vehicles are assumed to be available for the same time period.

Choosing the right EV charging infrastructure for your fleet (continued)

More complex load profiles exist when not all vehicles can be charged during the same time period or at the same rate. For example, Figure 4 illustrates the load profile from three vehicles that arrive at the yard at different times but must all finish their charging at the same time. In Figure 4, all vehicles must depart at 3 a.m., but vehicle one arrives at 6 p.m., vehicle two arrives at 9 p.m. and vehicle three arrives at 11 p.m., allowing for a nine-hour, six-hour, and four-hour charging window, respectively. Fleets may have multiple charging windows per day, depending on when and how vehicles are used.

FIGURE 4:
Power demand for multiple vehicles with different charging windows due to arrival times



Choosing the right EV charging infrastructure for your fleet (continued)

Three examples for estimating your basic load profile

Next, we look at three examples of EV charging scenarios that further illustrate the process of determining basic load profiles. In these examples, we will calculate the total energy demand, average power demand during a charging window and the average charging rate per vehicle. These values will be used later to inform infrastructure options and electricity prices.

These examples also show three different per-vehicle charging rates, ranging from 7 kW to 82.5 kW, which is important to consider when choosing the EVSE to meet your daily charging needs. If your charging scenario requires a higher kW charging rate than your EV can support, you must either select a different vehicle or extend your charging window to reduce the required charging rate. For example, if you need to charge at a rate of 50 kW per EV (to fulfill the time per charger requirements identified in your EV charging scenario) but the EV you have selected can only accept a charge rate of 25 kW, your charging scenario does not work for your selected EV type.

EXAMPLE 1: CITY DELIVERY VANS

EXAMPLE 2: LOCAL CLASS 8 TRUCKS (SINGLE SHIFT)

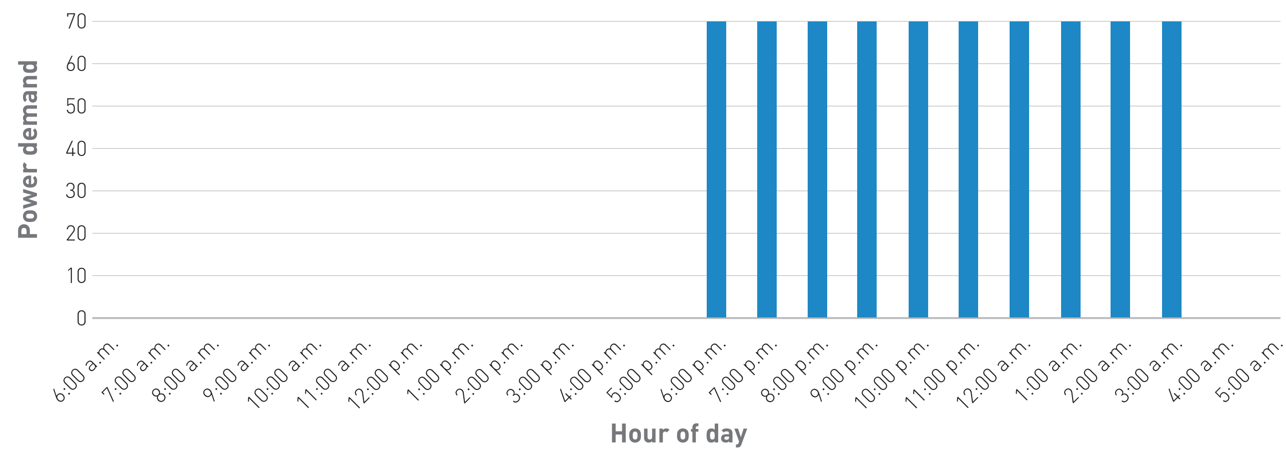
EXAMPLE 3: LOCAL CLASS 8 TRUCKS (TWO SHIFTS)

Choosing the right EV charging infrastructure for your fleet (continued)

EXAMPLE 1:
CITY DELIVERY VANS

A fleet of 10 delivery vans uses 0.7 kWh of electricity per mile. All vans travel an average of 100 miles per day. They return to the fleet yard by 6 p.m. and must be ready to depart by 4 a.m.

FIGURE 5:
Average power demand for 10 delivery vans over night



Charging window energy requirement

Energy (kWh)
=
10 vehicles
x
100 miles/vehicle/day
x
0.7 kWh/mile
=
700 kWh/day

Charging window

All vehicles return to the fleet yard by 6 p.m. and must be ready to depart by 4 a.m. Therefore, the charging window is **10 hours**.

Load profile and average power demand

All vehicles are available for the same charging window, so the load profile shows a flat power demand during the charging window (Figure 5).

Average power demand (kW)
=
700 kWh
÷
10 hours
=
70 kW

Per-vehicle charging rate

Because your vehicles charge at the same time for the same amount of time, your per-vehicle charging rate is simply your average power demand distributed over the total number of trucks.

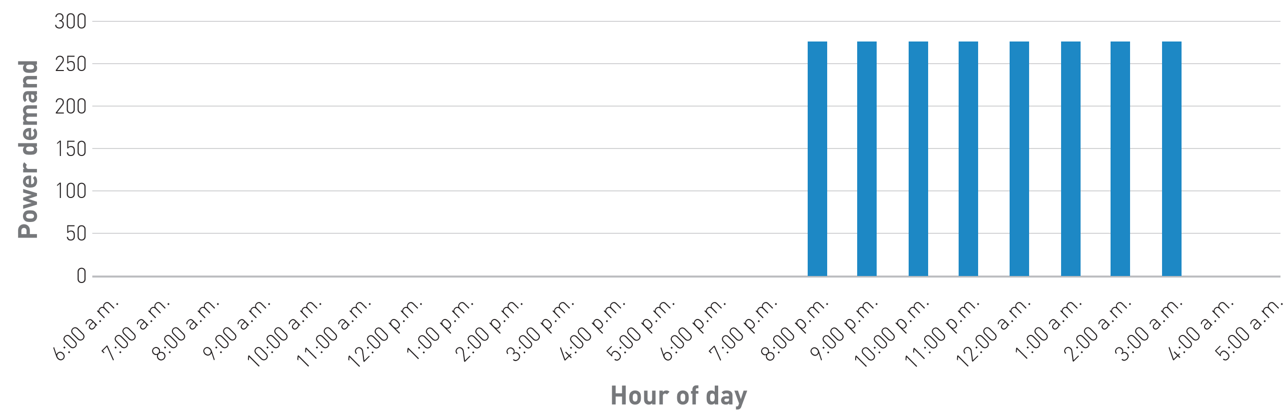
Per-vehicle charging rate (kW)
=
70 kW
÷
10 trucks
=
7 kW/truck

Choosing the right EV charging infrastructure for your fleet (continued)

EXAMPLE 2:
LOCAL CLASS 8 TRUCKS (SINGLE SHIFT)

Ten class 8 semitractors use 2.2 kWh of electricity per mile. All 10 trucks travel an average of 100 miles per day. They return to the fleet yard by 8 p.m. and must be ready to depart by 4 a.m.

FIGURE 6:
Average power demand for 10 heavy-duty trucks over one shift



Charging window energy requirement

Energy (kWh)
=
10 vehicles
x
100 miles/vehicle/day
x
2.2 kWh/mile
=
2,200 kWh/day

Charging window

All vehicles return to the fleet yard by 8 p.m. and must be ready to depart by 4 a.m. Therefore, the charging window is **eight hours**.

Load profile and average power demand

All vehicles are available for the same charging window, so the load profile is a flat power demand during the charging window (Figure 6).

Average power demand (kW)
=
2,200 kWh
÷
8 hours
=
275 kW

Per-vehicle charging rate

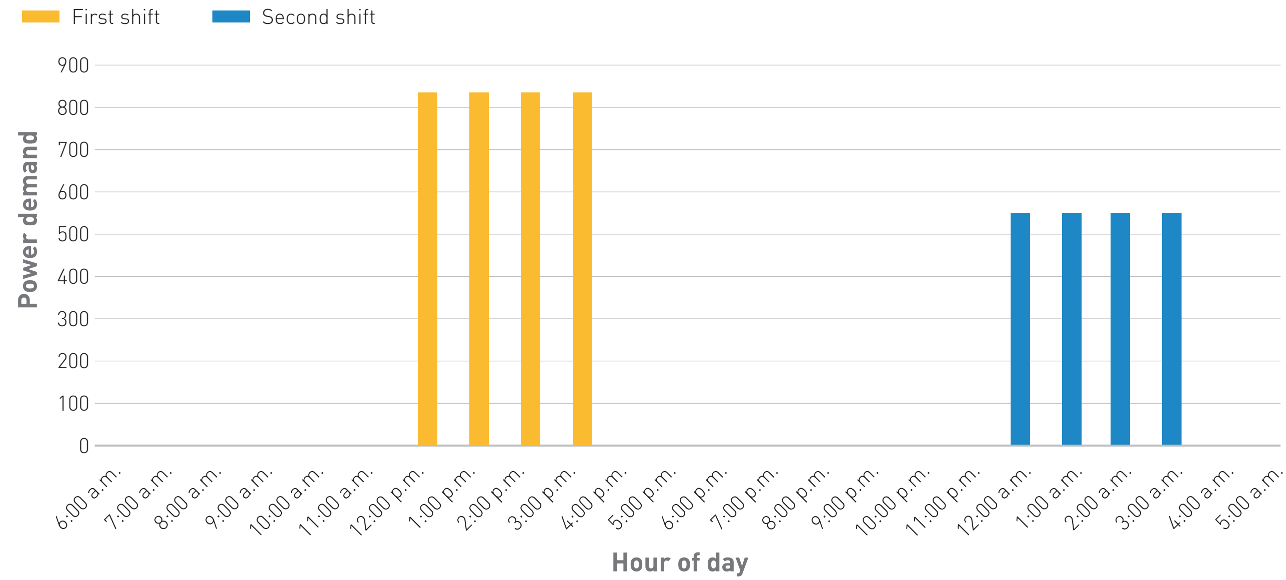
Per-vehicle charging rate (kW)
=
275 kW
÷
10 trucks
=
27.5 kW/truck

Choosing the right EV charging infrastructure for your fleet (continued)

EXAMPLE 3:
LOCAL CLASS 8 TRUCKS (TWO SHIFTS)

Ten class 8 semitractors use 2.2 kWh of electricity per mile. All 10 trucks are used for two shifts per day and travel an average of 150 miles during the first shift and 100 miles during the second shift. The first shift returns to the fleet yard by 12 p.m. and must be ready to depart by 4 p.m. The second shift returns to the fleet yard by 12 a.m. and must be ready to depart by 4 a.m.

FIGURE 7:
Average power demand for 10 heavy-duty trucks over two shifts



Charging window energy requirement

First shift energy (kWh)
=
10 vehicles
x
150 miles/vehicle/shift
x
2.2 kWh/mile
=
3,300 kWh/shift

Second shift energy (kWh)
=
10 vehicles
x
100 miles/vehicle/shift
x
2.2 kWh/mile
=
2,200 kWh/shift

Charging window

The first shift returns to the fleet yard by 12 p.m. and must be ready to depart by 4 p.m. The second shift returns to the fleet yard by 12 a.m. and must be ready to depart by 4 a.m. Therefore, the charging window is **four hours** for each shift.

Load profile and average power demand

All vehicles are available for the same charging window, so the load profile is a constant power demand during the charging window (Figure 7).

First shift average power demand (kW)
=
3,300 kWh ÷ 4 hours
=
825 kW

Second shift average power demand (kW)
=
2,200 kWh ÷ 4 hours
=
550 kW

Per-vehicle charging rate

First shift per-vehicle charging rate (kW)
=
825 kW ÷ 10 trucks
=
82.5 kW/truck

Second shift per-vehicle charging rate (kW)
=
550 kW ÷ 10 trucks
=
55 kW/truck

Purchasing electricity for your fleet

The process of estimating costs and buying electricity for your fleet differs from the process of procuring diesel and gas fuel in several ways. When buying electricity (for charging EVs or otherwise), there are two primary sources—PG&E and a community choice aggregator (often referred to as a CCA).

As an energy customer, you are billed according to your rate plan's structure, which defines the prices charged to different kinds of customers (residential, commercial, industrial and agricultural) and over different time frames (peak, partial-peak and off-peak). PG&E commercial customers have a choice of rate plans based on their load profile and electrical meter. It can be challenging for fleet managers who are unfamiliar with this information to understand their rate options. This section explains PG&E's commercial electric rate plans to make it easier to select a charging plan that minimizes charging costs while fully meeting your fleet's charging needs.

Learn more about **PG&E's Business EV rate plans here.**

Learn more about **PG&E's commercial rate plans here.**

PG&E commercial electric rate plans

Business EV rate plans: Those that install fleet charging on a separate meter can reduce energy costs up to 40% compared to traditional commercial electric rates. These rates eliminate demand charges, and instead use two monthly subscription pricing models and lower time-of-use rates to enable more affordable charging and improved certainty for budgeting.

Time-of-Use (TOU): With time-of-use rate plans, the cost of electricity varies based on the time of day and season in which it is used. Electricity rates are higher during times of peak energy demand and lower at all other times. Those who install one meter, or choose not to enroll in the Business EV rate plans can choose this rate structure.

Peak Day Pricing: An optional rate plan that offers businesses a discount on regular summer time-of-use electricity rates in exchange for higher prices during nine to 15 Peak Pricing Event Days per year, typically occurring on the hottest days of the summer. This rate is not applicable under the Business EV rate plans.

Additionally, these rate plans may include these charges on the bill:

Fixed charge: A fee covering the regulator-approved costs that the utility pays to supply your power, such as distribution and transmission (dollars per month).

Energy charges: Your baseline price of electricity, calculated by the amount of electricity (measured in kWh) used per time period multiplied by the per-kWh rate for those respective time periods.

Demand charge: A demand charge encourages businesses to spread their electricity use throughout the day. This charge is calculated by using the 15-minute interval during each billing month when your business uses its maximum amount of electricity. As a benefit to this type of rate plan, regular electricity usage charges are lower than for a comparable rate plan without a demand charge.

Seasonal rates: Additional distribution fees covering the costs of addressing weather stressors on the electric grid during winter or summer

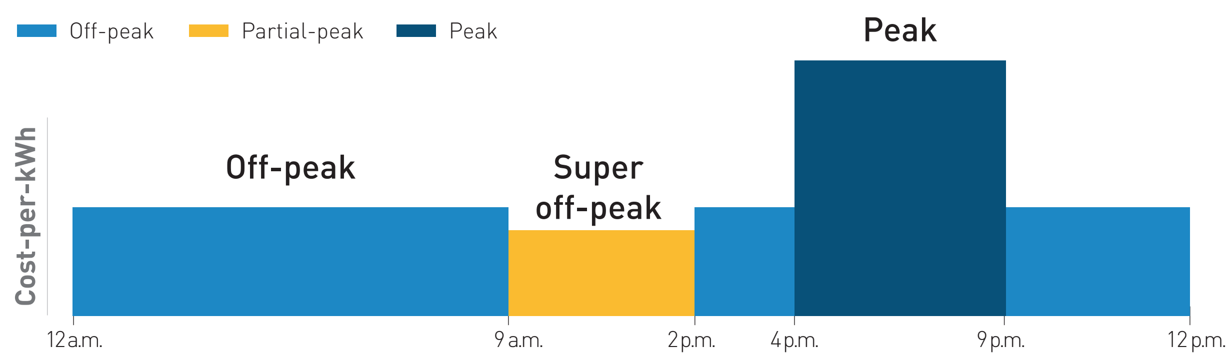
Power factor adjustment: An adjustment to your demand charge according to how efficiently your facility consumes power.

Rate plan availability subject to change. Please visit **pge.com/tvp** for the most current rate plan options.

Opportunities to manage EV charging costs

In general, charging your vehicles during off-peak periods (night and early morning hours) will reduce your overall energy costs, as shown in Figure 8. You can achieve further cost savings through proper load management, where energy is metered out at a consistent rate for the entire duration of charging to lower your monthly demand charge.

FIGURE 8:
Business EV rate plan time-of-use rate chart



Business High Use EV Rate (BEV2) values shown for illustrative purposes. Business Low Use EV Rate (BEV1) values will vary slightly from the values shown above. The kWh values of the TOU periods above are rounded for clarity.

Various utilities, including PG&E, apply seasonal rates when the cost of transmitting power rises due to weather-related events, such as downed lines during windstorms. Utilities may also apply a power factor adjustment, which measures how efficiently the customer's equipment consumes electricity. A higher power factor at your site indicates more efficient equipment. An electrician or your utility can help you understand whether this is a concern at your facility.

Business EV rate calculator:
Calculate your monthly fueling costs with the dynamic Business EV rate calculator tool. Estimate monthly fueling costs, toggle between rate option, see how your costs change depending on subscription level, set your charging schedule, and more.
Launch calculator.

TERMS YOU NEED TO KNOW

EV demand: The amount of power (kW) supplied to EVs during charging

Rate structure: A set of parameters used to define the prices that a customer may be charged for power over time

Meter: A device that records the amount of power flowing through a circuit

Peak shaving: A strategy to reduce power consumption during periods of high demand

Opportunities to manage EV charging costs (continued)

The following example illustrates how the demand charge affects your cost of power:

TOU RATE STRUCTURE

You are billed under a time-of-use rate plan with three rate periods: off-peak ($0.23/kWh), partial-peak ($0.25/kWh) and peak ($0.27/kWh). Last month, your fleet consumed 12,000 kWh evenly distributed across all three rate periods each day (i.e.,12,000 kWh/three rate periods = 4,000 kWh per rate period). Your energy charge would be as follows:

(4,000 kWh x $0.23/kWh) + (4,000 kWh x $0.25/kWh) + (4,000 kWh x $0.27/kWh) = $3,000 total energy charge

+

TOTAL DEMAND CHARGE

Now consider you are subject to a demand charge of $10/kW. Last month, your fleet consumed 12,000 kWh and had a maximum demand on the grid of 125 kW during peak usage (measured in 15-minute intervals). To calculate your total demand charge, multiply your peak demand on the grid by the demand charge.

(125 kW x $10/kWh) = $1,250 total demand charge

TOTAL CHARGE

$3,000 Energy charge + $1,250 Demand charge = $4,250 Total charge

Opportunities to manage EV charging costs (continued)

How peak shaving can reduce your cost of power:

Consumers use the peak shaving strategy to reduce their max demand charges by spreading out power consumption to off-peak periods, or by relying on energy storage on-site during peak periods to control costs.

In the **previous energy usage example**, you notice that demand charges comprise almost 30 percent of your total bill. You know that your partial-peak and peak periods are between 8:30 a.m. and 9:30 p.m., and that your staff plugs in the vehicles at 5 p.m. and unplugs them at 4 a.m.—but that charging is complete by midnight. Your facility is already open late with staff who can plug and unplug vehicles from your EVSE. After making some internal adjustments, you calculate that you can shift much of your consumption to off-peak periods **by starting vehicle charging later in the evening**. This reduces your peak power demand from 125 kW to 50 kW, saving you $750 per month.

REVISED DEMAND CHARGE

(50 kW x $10/kWh) = $500 demand charge (originally $1,250)

REVISED TOTAL CHARGES

$3,000 Energy charge + $500 Demand charge = $3,500 Total charge

Opportunities to manage EV charging costs (continued)

Some utilities may offer or require customers to participate in demand response programs. During periods of high demand, utilities may ask large commercial customers in the program to scale back their consumption for a brief period. Enrolled members may be rewarded for responding via reductions on their utility bill or penalized for not responding via higher fees.

Finally, some utilities offer a special EV rate for their commercial customers. In order to apply this rate to your EV fleet's electricity consumption, you may have to separate your EVSE load from the rest of your facility load by installing a dedicated meter for your EVSE. A separate meter allows your utility to bill only your EV consumption at the discounted rate.

PG&E now offers Business EV rate plans to fleet customers.

Use our **EV Fleet Savings Calculator** to find out how moving to an electric fleet will impact rates.

Utilities will typically assist their customers in setting up a dual meter tracking system at a nominal service fee. Installation fees for the second meter can be significant but can be offset by construction cost allowances provided by the utility.

- Your utility will typically offer an allowance or credit for the cost of constructing new or expanded electrical service based on your new EV electricity consumption. The size of this credit is often significant; for some projects, it may offset most or all of the cost of required utility improvements.
- Under California's Low Carbon Fuel Standard (LCFS) program, EV fleet owners may be eligible to earn carbon credits with the energy dispensed to charge EVs. LCFS credits can then be sold at a market-determined price. Current credit prices equate to $0.20-$0.30/kWh for medium- and heavy-duty vehicles.[3] Eligibility depends on several factors, including proof that the energy reported is only used to power EVs. In many cases, a dedicated meter offers the most reliable and lowest-cost data source.

If adding your new EV demand to your existing account does not tip your entire facility's load into a new rate category—and you do not need to track your EVSE energy consumption for a grant, LCFS program or another opportunity—then some utilities may allow you to add your EVSE to your existing meter account. This will eliminate the one-time cost (largely installation) of adding a dual meter, and it may reduce your administrative effort.

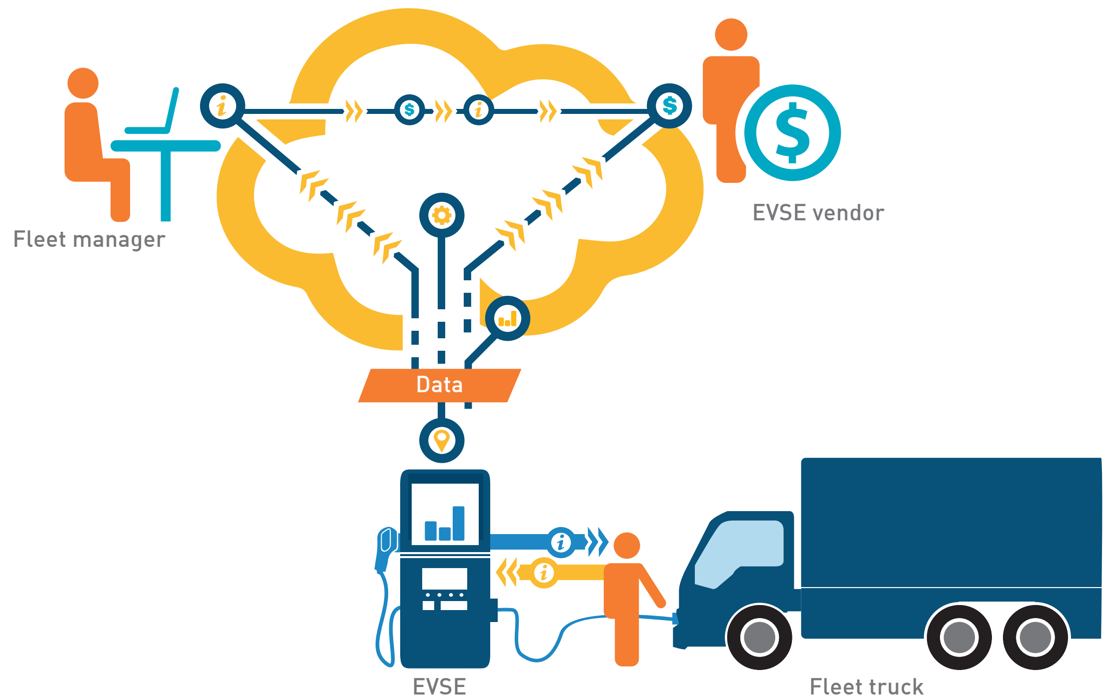
[3] Monthly LCFS Credit Transfer Activity Reports, California Air Resources Board: **https://ww3.arb.ca.gov/fuels/lcfs/credit/lrtmonthlycreditreports.htm**

Networking and cloud-based services for your EVSE

EVSE vendors may offer a networking service using a cabled or wireless Internet connection, as well as an additional cloud-based communications platform. These services are valuable to fleet managers who need to collect more activity data from their EVSE than what is reported on their monthly utility bill. Networking allows EVSE owners to monitor charging activity and detect failures in real time over a desktop or mobile device.

Additional functionality including payment collection and user interface can be added with a cloud-based communications service (Figure 9). Most EVSE use the Open Charge Point Protocol (OCPP), making them compatible with most network providers, but some effort may be required for integration. EVSE that use only proprietary communications protocols are likely to only communicate with the EVSE vendor's network services, restricting the fleet's choices for selecting other network providers.

FIGURE 9:
Cloud-based services allow fleet managers, EVSE vendors and EVSE users to share data and even payments over a wireless connection. Networked EVSE allow fleet managers to collect a smaller set of data from their EVSE.



TERMS YOU NEED TO KNOW

Networking service: An Internet-based service that allows an EVSE owner to analyze basic activity data from one or more EVSE

Cloud-based communications: A wireless Internet-based service carrying information on EVSE status, energy consumption, location and payments for use between the owner and the user(s)

Networking and cloud-based services for your EVSE (continued)

Most EVSE vendors offer networking and cloud-based services for an up-front cost plus a monthly fee. It is important to consider these costs as well as the reliability of Internet and cellular service in your area. While EVSE vendors provide the software for networked or cloud-based communications, their software's reliability depends on the quality of your Internet connection. If you've determined that networking or cloud-based communications are a good fit for your business, and your EVSE project's success depends on that connection, then it is important to review contingency plans in the event of less than 100 percent reliability from your Internet service provider. If you are using grant funds for your EVSE, you may want to find out whether the grant's reporting requirements include data from a cloud-based communications platform, and plan accordingly. Additionally, to participate in PG&E's EV Fleet program, you are required to provide EVSE usage data for a minimum of five years.

Another resource for tracking vehicle charging may be your EV manufacturer. Some manufacturers offer charging management systems on board their vehicles, which may produce sufficient information for some fleets.

EV Fleet program participants agree to provide five years of EVSE usage data.

Energy management best practices

The previous sections described ways that using specific charging periods, dedicated meters and networked or cloud-based services can optimize a fleet's transition to EVs in a cost-effective, operationally feasible manner. Additional energy management best practices include energy storage and an emergency preparedness plan.

Energy storage

Energy storage refers to any technology that can store electrical energy over a period of time. A steady power reserve can be valuable to fleets to reduce demand charge spikes, avoid energy charges during peak periods or mitigate issues from an unreliable power supply. In these scenarios, the energy storage resource typically draws power from a separate source or at a time when electricity prices are low. A fleet can then use that prepaid power when prices are high or electricity is not available. This behavior reduces the fleet's exposure to volatile prices and operations interruptions.

Batteries are the most common form of energy storage technology, and they are available in a range of capacities, physical sizes and chemistries. Depending on your basic load profile, EVSE options and level of power supply, energy storage may be a useful option to explore.

Emergency preparedness

While the electric grid is reliable, disruptions can occur. An emergency preparedness plan can minimize the impact of an outage. Answer the four questions below to ensure your fleet is sufficiently prepared.

- How much energy do you need?
  An emergency such as a natural disaster may halt your operations for several days, so you might not need 100 percent of your typical capacity.
- How will you get enough energy?
  Energy storage and on-site generation are two options to keep your fleet charged.
- Are any of your operations critical?
  You might be able to get redundant feeds from your electric company to maintain essential operations.
- How likely is an outage?
  To help you plan, consult with your electric company about the reliability of your area's electricity.

TERMS YOU NEED TO KNOW

Generation: The process of producing electricity from a fuel or other energy source

PG&E has energy storage and generation incentives to help. For more information, visit pge.com/sgip.

Understanding your EVSE options

Selecting which type of EVSE solution is right for you is based on your fleet type, fleet requirements and business or operational needs. Having the proper EVSE will maximize fleet efficiency and minimize energy costs.

An EVSE solution is composed of three basic components:

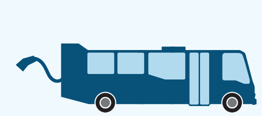
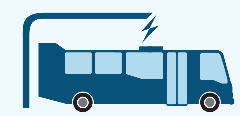
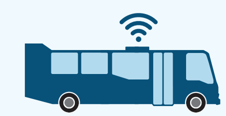
1. **EVSE interface (physical charging layout)**
2. **Charger power (AC vs. DC)**
3. **Charger level**

This section will provide a top-line overview of each of these components, along with a summary of the facts you need to select the right EVSE for your fleet application.

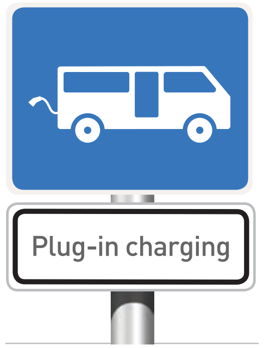
EVSE interfaces

There are three basic types of EVSE interfaces: 1) plug-in, 2) overhead and 3) wireless. Each type is briefly described in Figure 10 with supporting details on the next couple pages. Figures 11, 12 and 13 summarize the key features as well as the pros and cons of each type. Toward the end of this section, you'll also find some general takeaways to consider when selecting the right EVSE for your fleet.

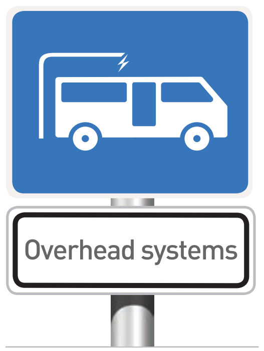
FIGURE 10:
Basic EV charging interface types

Type	Plug-in	Overhead	Wireless
Activation	Manual	Automated	Automated
Connection	 Conductive	 Conductive	 Wireless
Power range	Up to 350 kW	Typically 350-500 kW	Up to 250 kW
Voltage type	AC, DC and AC + DC	DC	AC

Understanding your EVSE options (continued)



Plug-In charging is done via a charging cord that is manually plugged into an EV's charging receptacle. Plug-in charging is by far the most common interface used today. These are considered "conductive" systems because power is transferred to the vehicle via conductors in the plug and receptacle. (See Figure 11). There are many different plug-in interfaces based on various standards (e.g., SAE J1772, CHAdeMO, SAE Combo CCS). In addition, some EV manufacturers (e.g., Tesla) have adopted their own proprietary standards.



Overhead systems are another type of conductive interface that provide power by connecting an EV to a DC fast charger (DCFC) using a pantograph, as detailed in Figure 12. Because the pantograph can handle large conductors that would be difficult for an individual to manage in a manual plug-type interface, overhead systems can charge at higher power levels than plug-type interfaces. Currently, overhead charging is mostly used in specific transit bus applications. However, it could eventually be used to provide rapid charging for trucks and other heavy-duty applications (e.g., cargo-handling equipment).

Wireless charging is a nonconductive interface that transfers power from a ground-mounted "transmitter" coil to a receiving coil mounted to the bottom of a vehicle. In practice, it is similar to wireless cell phone charging. The power received by the receiving coil is provided to the vehicle's AC charging electronics as if the vehicle was connected to a plug-in AC charger. Wireless charging systems with power levels as high as 250 kW have been demonstrated. Wireless charging typically requires retrofitting the receiving coil to an EV because medium- and heavy-duty vehicle manufacturers do not currently offer wireless EV charging interfaces as an integrated option.

FIGURE 11:
The EVSE plug connects with the EV receptacle to transmit power over a conductive system

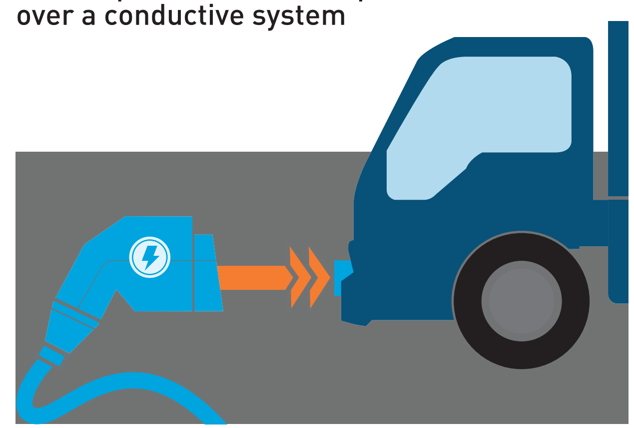
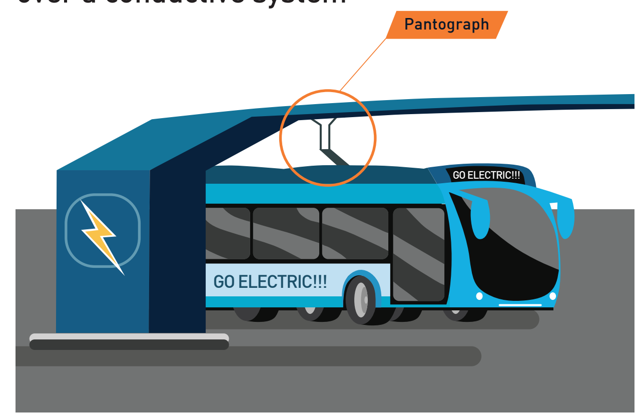


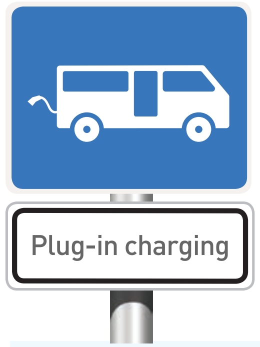
FIGURE 12:
The DC fast charger uses a pantograph to transmit power over a conductive system



At present, plug-in charging is the most common and widely available option based on existing vehicles and infrastructures. Overhead charging, while more powerful than plug-in, is still limited to certain applications. Wireless charging is a promising, yet nascent solution with potential for growing adoption in the years to come.

Understanding your EVSE options (continued)

FIGURE 13:
Advantages and disadvantages of EV charging interface types



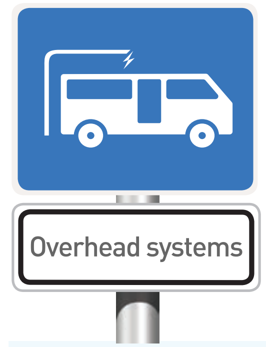
Manual conductive

PROS

- Proven solution (standard EV charging approach)
- Lower capital cost per charge port
- Very high power (>300 kW)
- Subsurface work generally limited to trenching for power cabinets

CONS

- Requires personnel to plug in and unplug vehicle for charging
- Cable management



Automated conductive

PROS

- No delay waiting for personnel to connect EV
- Similar subsurface work as manual systems

CONS

- Cable management/connection logistics
- Higher capital cost per port
- Large footprint
- Parking misalignment can prevent charging

Automated wireless

PROS

- No delay waiting for personnel to connect EV
- No cable management issues
- No operator action required to begin charging

CONS

- Slightly lower power range (50-250 kW typical)
- Higher capital cost per port
- Requires retrofit of vehicle to incorporate interface
- Parking misalignment can prevent charging
- Requires extensive subsurface work

Understanding your EVSE options (continued)

Charger power

In addition to the physical interface types described above, EVSE are further divided into AC and DC charging. AC charging essentially passes the voltage as is from the utility to the vehicle. On board the vehicle, electronics convert the AC power to the DC power that is required to charge the battery. AC charging is typically limited to power levels of 20 kW or less because vehicles may not have space for the larger electronics required to support higher power levels. There are some exceptions, particularly on large transit buses and some off-road equipment where space is less constrained. Above 20 kW, the electronics required to convert power from AC to DC are placed outside the vehicle and the DC fast charger provides DC power to the EV. These chargers are currently capable of supplying power up to approximately 350 kW.

Charger level

Currently, most medium- and heavy-duty EVs in the U.S. are equipped for at least one of three standard plug-in charging levels. For lower power charging, an AC charger is typically specified (either Level 1 at 120 volts or Level 2 at 240 volts). Between 20 and 50 kW, vehicles may be equipped with both an AC and DC fast charger (Level 2 and Level 3). Above 50 kW, most vehicles will be equipped with a DC fast charger (Level 3). These chargers are summarized in Figure 14.

When determining which charging level works best for you, also consider the plug location of your current and/or future EVs.

TERMS YOU NEED TO KNOW

Voltage: Electrical pressure created by a difference in electrical potential

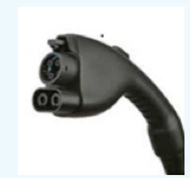
Amperage: A measure of the flow of electrical charge eVfleet

Understanding your EVSE options (continued)

EVSE options

Since there is not yet a standard EV fleet charging system for all vehicles, your choice of a charging system will play a major role in determining your charging times, fleet availability, infrastructure upgrades and energy costs. Use this as a guide to help select which might work best for you.

FIGURE 14:
EVSE connection standards

	AC	AC + DC	DC
LEVEL	**Level 1 (120 V)** **Level 2 (240 V)**	**Level 2** **Level 3**	**Level 3**
SAE J1772	 **SAE J1772 AC** Charging rate: up to 20 kW Supply voltage: 120/240 V/208 V Supply amperage: up to 80 A	 **Combined Charging System (CCS Type 1)** Charging rate: up to 20 kW (AC) or 350 kW (DC) Supply voltage: 480V Supply amperage: up to 500A	 **Combined Charging System (CCS Type 1)** Charging rate: up to 350 kW (DC) Supply voltage: 480 V Supply amperage: up to 500 A
SAE J3068	 **SAE J3068 AC_6** Charging rate: up to 133 kW Supply voltage: 208-480V 3P Supply amperage: up to 160 A	 **SAE J3068 AC_6/DC_8** Charging rate: up to 133 kW (AC) or 200 kW (DC) Supply voltage: 208-480 V 3P Supply amperage: up to 160 A (AC) or 200 A (DC)	 **SAE J3068 DC_8** Charging rate: up to 200 kW (DC) Supply voltage: 480 V 3P Supply amperage: up to 200 A (DC)
CHAdeMO	**N/A**	**N/A**	 **CHAdeMO** Charging rate: up to 400 kW (DC) Supply voltage: 208-480 V 3P Supply amperage: up to 500 A
GB/T 20234	 **GB/T 20234 AC** Charging rate: up to 40 kW Supply voltage: 240 V/480 V Supply amperage: up to 63 A	**N/A**	 **GB/T 20234 DC** Charging rate: up to 238 kW Supply voltage: 480 V 3P Supply amperage: up to 300 A

Understanding your EVSE options (continued)

FIGURE 15:
EVSE equipment configurations for DC fast chargers

WALL BOX/PEDESTAL MOUNT

INTEGRATED DISPENSER

MODULAR SYSTEM
(POWER CABINET + DISPENSER)

DC fast chargers

DC fast chargers are often the preferred charger for medium- and heavy-duty fleets because of their quicker time to charge. They are available in a range of sizes and power capacities, with maximum power ratings from 24 kW to over 350 kW. They are most commonly offered as wall boxes, integrated cabinets/dispensers and modular systems as shown in Figure 15. Wall box or pedestal-mounted units are typically available in the lower end of the power range, while integrated cabinets/dispensers are available up to approximately 100 kW. Modular systems use one or more power cabinets to supply one or more dispensers and can supply up to 350 kW to a single dispenser, or they can split power among multiple dispensers. A DC fast charger that delivers power at a rate greater than 150 kW typically requires liquid cooling of the cable assembly. While these systems exist, they need additional equipment and usually have a shorter cable length. Keeping charging power levels below 150 kW will increase a fleet's charging options, reduce equipment and usage costs and allow greater flexibility with respect to cable lengths.

Visit **pge.com/evfleetapprovedvendor** to see which charging options qualify for PG&E rebates.

To calculate your potential rebate, use our **EV Fleet Savings Calculator.**

Understanding your EVSE options (continued)

Charging examples

Previously, we introduced examples to discuss load profiles and charging windows resulting in the following per-vehicle charging rates: 7 kW, 27.5 kW, 82.5 kW and 55 kW. The following examples illustrate how you can leverage this information to help you identify appropriate charging interface.

EXAMPLE 1: CITY DELIVERY VANS

Previously, we determined in Example 1 (page 15) that the per-vehicle charging rate for 10 delivery vans would be 7 kW/truck:

Per-vehicle charging rate (kW) = 70 kW ÷ 10 trucks = **7 kW/truck**

The 7 kW charging rate is well within the power range for the J1772 AC interface that is commonly used in the U.S. J1772 AC EVSE are available in several standard sizes as determined by common circuit breaker ratings and electrical code requirements. According to these requirements, the continuous load on a circuit should not exceed 80 percent of the circuit's rated capacity. For example, and as shown in Figure 16, a Level 2 EVSE has a maximum power draw of 32 amps on a 240-volt circuit, providing 7.7 kW of peak power and meeting the delivery van fleet's minimum charging requirements. The following formula is helpful for understanding these relationships:

Watts = Volts x Amps

In this example, a Level 2 charger drawing power at 32 amps from a 240-volt circuit provides a charge rate of 7,680 watts, or 7.7 kW.

Watts = 240 volt x 32 amps = 7,680 watts ÷ 1,000 = 7.7 kW

Although this meets the delivery van fleet's calculated charging requirement of 7 kW, it leaves little margin for error when a vehicle uses more than the average daily energy usage or has a shorter than anticipated charging window. Specifying a 9.6 kW EVSE in your design instead would provide a reasonable amount of additional margin without unnecessarily adding costs for greater electrical service capacity or EVSE capability. Networked chargers may be controlled through load management software to minimize the actual charging rate and associated costs while meeting fleet requirements.

FIGURE 16:
Common EVSE power ratings (240V) and their supporting circuits

Common breaker size (amps)	Maximum continuous draw (amps)	Power rating (kW @ 240V)
20	16	3.8
25	20	4.8
30	24	5.8
40	32	7.7
50	40	9.6
60	48	11.5
80	64	15.4
100	80	19.2

Understanding your EVSE options (continued)

EXAMPLE 2: LOCAL CLASS 8 TRUCKS (SINGLE SHIFT)

Previously, we determined in Example 2 (page 16) that a fleet of class 8 trucks running local routes on a single shift schedule would require a charging rate of 27.5 kW/truck:

Per-vehicle charging rate (kW) = 275 kW ÷ 10 trucks = **27.5 kW/truck**

The 27.5 kW charging rate exceeds the J1772 AC standard rating and would likely require a DC fast charger based on either the CCS-1 or CHAdeMO standard. Vehicle manufacturers will typically specify which standard is available on their vehicles, and very few manufacturers offer the option to have more than one standard on the vehicle. For this reason, the standard of your charging equipment is determined by the standard of the interface on the EVs you are purchasing. If a fleet plans to purchase a mix of vehicles using the CCS-1 and CHAdeMO standards, DC fast chargers are available with multiple cables and can be configured to support both CCS-1 and CHAdeMO connector standards on a single dispenser.

EXAMPLE 3: LOCAL CLASS 8 TRUCKS (TWO SHIFTS)

Previously, we determined in Example 3 (page 17) that a fleet of class 8 trucks running local routes on a two-shift schedule would require two different charging rates.

First shift per-vehicle charging rate (kW) = 825 kW ÷ 10 trucks = **82.5 kW/truck**

Second shift per-vehicle charging rate (kW) = 550 kW ÷ 10 trucks = **55 kW/truck**

In a situation where the per-vehicle charging rates vary between shifts, the higher charging rate (in this example, 82.5 kW/truck) sets the minimum charging rate required from your EVSE. In other words, your charging infrastructure should be capable of delivering at least 82.5 kW per port. Both CCS-1 and CHAdeMO are viable options for this charge rate, in addition to various proprietary chargers that may be required by your EV manufacturer. At this power level, it is common to consider modular DC fast charging systems rather than integrated dispensers. As previously explained, modular systems connect one or more power cabinets to one or more dispensers to provide up to 350 kW, while most integrated dispensers are limited to 50-100 kW. As a two-part system, the modular option also offers more flexibility for your layout because the power cabinets can be sited at distance from the dispensers. This is valuable at sites with significant space constraints.

FIGURE 17:
Common EVSE power ratings (480V) and their supporting circuits

Minimum Breaker Rating (Amps)	Maximum Continuous Draw (Amps)	Power Rating (kW @ 480V)
40	30	25
80	60	50
150	120	100
225	180	150
300	240	200
550	420	350

Understanding your EVSE options (continued)

EVSE selection takeaways

The following are points to consider when selecting EVSE for your fleet application:

- AC chargers are less expensive than DC chargers for the same power level and are supplied by 240-volt single phase or 208-volt three-phase circuits commonly available in most commercial facilities. Where AC charging is sufficient for your fleet's needs, it is generally the most cost-effective option.
- Specifying EVSE power ratings that are greater than the calculated average required charging rate will help avoid incomplete charging cycles. Regardless of your charging rate, most batteries currently available in EVs charge more slowly when they are nearly depleted or nearly full.
- Keeping charging power levels below 150 kW will increase your DC charging equipment options, reduce equipment and electricity costs and allow greater flexibility with respect to cable lengths.
- Rightsizing (neither under- nor oversizing) your charging scenario for your fleet's specific application may also optimize the lifetime of your EV's battery and energy storage system.
- Ambient temperature affects EV charging rates and range. Fleets that may operate in cold environments with sustained average daily temperatures at or below freezing should account for the impact of extended charging times and shorter vehicle ranges on charging windows during seasonal cold periods.

Cost guidelines and funding solutions for your EVSE

While EVSE costs vary by vendor, order size and level of sophistication, average EV charger price ranges in Figure 18 are useful benchmarks for estimating your capital cost, exclusive of electrical infrastructure upgrades. Electrical infrastructure upgrade costs may range from a few hundred to a few thousand dollars for lower-power EVSE to tens of thousands for higher-power EVSE and are ultimately site-specific. If you contact a PG&E EV specialist early on in your consideration process, they can help guide you toward vehicle manufacturers as well as help evaluate your site to determine the infrastructure support that may be needed. In addition, depending on your vehicle type and location, PG&E has incentives and rebates to help absorb upfront infrastructure costs.

The PG&E EV Fleet program supports Level 2 and DC fast chargers in a variety of installation configurations to meet your needs. You are responsible for procuring the chargers and having them installed. You can select EV charger options from our **approved vendor list** and receive a rebate of up to 50 percent of the cost for eligible chargers.

FIGURE 18:
Per unit EVSE average cost ranges by power level and networkability

Charging type	Power level	Networkable	Price range ($)
Level 1 AC	<2 kW	No	$500-$1,000
Level 2 AC	<8 kW	No	$500-$1,000
Level 2 AC	10-20 kW	No	$700-$1,500
Level 2 AC	<8 kW	Yes	$500-$1,000
Level 2 AC	10-20 kW	Yes	$3,000-$6,500
Level 3 DC	20-30 kW	Yes	$10,000-$40,000
Level 3 DC	50-150 kW	Yes	$50,000-$100,000
Level 3 DC	>150 kW	Yes	$150,000+

Note:The power level ranges presented cover the standard offerings and are based on 2018 data. Costs do not include extended warranties, maintenance service contracts or recurring subscriptions fees. There are currently few standard DC fast charge offerings between 30 kW and 50 kW.

Please see **PG&E program details** on page 37.

The fleet program supports Level 2 and DC fast chargers. Go to **pge.com/evfleetapprovedvendor** for a list of vendors.

PG&E EV Fleet program for medium- and heavy-duty vehicles

PG&E EV Fleet program for medium- and heavy-duty vehicles

California has aggressive goals when it comes to reducing greenhouse gases, and transportation is the single largest source of climate-related pollution. To reach our greenhouse gas reduction goals in 2030 and 2050, we must electrify our fleets. PG&E is here to help you go electric.

While transitioning a vehicle fleet to electric can offer significant total cost of ownership savings over the long term, upfront costs to procure new EVs and install chargers can be prohibitively high for many. To help mitigate these upfront costs, PG&E created the EV Fleet program, offering rebates and incentives on charging infrastructure upgrades.

TERMS YOU NEED TO KNOW

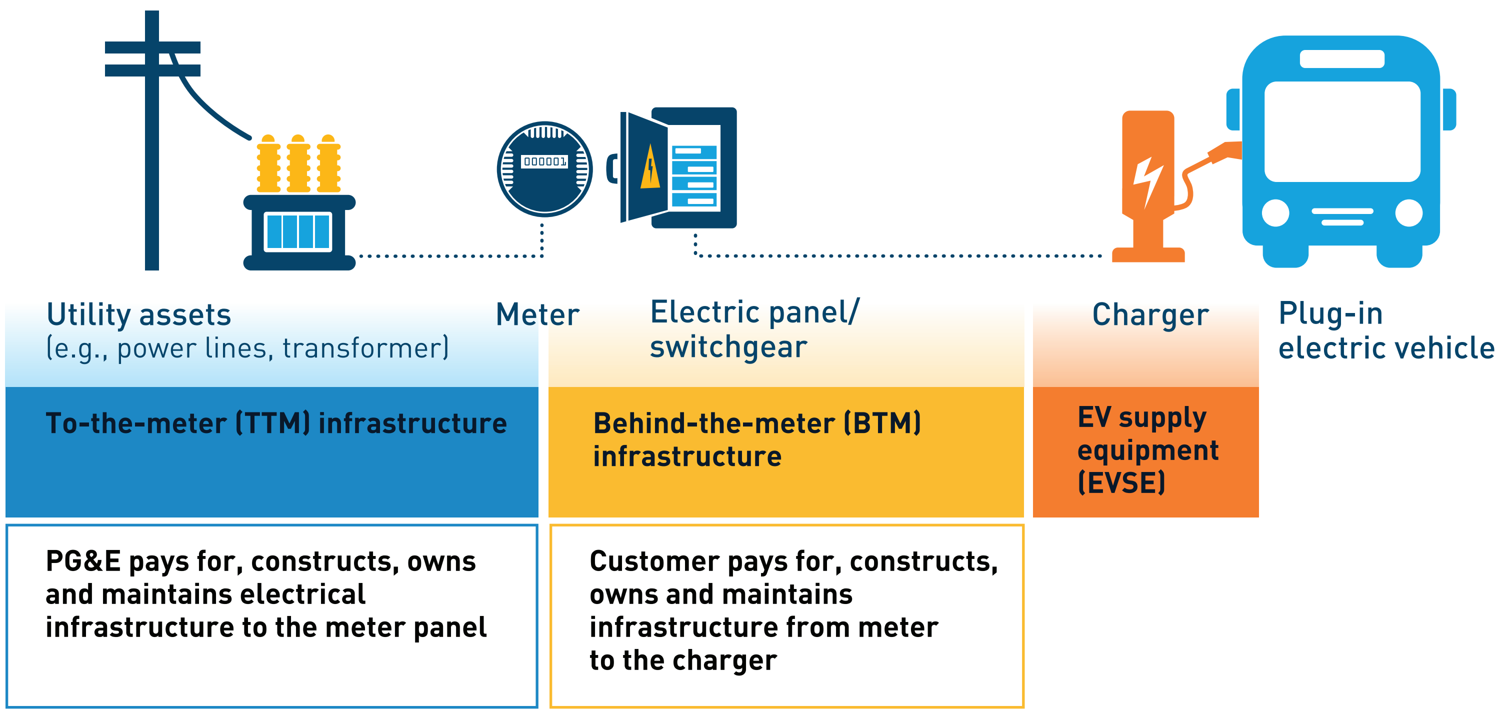
Transformer: An electric device that changes electricity from one level of voltage to another

Here's how the PG&E EV Fleet program works

To participate in the program, the customer will design, build, own, operate and maintain the electrical infrastructure from the meter to the EV charger. This is often referred to as **behind-the-meter** (or BTM). PG&E will construct, own and maintain all electrical infrastructure from the transformer to the meter. This is often referred to as **to-the-meter** (or TTM). See Figure 19.

Go to **pge.com/evfleet** to see a video overview of the program.

FIGURE 19:
Infrastructure breakdown



PG&E EV Fleet program for medium- and heavy-duty vehicles (continued)

Two ways to save

CHARGER REBATES

Charging equipment rebates for schools, transit agencies and disadvantaged communities only.

You may be eligible for rebates on certain EV chargers, based on power output, to help offset a portion of the cost for behind-the-meter work. Use our **EV Fleet Savings Calculator** to find out if you're eligible and how much you can save, or see the chart below.

Chargers	Rebate for eligible customers
Up to 50 kW	50% of the cost of EV charger, up to **$15,000**
50 kW to 150 kW	50% of the cost of EV charger, up to **$25,000**
150 kW and above	50% of the cost of EV charger, up to **$42,000**

INFRASTRUCTURE INCENTIVES

Limited to 25 vehicles per site; sites with more vehicles to be considered on an individual basis.

PG&E offers infrastructure incentives for all customers. Use our **EV Fleet Savings Calculator** to find out how much you can save, or see the chart below.

Vehicle type	Per vehicle incentive cap
Transit buses and class 8 trucks	**$9,000** per vehicle
Transportation refrigeration units, truck stop electrification, ground support equipment and forklifts	**$3,000** per vehicle
School buses, local delivery trucks and other vehicles	**$4,000** per vehicle

PG&E EV Fleet program for medium- and heavy-duty vehicles (continued)

Additional savings

In addition to savings from PG&E, your move to an electric fleet may also enable you to take advantage of other incentive and grant programs. California has dedicated funding pools for EV infrastructure, and several federal programs are also available. Use our **EV Fleet Savings Calculator** to find more ways to save and additional funding sources for your efforts to reduce greenhouse gas emissions.

PG&E EV Fleet program eligibility requirements

1. Be an existing PG&E or community choice aggregator (CCA) customer.
2. Commit to procuring a minimum of two electric fleet vehicles.

   Eligible vehicles include: transit bus, school bus, medium-duty vehicle, forklift, truck stop electrification, transportation refrigeration unit, port cargo truck, airport ground support, other heavy-duty vehicles and class 8 vehicles.
3. Demonstrate long-term electrification growth plan and schedule of load increase.
4. Provide data related to charger usage for a minimum of five years.
5. Own or lease the property where chargers are installed, and operate and maintain vehicles and chargers for a minimum of 10 years.
6. Provide a property easement as needed.
7. Agree to program terms and conditions. Go to **pge.com/evfleetterms** and click on the Understanding Costs tab. You will find the terms and conditions link there.

PG&E Fleet electrification process

PG&E EV Fleet electrification process

Consult with PG&E early to identify the best solution for your needs.

Your vehicle and charging needs will drive site design and electrical requirements, and PG&E EV Fleet specialists are here to lend their expertise, from recommending vehicle and charger manufacturers to reviewing logistical considerations and your site designs. They can also help with solution design through construction execution. By partnering with you and your team, PG&E can make the electrification process move as quickly and smoothly as possible.

Figure 20 on the following page shows the approximate timing, collaboration and responsibilities of those involved in the design, permitting and execution of the electrification process.

It's never too early

Submit an interest form to get in touch with a PG&E EV specialist who can discuss the program in detail: **pge.com/evfleetform**

PG&E EV Fleet electrification process

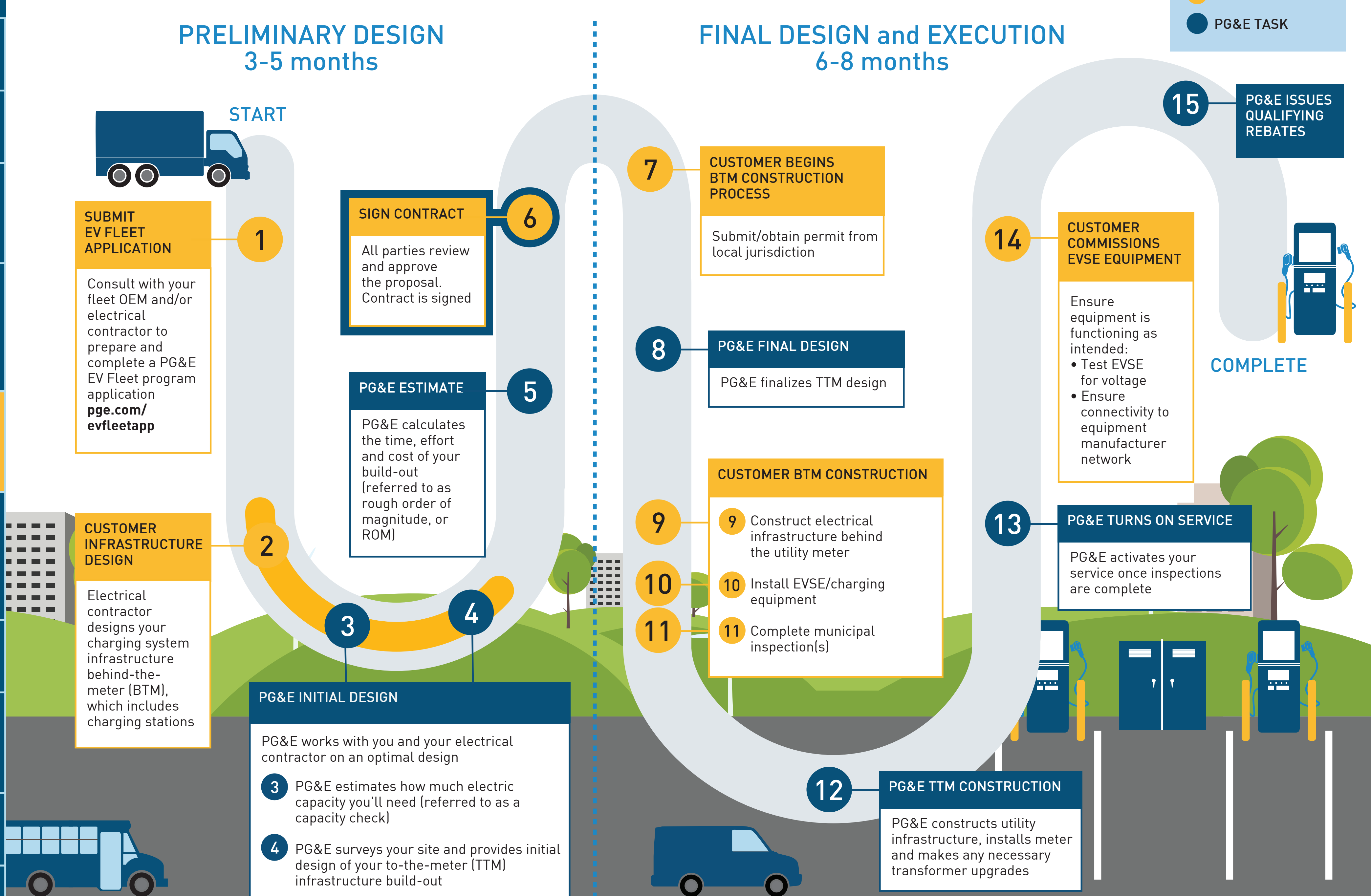


FIGURE 20

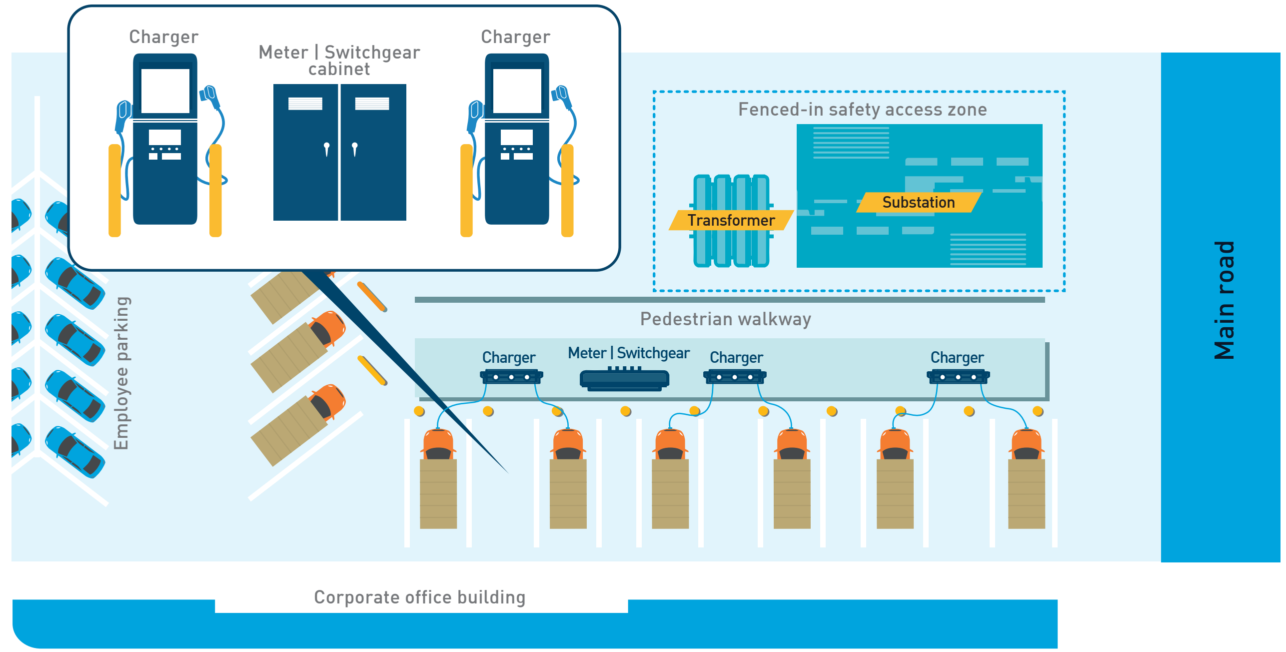
Preliminary design for your EV charging infrastructure

Deciding where to site and install charging infrastructure to accommodate your new EV fleet requires planning to optimize location, operations and logistics. In California, you must notify your utility of any electrical additions or upgrades at your facility regardless of the scope or scale.

When working with PG&E, it is good practice to engage early. We can be particularly helpful once you have determined your on-site energy needs and existing electrical equipment's capacity (see **Choosing the right EV charging infrastructure for your fleet**) or sooner if you need guidance. Once notified, PG&E will advise if the current service meets your new electricity needs or if infrastructure upgrades are required. We will also provide you with a time frame. This is the output from the capacity check in step three in Figure 20 as shown on page 42.

When you partner with PG&E from the beginning of your process, PG&E can advise you of incentives and charger rebates and design the to-the-meter (TTM) infrastructure (everything up to and including your EV system's charging meter). Meanwhile your electrical contractor designs your behind-the-meter (BTM) infrastructure, and together we will ensure you have an optimal design. Plus, you'll have access to resources, assistance and information that can significantly reduce the time and cost of your infrastructure upgrades. For example, we can often help reduce infrastructure costs associated with connection to PG&E power poles simply by identifying where on your property is the shortest distance to an interconnection point with available electric capacity.

FIGURE 21:
Electrical equipment layout at a charging depot



When assessing your site, it is important to consider not just the entry, park and exit pathways but also the vertical surfaces, protected areas and locations of existing electrical equipment. Walls, light posts and other vertical structures may serve as EVSE mounting locations if adjacent parking space is available and vertical surfaces can support overhead charging equipment. Using existing surfaces can reduce capital costs by eliminating the need for a dedicated EVSE post and in-ground wiring. However, if the space between vehicles and the wall serves as a walkway, then stretching EVSE cords across that space could create a hazard that forces pedestrians to walk through more exposed parts of your lot. (See Figure 21.)

Preliminary design for your EV charging infrastructure (continued)

If your existing surface is far from your electrical panel, the construction to extend the wired connection may be costly and disruptive. You may want to consider purchasing solar canopies. This will help keep your fleet clean while also providing shade and a method for overhead reels for the charger plugs. Finally, when mapping your layout, consider the space that protective infrastructure such as bollards and parking blocks will require to prevent vehicles from colliding with your EVSE or your personnel.

Your preliminary design is considered complete when you sign a contract with PG&E, indicated by step six in Figure 20 as shown on page 42.

Choice of electrical equipment types plays an important role in site design. If your EVSE selection requires an electrical upgrade, you will be installing a new meter and electrical panels or switchgear. The size of this equipment depends on its capacity and may require modifications to your building or lot. Planning for this upgrade should consider the EVSE footprint, safe-distance requirements, allowable or recommended cable lengths and worker access.

If this is likely to be the first of several EV projects at your facility or you think you will add EVs to your fleet over time, you may want to plan for larger future upgrade costs at the onset. Also, be aware that the nature or size of the project may trigger certain regional building code requirements to upgrade the facility, and these costs should be included in your budget development. Your PG&E EV specialist can partner with you to navigate some of these requirements and considerations.

Preliminary design for your EV charging infrastructure (continued)

Questions to ask when developing your design

Your PG&E's EV specialists will work with you to find the optimum solution for your charging and electrification needs. On your path to signing a contract, we'll likely use many of the following questions to help guide the design process:

Question	Points of assessment
What are your fleet's parking logistics and other operational characteristics at the depot?	• Parking location—daytime, overnight • Parking duration—daytime, overnight • Vehicle requirements—turn radius, cargo transfer, washing
What existing surfaces, structures or spaces will support the EVSE that you plan to procure?	• Wall, bollard or overhead features' proximity to current and potential vehicle parking locations • Wall, bollard or overhead features' proximity to your electrical equipment • Level of EVSE exposure to moving vehicles or other hazards
Can your existing electrical equipment support your expected maximum load?	• Transformer and electrical panel capacity ratings • Utility supply
What areas are commonly used for pedestrian activity?	• EVSE hazards to current pedestrian activity • Pedestrian activity as a hazard to EVSE layout
Will you need new electrical services?	• Source of utility power (underground facilities for trenching or boring) • Power level: secondary or primary, transmission • Transformer location for stepping down power to meet EVSE voltage requirements

TERMS YOU NEED TO KNOW

Transmission: The process of moving power in large quantities across long distances

Substation: A set of electric equipment that reduces high-voltage power to a voltage suitable for customer use

Final design and charging infrastructure permitting

As indicated by step seven in Figure 20 as shown on page 42, every EVSE installation requires a building permit or similar nondiscretionary permit. In California, jurisdictions are required to provide an expedited approval process for EVSE permits. Work with your electrical design firm or contractor to learn what information you must provide to be eligible for an expedited review and how to properly prepare and submit the appropriate application forms.

EVSE permit applications typically require information on the proposed site, equipment (including manufacturer), utility service and expected level of use. This information is collected from vendors and contractors during the technology and site assessments previously described during the design phase; PG&E or other utility approval of the project design must be included.

Permit applications are typically completed by your contracted engineer and reviewed by a designated building official for compliance with local building, electrical, accessibility and fire safety codes. Public safety, structural and engineering reviews may also be required. These reviews may be conducted sequentially or concurrently, depending on the jurisdiction and the proposed project. Permit approvals typically take three months including obtaining your utility's approval, but the actual timeline varies by jurisdiction, utility and project complexity. Once a permit is approved, the applicant is required to host a final site visit with a building inspector before beginning construction and commissioning.

Although permit applications may require detailed information on your EVSE, it is advised that equipment should only be purchased once your project has been approved. A project may be rejected under an exemption, or the jurisdiction may request a revision that can only be addressed by changing your equipment type. When developing your project permit and construction timelines, you should build in time for the possibility of a permit revision process and a post-approval equipment delivery period to maintain your planning flexibility and minimize your financial risk.

Execution: construction and electrification of your system

Once the EVSE permit is approved, you can begin construction of your charging infrastructure (see steps nine through 11 in Figure 20 as shown on page 42). This includes installing your EVSE charging equipment and construction of your electrical infrastructure from your panel to your EVSE. Meanwhile, PG&E will finalize the TTM design and prepare for infrastructure construction. Once your construction is complete and has been approved by municipal inspectors, PG&E will build the TTM infrastructure as indicated by step 12 in Figure 20 as shown on page 42. When finished, PG&E will activate and test your electrical service. You and your electrical contractor will test your EVSE equipment to ensure it is functioning and that you have connectivity to your equipment manufacturer network. Once verified, your project is considered complete and PG&E will issue qualifying rebates.

! REMINDER

All behind-the-meter work to install your EVSE must be completed before PG&E can construct its infrastructure to the meter. Lack of coordination of these efforts can significantly extend timelines and even costs.

eVfleet

EXECUTIVE SUMMARY

INTRODUCTION

TRANSITIONING TO ELECTRICITY FOR YOUR FLEET

PG&E EV FLEET PROGRAM FOR MEDIUM- AND HEAVY-DUTY VEHICLES

PG&E EV FLEET ELECTRIFICATION PROCESS

ONGOING MAINTENANCE AND SUPPORT FOR YOUR EV CHARGING INFRASTRUCTURE

CONTINUING THE PROCESS

INTERESTED IN THE EV FLEET PROGRAM?

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Execution timelines

An EVSE electrification project duration depends on a variety of factors. However, in PG&E's experience, the preliminary design phase can take three to five months or more, and the construction phase can take another six to eight months or more. A small project with no infrastructure upgrades may only require utility notification, but projects that fit the scope of PG&E's EV Fleet program require analysis, site inspections, construction and collaboration to produce an optimal solution.

Construction timelines on your property will depend on your site design and chosen vendors. If the wiring is already in place and no ground trenching is required to connect your EVSE to your electrical service, a charging station can typically be installed in one to two weeks. As previously mentioned, if electrical work is required, which is usually the case with any new electrification of a fleet, then the construction period may extend over several months or longer. The type of EVSE you choose will also play a role in estimating timelines. Currently, a growing number of vendors offer Level 2 EVSE as an off-the-shelf product with efficient installation, while DC fast chargers are sold by fewer vendors. A lower-power EVSE may also require fewer infrastructure upgrades than a DC fast charger. Your electrical contractor and EVSE vendor can advise on their timelines and, if appropriate, how delivery and construction can be staggered to minimize disruption to your existing operations.

Finally, the planning and construction for a transformer upgrade is typically a three-month job, but larger projects requiring new equipment such as cabling and substation modifications may require six to eight months or more.

GET IN TOUCH

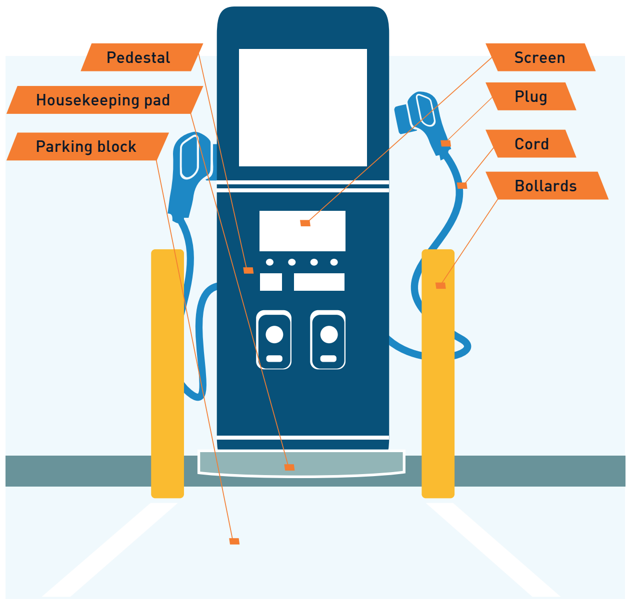
Your PG&E EV Fleet specialist is your go-to contact for everything EV. If you don't yet have an EV Fleet specialist assigned, start here.

Ongoing maintenance and support for your EV charging infrastructure

Ongoing maintenance and support for your EV charging infrastructure

Maintaining your EVSE

FIGURE 22:
Anatomy of an EVSE



Performing maintenance on your EVSE is generally considered simpler than maintaining diesel and gas fueling equipment. Still, maintaining your EVSE will initially involve unfamiliar components and procedures, which may require new training, knowledge and skills.

Fleets can significantly reduce EVSE maintenance by incorporating preventive designs into site planning. During the design stage, ask prospective EVSE vendors about the following measures:

- **Housekeeping pads:** Installing these under EVSE posts can limit exposure to heavy rain, snow and dust.
- **Screen protection:** Using protected screens that are oriented away from direct sun exposure minimizes overheating, avoiding malfunctions.
- **Collision protection:** Installing bollards and clear signage can protect the EVSE from accidental vehicle collision, particularly in poor-visibility conditions.
- **Cord length:** Using shorter cords and/or cord controls to securely store cords when not in use limits your EVSE cord's exposure to moving vehicles and people.
- **Cord management:** Safely storing cords on EVSE dispensers or using cord retractors when not in use will increase safety and reduce the chances of damaging equipment.

Ongoing maintenance and support for your EV charging infrastructure (continued)

Once your EVSE is up and running, incorporating the following best practices into your regular maintenance schedule can help maximize your EVSE's useful life. You can enlist the help of your EVSE vendor to understand and implement these practices:

Best practices

- Turn off the power to your EVSE equipment before conducting maintenance.
- Routinely inspect cords, plugs and cord storage devices for wear and tear or misuse.
- Clean plugs, including pins, with a light detergent and a nonabrasive washcloth to eliminate buildup of grit or grime, which can compromise your EVSE's efficiency.
- For DC fast chargers, inspect air conditioning or other cooling filters for clogs or buildup.
- Inspect area surrounding the EVSE for changes that could compromise the equipment's integrity, such as cracked pavement, flooding, access barriers or compromised building structures (for wall-mounted EVSE).
- Review data reports for unusual results or other signs of error in the network or cloud-based communications platform.
- Compare EVSE data with your utility bills to confirm that the equipment is functioning as intended.

Most EVSE vendors currently offer three-year, five-year and 10-year warranties on their equipment. As a participant in the PG&E EV Fleet program, you agree to maintain your equipment for 10 years, so you may want a warranty to cover the full 10 years. If you are purchasing networking and/or cloud-based communications services, the warranty on these features may be separate. Ask your EVSE vendor to clearly explain what components of your EVSE are covered under warranties and their time frame.

PG&E will maintain our constructed portion of the electrical infrastructure (i.e., pole to the meter) as part of the EV Fleet program.

Continuing the process

eV fleet

Continuing the process

The state of California has set clear goals to increase the numbers of EVs in medium- and heavy-duty fleets by the year 2030 and beyond. The PG&E EV Fleet program has set a goal of establishing more than 700 sites supporting 6,500 EVs. Meeting these goals will require significant expansion in the number of EVSE across the state.

Your first project to set up EV charging to electrify your fleet will likely be the most time-intensive, since you will be working on this with PG&E, vehicle manufacturers and EVSE vendors for the first time. You will likely find that subsequent projects—whether electrifying more vehicles at the same location or expanding to new facilities—become more efficient through established relationships. In any case, following best practices will help you achieve the greatest success:

Best practices

- **Notify PG&E early and often.** Not only are you required to notify any utility in California, but PG&E can be a valuable resource for discovering new equipment solutions and cost-saving opportunities. Take advantage of PG&E's EV Fleet program.
- **Know your fleet vehicle requirements.** Understand your fleet's charging and logistical needs so you can clearly communicate and build everything to support these requirements.
- **Faster is not always better.** Consider the cost and benefit tradeoffs of all charging scenarios and rate structures.
- **Plan for the future.** Design your layout and electrical infrastructure today to support your fleet's needs of tomorrow, minimizing future construction and connection costs.
- **Leverage available support.** Contact your PG&E EV Fleet specialist to get started on your EV journey.

Look for funding. EVSE-supportive programs exist from a variety of sources and will continue to evolve. Track the programs relevant to your business for right-sized opportunities.

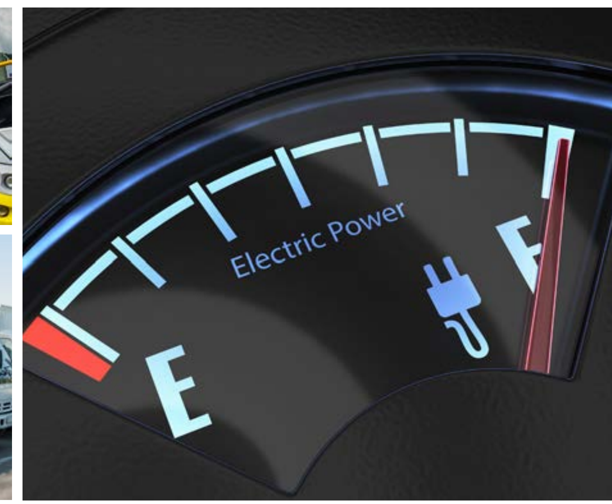
Use our **EV Fleet Savings Calculator.**

Interested in the EV Fleet program?

Ready to learn more about your eligibility for the EV Fleet program and next steps to electrify your fleet? Take the next step. Reach out to your **PG&E EV specialist** or sign up online to get connected.

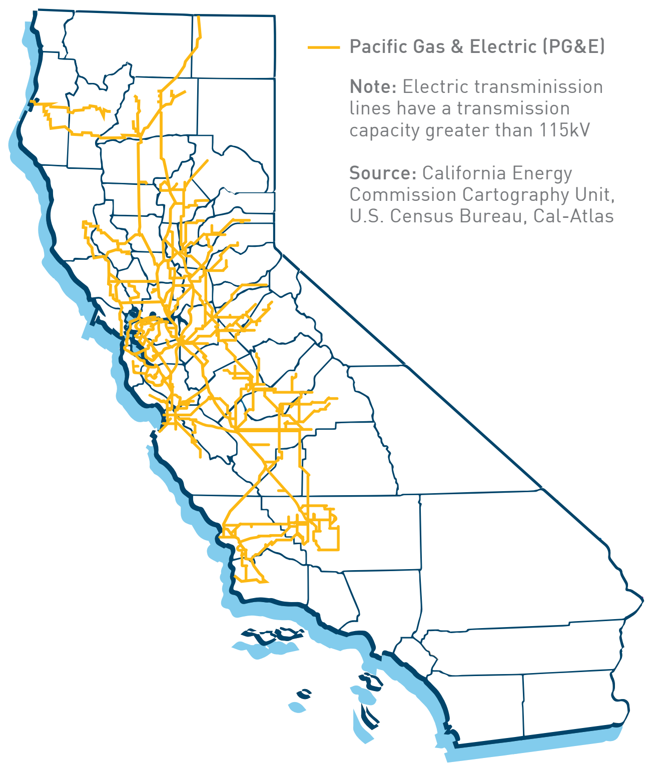
SIGN UP

Appendix



The electric grid: an overview

FIGURE 24:
California's electric grid is managed and maintained by nearly a dozen utilities



PG&E's electric grid consists of more than 106,681 circuit miles of electric distribution lines and 18,466 circuit miles of interconnected transmission lines.

By understanding the basics of how electricity is generated, transported and sold, you can make better decisions regarding your electrical usage and costs—and understand why electricity as a fuel source might be an advantage over your existing gas and diesel fleets. This becomes especially important as you increase your electrical usage to accommodate a much higher demand. The following section will provide an overview of the electrical grid and the role it may play in your EV transition and ongoing operations.

In the simplest terms, electricity is the flow of electrical charge. Electricity is humankind's most widely used form of energy; it powers a wide array of essential electrical devices. The electric grid is the interconnected group of power lines and associated equipment that delivers electric energy to consumers from where it is generated (at high voltage) to where it is consumed (usually at much lower voltage).

PG&E's electric grid consists of transmission lines supported by countless subsystems and components. Using this complex system, PG&E can generate, procure and distribute electricity. To continually ensure that customers receive reliable and affordable electricity, we must carefully manage and maintain portions of the grid within their service territory.

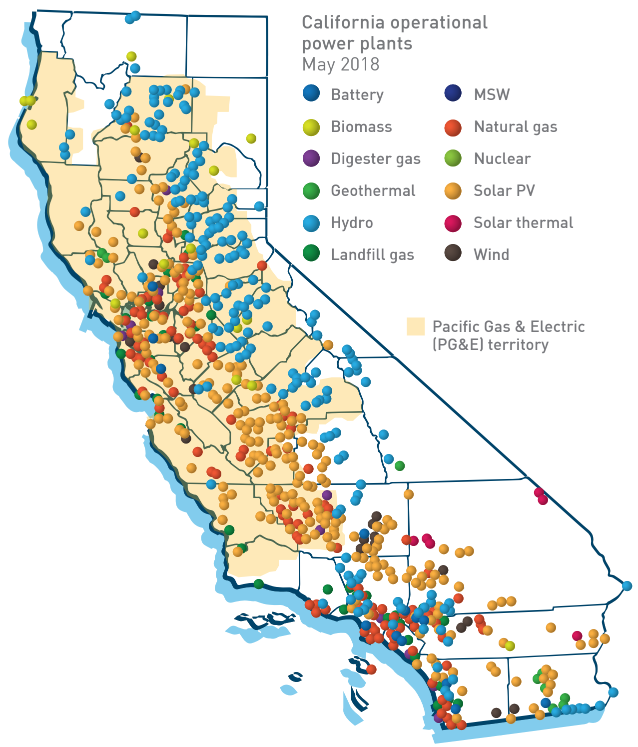
The grid carries electric power, as measured in watts or joules per second. This refers to the rate at which electric energy is (or can be) consumed in an electrical circuit. The grid is a massive, far reaching and nearly omnipresent set of infrastructure that has been called the largest machine in the world. This "machine" draws on a plethora of different sources of power and connects those sources to the countless devices that turn that power into useful work.

The following sections describe key steps in producing electric power and delivering it to users through the grid. They provide basic information to better understand how electric power reaches consumers for use in electrical equipment ranging from light bulbs to electric vehicles and everything in between.

The electric grid: an overview (continued)

Grid 101: generation to distribution

FIGURE 25:
California's electric grid is fed by a variety of fuel sources spread across the state



The electric grid serves as the bridge between power plants and electricity consumers. Most traditional power plants generate electricity by burning fuel such as natural gas to heat steam that then powers large generators. These centralized thermal (heat-based) power plants typically have large space requirements and are located for convenient access to their fuel source (e.g., near a natural gas pipeline or rail terminal). Electrical power can also be produced in smaller or less-centralized plants that use other mechanical energy to turn generators; example power plants of this type use hydro or wind energy. Solar plants work differently; they use photovoltaic cells to absorb sunlight and induce electron flow, thereby generating power. As Figure 25 illustrates, PG&E's electric grid uses all of these types of power generation. Generally, a common trait among power plants is that they are located farther from population centers, where land use is less constrained and where the plants have good access to their primary energy source (that is, natural gas, wind, sunshine and rivers).

To reach consumers, power plants feed electricity into their local grid's network of transmission and distribution lines. As shown in Figure 26, step-up transformers prepare electricity for transmission in large volumes over long distances. These are analogous to water pumps that push water through pipes over hills and across long distances while regulating the pressure (voltage) at critical transition points.

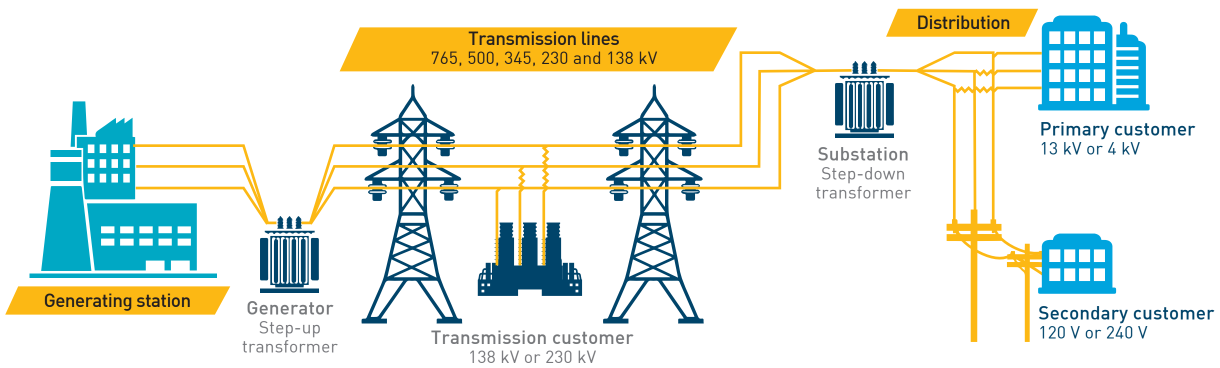
Today, customers also have more options to produce energy with on-site generators or distributed energy resources such as rooftop solar photovoltaic panels, fuel cells, small wind turbines and battery energy storage systems. These distributed energy sources supplement the large centralized power plants by providing some or all of a customer's energy needs. Any customer-owned generation that connects to the grid is coordinated by interconnection requirements that utilities follow to make sure these new smaller generators work safely and reliably with the existing grid.

Generating, transmitting and consuming power involves multiple entities, which means that ownership structures vary across the electricity supply chain. Power plants may be publicly or privately owned. The electric grid is managed by independent system operators and utilities. Utilities also provide maintenance to the grid and collect revenue from consumers for the energy they consume. The prices that consumers pay vary by the time of day and rate at which the electricity is consumed. More details on the key components that go into the price of electricity are provided in the section **Purchasing electricity for your fleet**.

Grid 101: generation to distribution (continued)

Utilities are responsible for expanding the grid's capacity to deliver power as more consumers connect to the system. Utilities also have a key responsibility in sustaining the grid's high reliability, which ensures that the power is there whenever it's needed. This includes ongoing grid maintenance and new infrastructure development to adapt to changes in how people use electricity. One of the recent changes in electricity use is the increasing appeal to power fleets of vehicles. To manage these responsibilities, utilities maintain regular inspection and operational review schedules for power lines, transformers and substations. As more EVs are put on the road, some utilities are developing long-term maintenance protocols for newly laid EV charging infrastructure. On the other side of this equation, consumers who own or operate vehicle chargers—referred to as electric vehicle supply equipment (EVSE)—are responsible for conducting regular maintenance to ensure that their equipment safely and successfully receives power and transmits it to vehicles.

FIGURE 26:
The electric grid carries electrical energy from generators to the end user



Power market 101: how power reaches your fleet

A range of stakeholders coordinate closely to buy and sell electrical power on the grid. The initial vendor is the fuel provider who sells fuel to the power plant at a market-determined price; the power plant owner-operator may also be the fuel provider. Power plants sell the power they produce to utilities at prices determined under a variety of structures ranging from long-term power purchase agreements (PPAs) to last-minute bids for immediate use. These transactions are brokered by an independent system operator (ISO), which ensures that power flow across the grid is balanced, meaning that supply meets demand at all times. This is done by constantly and rapidly matching utility purchase requests with power plant sales bids.

Utilities and community choice aggregators (CCAs) typically use PPAs to support their baseload power, or the minimum amount of power that they expect to provide at any given time. To meet next-daily needs, they buy power as it is bid on the day-ahead market, where market participants purchase and sell electric energy at financially binding prices for the following day. Finally, to meet minute-to-minute needs, utilities buy power as it is bid on the spot market under immediate market conditions. This is typically the power with the most volatile pricing, with high costs during peak loads and low costs during low demand times of day.

TERMS YOU NEED TO KNOW

PPA: Power purchase agreement, a contract for one entity to delivery power to another over a defined period of time

CCA: Community choice aggregation, an alternative to the investor-owned utility energy supply system in which local entities aggregate buying power within a defined jurisdiction

ISO: Independent system operator, an entity that monitors, coordinates and directs operations on the electric grid

Day-ahead market: Market on which power is traded for next-day delivery

Spot market: Market on which power is traded for immediate delivery

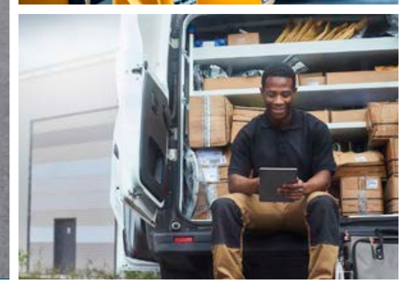
Power Market 101: How Power Reaches Your Fleet (continued)

While utilities pay a range of prices to maintain balance in their service territories, they bill their customers at a predetermined rate that accounts for these fluctuations over the course of a billing cycle. Utilities' approaches to establishing these rates vary by their structure (Figure 27). PG&E is an investor-owned utility (IOU), one of the types that propose and request rate approval from the California Public Utilities Commission (CPUC). Publicly owned utilities (POUs), also known as municipal utilities, apply rates set by their governing board or city council. The electricity rate structures used by many utilities result in a time-of-use price of power for an EV fleet that can vary throughout the day, offering lower prices at less busy times (like late at night) and higher prices when energy use is highest across the grid. Further discussion on electricity rates as they affect your bill is provided in the section **Purchasing electricity for your fleet**.

FIGURE 27:
Key structural differences between IOUs and POUs

Investor-owned utilities (IOUs)	Publicly owned utilities (POUs)
Owned by shareholders or investors in and outside the service area	Owned by citizens or local government body in service area
Private, for-profit	Public, not-for-profit
Regulated by a state agency	Regulated by its elected board

Glossary



Glossary

Amperage: A measure of the flow of electrical charge

Average power: The average amount of power that your fleet requires at any given time while charging

BEV: Battery electric vehicle is a specific term used to distinguish it from a plugin hybrid electric vehicle (PHEV).

CCA: Community choice aggregation, an alternative to the investor-owned utility energy supply system in which local entities aggregate buying power within a defined jurisdiction

Charge rate: The rate at which a battery can charge, measured in kilowatts (kW)

Charging window: The period of time in your fleet's duty cycle when vehicles can charge, measured in hours

Day-ahead market: Market on which power is traded for next-day delivery

DCFC: Direct current fast charge, usually stated as DC fast charge

Distribution: The process of delivering power from transmission lines to the customer

Duty cycle: The proportion of time during which a vehicle is operated.

EV: An electric vehicle

EV demand: The amount of power supplied to EVs during charging

EVSE: Electric vehicle supply equipment, or the charger unit

Generation: The process of producing electricity from a fuel or other energy source

IOU: Investor-owned utility

ISO: Independent system operator, an entity that monitors, coordinates and directs operations on the electric grid

kWh: Kilowatt-hour, the unit of measure for electrical energy

Load profile: The amount(s) of power that your fleet requires on an hourly basis over the course of a day

LCFS: Low Carbon Fuel Standard (California)

Meter: A device that records the amount of power flowing through a circuit

PPA: Power purchase agreement, a contract for one entity to delivery power to another over a defined period of time

POU: Publicly owned utility

Peak shaving: A strategy to reduce power consumption during periods of high demand

Rate structure: A set of parameters used to define the prices that a customer may be charged for power over time

ROM: Rough order of magnitude, an estimation of a project's level of effort and cost to complete

Spot market: Market on which power is traded for immediate delivery

Substation: A set of electric equipment that reduces high-voltage power to a voltage suitable for customer use

Transformer: An electric device that changes electricity from one level of voltage to another

Transmission: The process of moving power in large quantities across long distances

Voltage: Electrical pressure created by a difference in electrical potential

ZEV: Zero emission vehicle

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