SDGE A Sempra Energy utility®

Power Your Drive *for* Fleets

ELECTRIC VEHICLE CHARGING GUIDEBOOK FOR MEDIUM- AND HEAVY-DUTY FLEETS

Who Is This Guidebook For?

This guidebook is designed to help fleet managers and decision-makers involved in any stage of the fleet electrification process. Sections of particular value for readers in specific fields are identified by placing the appropriate icons (below) in the bottom right corner of each page.

Fleet Management

Executives

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EXECUTIVE SUMMARY

Executive Summary

The transportation sector currently accounts for the largest portion (41 percent) of total statewide greenhouse gas emissions in California, and is a major contributor of local air quality pollutants. Medium- and heavy- duty (MD/HD) commercial vehicles account for an outsized share of these emissions on a per-vehicle basis. Reducing emissions by electrifying these fleets offers major environmental benefits, and supports the local, state and federal climate targets designed to create a more efficient, affordable and clean energy future.

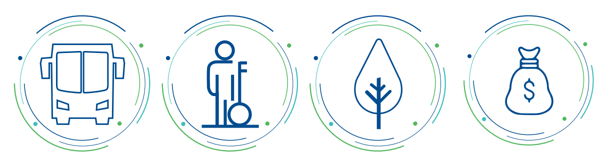
Innovations in vehicle technology, electrical infrastructure and energy storage are encouraging fleets to introduce battery-powered electric vehicles (EVs) into their operations through small pilots as well as bulk orders. Policymakers and funding agencies in California—and around the world—are motivating this transition by opening up funding opportunities that enable fleets to overcome cost barriers to adoption.

Recent studies show that the majority of early adopter fleets that are transitioning to electricity are primarily motivated by both the environmental benefits and the reduced total cost of ownership (TCO).[1]

EVs generally have lower maintenance costs than conventionally fueled vehicles, as well as reduced total fuel costs, particularly on fixed route, return-to-base duty cycles. Their efficient powertrains, regenerative brakes, and predictable fuel prices all help fleets reduce their costs. **Additionally, investing in EVs today avoids the risk of non-compliance with existing and future legislation that place zero-emission requirements on various segments of the transportation sector.**

Reliable and affordable charging infrastructure is a key component of successful vehicle electrification. Fleets must have confidence in any equipment that they purchase or plan to use in a public space. In this guidebook, you will learn the basics of selecting, installing, operating and maintaining the best fit charging solution for your fleet.

You'll also get important information on SDG&E's services and funding programs, and how your utility can help you throughout the fleet electrification process.



[1]*State of Sustainable Fleets Report - 2020:* https://www.stateofsustainablefleets.com/

Power Your Drive *for* Fleets

INTRODUCTION

Introduction

A wide array of funding resources are available today to help California fleets go electric. The selection of MD/HD models is rapidly expanding, with a growing number of manufacturers electrifying chassis for a variety of applications. The number of reliable charging solutions has similarly grown, offering fleets multiple styles and power ratings from which to select the best fit for their fleet.

This guidebook walks you through the key steps of selecting, installing and maintaining a charging solution that meets your needs. Each section is supported by sample calculations, average industry costs and key term definitions, along with educational graphics for your general reference.

After reading this guidebook, you will be able to:

- Estimate your fleet's baseline energy needs and charging time requirements.
- Identify the charging equipment options that meet your fleet's physical interface, charge time, and cost requirements.
- Develop charging station configurations that work with your facility's existing space, support current and future operations, maximize equipment lifecycles, and control costs.
- Identify the right entities to engage for project design, permitting, and construction.
- Discuss important details of your electric service and electricity price bands with your utility.
- Find funding opportunities to reduce your total project costs.

This guidebook has been designed to provide a comprehensive overview of the EV charging station procurement process for MD/HD fleets. When developing your charging solution, it is critical that you consult your vehicle manufacturer, local utility, local jurisdiction, and other relevant entities for project-specific guidance.

Visit sdge.com/evfleets to learn more about SDG&E's Power Your Drive for Fleets program for commercial fleets, and complete our Interest Form to connect with a Customer Solutions Team Member about your project.

Wondering how the electric grid works?
Check out our 101 guide in the **Appendix.**

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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 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 your current fleet. Others introduce new concepts that are unique to EVs.

Regardless of your fleet's specific needs and transition schedule, 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 ensuring that your EVs are charged and deployed to best fit your fleet's duty cycles and bottom line.

This section provides strategies and examples to help you answer key questions about energy requirements, charging equipment options, and site design.

Your SDG&E Customer Solutions Team Member can advise you at any point during the electrification process. For a complete list of charging equipment approved under the Power Your Drive for Fleets program, check out the **Approved Product List** at **sdge.com/evfleets.**

Terms 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 portion of time during which a vehicle is operated

EVSE: Electric vehicle supply equipment, or the charger unit

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

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

Defining Your Fleet's Charging Needs

The first step of developing your charging infrastructure is to understand how much electricity your vehicles will need and when, over the course of a typical day. Known as your load profile, this information enables you to choose the appropriate equipment to charge your EVs in a timely and cost-effective manner, and to forecast your electricity costs The examples on the following pages walk you through the calculations to complete your load profile.

A good place to start is to work with your vehicle manufacturer to estimate the amount of energy your EV needs to complete your specific duty cycle. This will be calculated in terms of kilowatt-hour (kWh) per mile (or kilowatt-hour per hour for some vocational fleets). Note that while traditional fuel economy is better when the number of miles per gallon is higher, with electricity it is better when the number of kWh per mile is lower. The lower your energy-per-mile, the less energy you use to travel that distance. Keep in mind that as with conventionally fueled vehicles these are estimates and subject to change with your payload. Some typical energy consumption rates are illustrated in Figure 1.

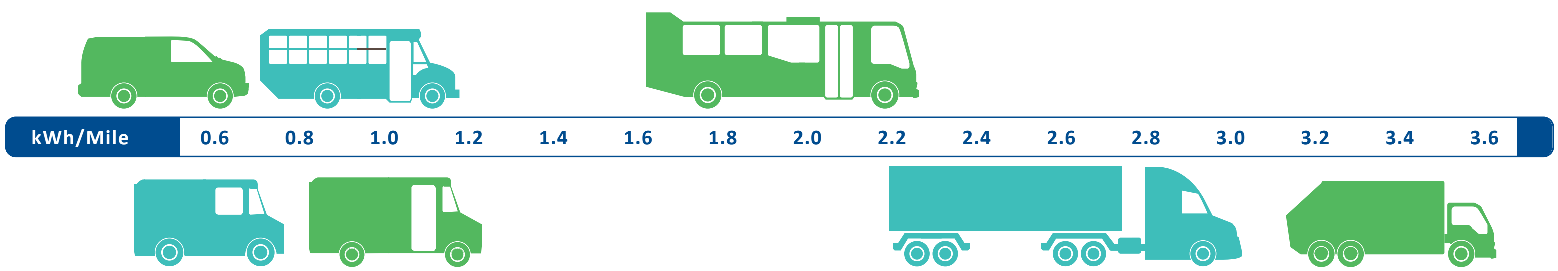

Figure 1: Typical EV consumption rates for medium- and heav-duty vehicles.

Defining Your Fleet's Charging Needs (Continued)

Using your estimated EV fleet energy consumption rate, use the following steps to calculate your basic load profile:

❶ Calculate the amount of **energy needed per charge** per vehicle. This is the energy consumption rate (kWh per mile) multiplied by the miles traveled between charging events.

❷ Calculate the **total energy requirement** for your fleet. This is simply the sum of the energy requirements for each vehicle plugged in during that charging window.

❸ Identify your vehicles' charging windows. For example, if all of the vehicles at the fleet yard are available for charging between 6:00 PM and 4:00 AM, then there is a 10-hour charging window during which the electricity can be delivered to the vehicles. This allows you to calculate your fleet's average power demand, or **average energy required to charge**.

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)

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Defining Your Fleet's Charging Needs (Continued)

Vehicles that are only available to charge 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 an electrical system to operate at peak power, or the maximum level at which it can deliver power in a short period of time. Figure 2 *(right)* illustrates the difference in power demand when vehicles are charged over a ten-hour window (requiring 70 kW peak power) versus a four-hour window (requiring 175 kW peak power).

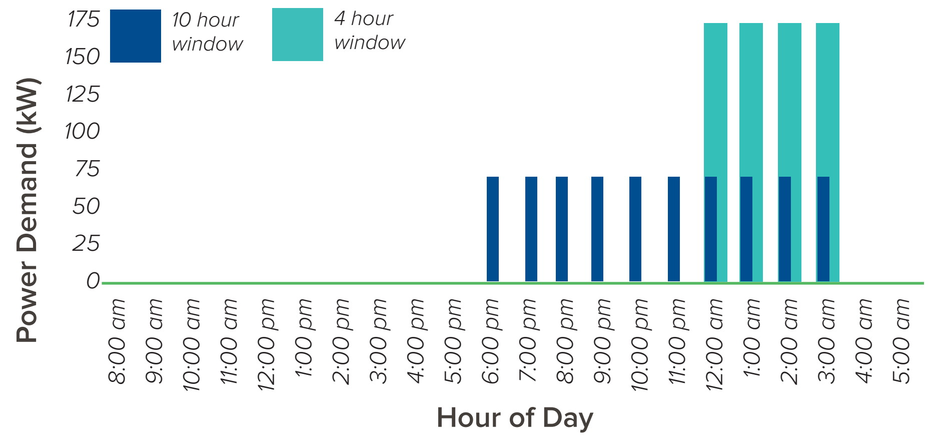


Figure 2: Power demand over 4- and 10- hour charging windows.

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

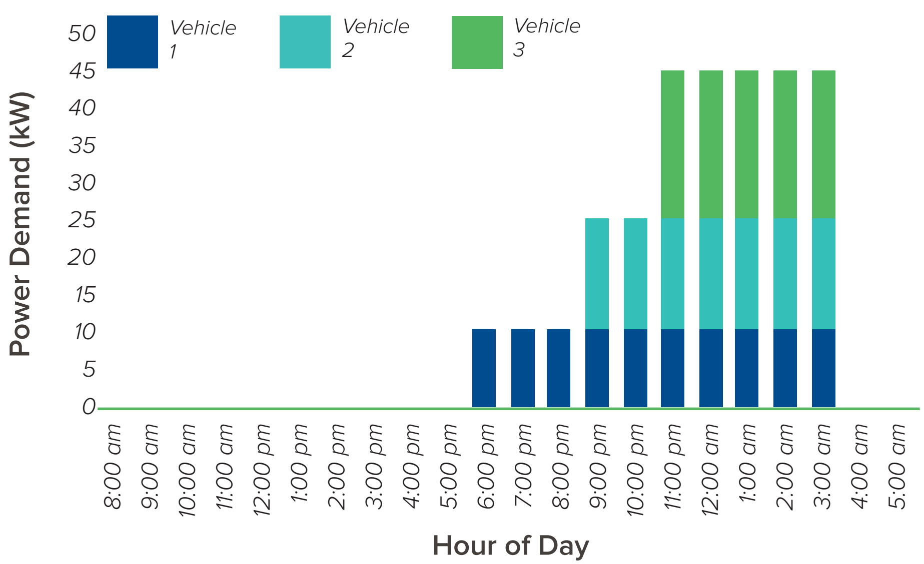


Figure 3: Power demand for multiple vehicles with different charging windows due to arrival times.

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 3 *(left)* 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 3, all vehicles must depart at 3 AM but Vehicle 1 arrives at 6 PM, Vehicle 2 arrives at 9 PM, and Vehicle 3 arrives at 11 PM, allowing for a 9-hour, 6-hour, and 4-hour charging window, respectively. Your fleet may have multiple charging windows per day, depending on when and how vehicles are utilized.

Three Examples for Estimating Your Basic Load Profile

To further illustrate the process of determining basic load profiles, we will use the following examples to calculate a fleet's total energy demand and average power demand during a charging window, as well as the average charging rate per vehicle. These values will be used later to inform infrastructure options and electricity prices.

These examples illustrate three different per-vehicle charging rates, ranging from 7 kW to 82.5 kW. If your fleet's per-vehicle charging rate is greater than the actual charging rate that your EVs can support, you must either select a different EV or extend your charging window so that you can reduce your charging rate. For example, if you need to charge at a rate of 50 kW per EV (to fulfill the requirements identified in the previous exercise), but the EV you have selected can only accept a charge rate up to 25 kW, your charging scenario does not work for your selected EV model.

❶ EXAMPLE 1: CITY DELIVERY VANS

A fleet of 10 delivery vans uses 0.7 kWh of electricity per mile, each. All vans travel an average of 100 miles per day. They return to the fleet yard by 6:00 PM and must be ready to depart by 4:00 AM.

❷ EXAMPLE 2: LOCAL CLASS 8 TRUCKS (SINGLE SHIFT)

Ten Class 8 semi-tractors each 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 8:00 PM and must be ready to depart by 4:00 AM.

❸ EXAMPLE 3: LOCAL CLASS 8 TRUCKS (TWO SHIFTS)

Ten Class 8 semi-tractors 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 12:00 PM and must be ready to depart by 4:00 PM. The second shift returns to the fleet yard by 12:00 AM and must be ready to depart by 4:00 AM.

Three Examples for Estimating Your Basic Load Profile (Continued)

❶ EXAMPLE 1: CITY DELIVERY VANS

A fleet of 10 delivery vans uses 0.7 kWh of electricity per mile, each.

All vans travel an average of 100 miles per day. They return to the fleet yard by 6:00 PM and must be ready to depart by 4:00 AM.

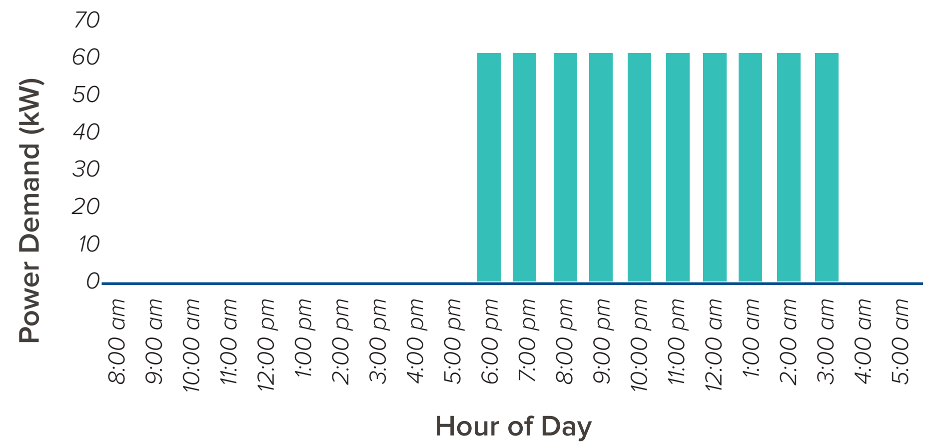


Figure 4: Average power demand for 10 delivery vans overnight.

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 6:00 PM and must be ready to depart by 4:00 AM. 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 4).

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 vans.

Per-Vehicle Charging Rate (kW)
=
70 kW / 10 vans
=
7 kW / van

Three Examples for Estimating Your Basic Load Profile (Continued)

❷ EXAMPLE 2: LOCAL CLASS 8 TRUCKS (SINGLE SHIFT)

Ten Class 8 semi-tractors each 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 8:00 PM and must be ready to depart by 4:00 AM.

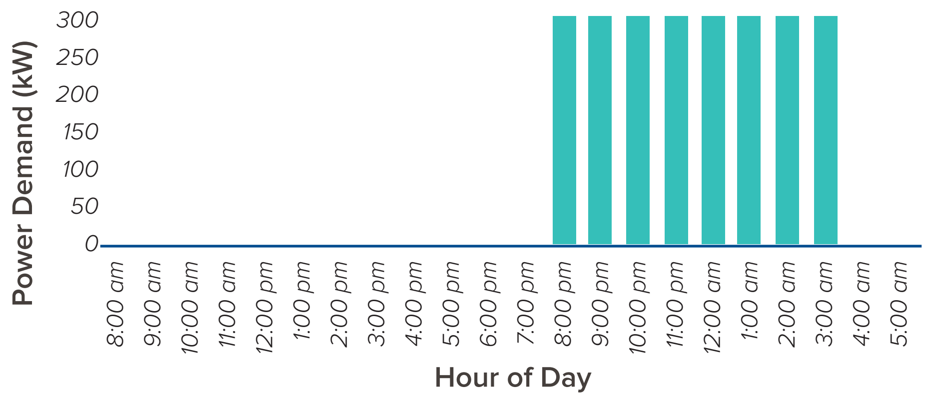


Figure 5: Average power demand for 10 heavy-duty trucks over 1 shift

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 8:00 PM and must be ready to depart by 4:00 AM. Therefore, the charging window is **8 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)
=
2,200 kWh / 8 hours
=
275 kW

Per-Vehicle Charging Rate

Per-Vehicle Charging Rate (kW)
=
275 kW / 10 trucks
=
27.5 kW / truck

Three Examples for Estimating Your Basic Load Profile (Continued)

❸ EXAMPLE 3: LOCAL CLASS 8 TRUCKS (TWO SHIFTS)

Ten Class 8 semi-tractors 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 12:00 PM and must be ready to depart by 4:00 PM. The second shift returns to the fleet yard by 12:00 AM and must be ready to depart by 4:00 AM.

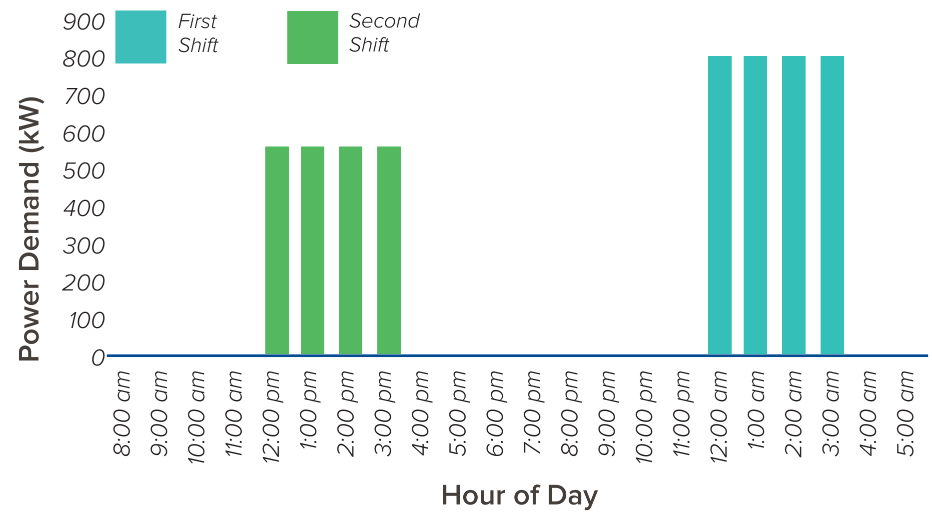


Figure 6: Average power demand for 10 heavy-duty trucks over two shifts.

Charging Window Energy Requirement

First Shift Energy (kWh) =
10 vehicles x
150 miles/vehicle/day x
2.2 kWh/mile =
3,300 kWh/day

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

Charging Window

The first shift returns to the fleet yard by 12:00 AM and must be ready to depart by 4:00 AM. The second shift returns to the fleet yard by 12:00 PM and must be ready to depart by 4:00 PM. Therefore, the charging window is **4 hours** for each shift.

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 6).

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 conventional fuel in several ways. When buying electricity (for charging EVs or otherwise), there are two primary sources–SDG&E and a community choice aggregator (often referred to as a CCA).

As a SDG&E customer, you are billed according to your rate plan's structure, which defines the prices charged to different kinds of customers (i.e., residential, commercial, industrial, agricultural) and over different time frames throughout the day (i.e., peak and off-peak). As state policies push for an increase in EV deployments, SDG&E has proposed a fleet-focused subscription-based rate plan that protects fleets from high demand charges and provides greater bill stability. This High-Power (EV-HP) plan allows customers to pay a subscription fee according to the amount of power that they need to charge their vehicles–similar to an internet plan that allows you to choose your download speed. If approved by the California Public Utilities Commission, the EV-HP plan will be implemented in early 2021. Until then, SDG&E is offering a rate waiver to incentivize fleets to flip the switch on EVs now.

Identifying the right rate structure for your fleet can be complex. This section describes key components of SDG&E's proposed fleet plans and presents opportunities for you to manage your charging costs.

Terms to Know

Demand: The amount of power that a site or piece of equipment requires to charge at a given time, also referred to as "load"

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

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

SDG&E Commercial Electric Rate Plans

Commercial customers have a choice of rate plans:

Time-of-Use (TOU)
Customers are billed different prices for power consumed at different times of day, and seasons of the year. SDG&E offers plans for small, medium and large commercial customers, with two and three distinct pricing periods.

Interim Rate Waiver
Customers that meet SDG&E's Power Your Drive for Fleets program requirements can use the small commercial TOU-M rate plan, which has a lower demand charge than the medium- and large- commercial TOU rate plans.

Event Day
Customers agree to reduce their energy use between 2 PM and 6 PM with one day's notice from SDG&E, on at most 18 days per year. In return, they may receive credits on their utility bill, or avoid penalizing fees.

Additionally, the following charges may appear on your bill:

Fixed Charge
A monthly fee covering the regulator-approved costs that SDG&E pays to supply power, such as distribution and transmission ($/month).

Energy Charge
The baseline price of electricity, charged based on the amount of energy consumed ($/kWh).

Demand Charge
A fee applied to the greatest power draw during peak periods, on top of the rate that you pay for the energy ($/kW).

Visit sdge.com/interim-rate-waiver
for more on getting a reduced rate for your EV fleet today.

Opportunities to Manage EV Charging Costs

Charging your vehicles during off- and super off-peak periods will reduce your overall energy costs, as shown in Figure 7 *(right)*. Under SDG&E's TOU-M rate, shifting power use from the on-peak to off-peak periods can achieve a greater than 50 percent cost savings on your bill. You can achieve further cost savings by strategically managing your load so that your fleet's total power consumption at any given point in time remains below a certain threshold, lowering your monthly demand charge.

TOU-M Energy Charges for Bundled Customers		
	Summer	Winter
Peak	$0.39	$0.16
Off-peak	$0.19	$0.16
Super Off-peak	$0.11	$0.11

Figure 7: Time-of-use rate chart.

Seasonal rates may be applied when the cost of transmitting power rises due to weather-related conditions that prompt changes in customer behavior, such as increased use of air conditioning during hot summer months. Utilities may also apply a power factor adjustment, which basically measures how efficiently your 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.

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

Energy Cost

You are billed under a TOU rate structure with three rate periods: super off-peak ($0.11), off-peak ($0.16/kWh), and peak ($0.39 in the summer). Last month, your fleet consumed 15,000 kWh/day, evenly distributed across all three rate periods. With your fleet consuming 5,000 kWh per rate period, your energy costs would be calculated as follows:
(5,000 kWh x $0.11) + (5,000 kWh x $0.16) + (5,000 kWh x $0.39) = $3,300

Demand Charge

Under your rate plan, you are assessed a demand charge of $10/kW for energy consumed during the peak period. Last month, your fleet's highest demand on the grid during peak periods was 120 kW. In addition to the $3,300 energy cost, your utility charges you for this demand as follows:
(120 kW x $10/kW) = $1,200

Total Electricity Cost

Under your TOU rate structure, your total charge is the sum of your energy cost and your demand charge:
$3,300 energy cost + $1,200 demand charge = $4,500 total electricity cost

Note: Charging management software can automatically start and stop charging to reduce electricity costs, as an alternative to manually plugging in vehicles on a specific schedule.

Opportunities to Manage EV Charging Costs (Continued)

Another method to reduce your total costs is known as peak shaving. Customers move power consumption to off-peak periods, or rely on on-site energy storage during peak periods, to avoid high base energy costs and demand charges.

Revised Demand Charge
(60 kW & $10/kW) = **$600 demand charge**

Revised Total Electricity Cost
(5,000 kWh x $0.11) + ($7,500 kWh x $0.16) + (2,500 kWh x $0.39) + (60 kW x $10/kW) = **$3,325 total electricity cost**

You may have noticed that the demand charges in the previous example comprise more than 30 percent of your total electric bill. You realize that while you are benefitting from the off-peak and super off-peak periods, some of your chargers are available during the off-peak periods, and your vehicle schedule has room for adjustment. After making some internal calculations, you shift 50 percent of your peak consumption to an off-peak period by starting charging earlier in the morning. This reduces your peak power demand from 120 kW to 60 kW, saving you $600 per month.

Customers that enroll in SDG&E's interim rate waiver, or the forthcoming EV-HP plan, can expect to see reduced EV charging costs. However, you will have to separate your EV fleet's load from the rest of your facility's load by installing a dedicated meter, which is a requirement of the Power Your Drive for Fleets program. This allows SDG&E to bill only your EV energy consumption at the discounted rate. It also allows you to track your fleet's energy consumption, which can inform your fleet management strategy.

Even if you are not required to install a separate meter for your EVSE, there are some operational and financial benefits to separating your EV consumption from the rest of your facility's electric needs. Specific considerations are listed below.

- 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 owners may be eligible to earn carbon credits with the energy used to charge their vehicles. LCFS credits can then be sold at a market-determined price. Current credit prices equate to $0.20-$0.30 per kWh for MD/HD vehicles.[1] 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 low-cost data source, although some EV manufacturers may include energy use data as part of their on-board diagnostic software. Your vendor can advise if their technology includes this option.

If adding your new EV demand to your existing utility account does not tip your entire facility's load into a new rate category–and you do not need to track your energy consumption for a grant, LCFS program, or other opportunity–then it may be appropriate to add your EVSE to your existing account.

[2]https://ww3.arb.ca.gov/fuels/lcfs/credit/lrtmonthlycreditreports.htm

Networking and Cloud-based Services

EVSE vendors may offer a networking service using a cabled or wireless internet connection, or a 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.

It can also open up revenue streams, with payment collection features and user interfaces. Most EVSE that utilize the Open Charge Point Protocol (OCPP) are compatible with most network providers, but it may be necessary to integrate the EVSE into the network provider's systems (in the case where the EVSE provider does not offer its own networking service). EVSE that use only proprietary communication protocols are likely to only communicate with the EVSE vendor's network services, restricting your choices.

Most EVSE and network vendors offer networking and cloud-based services for an up-front cost plus a monthly fee (typically amounting to $100-$900 per cord, annually). 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% 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.

Similarly, since **SDG&E's Power Your Drive for Fleets program requires participants to share EVSE use data for at least 5 years**, it is important to understand your EVSE's reporting functionality.

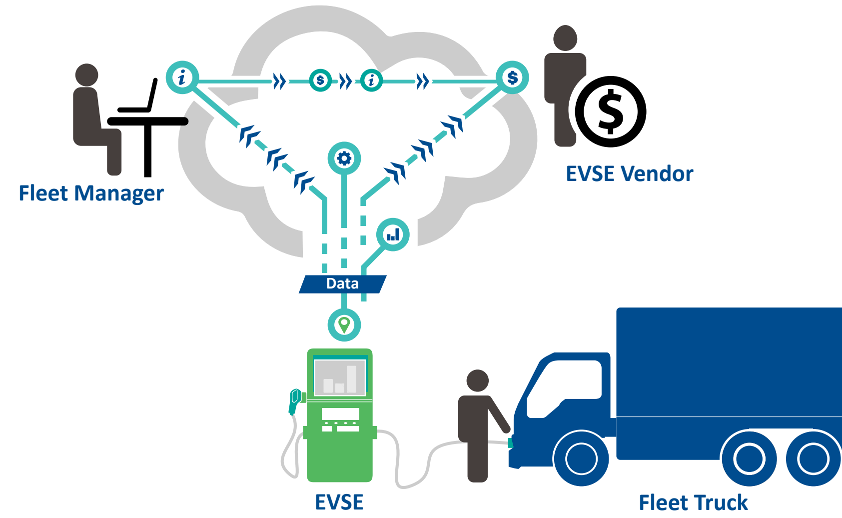


Figure 8: Cloud-based services allow fleet managers, EVSE vendors and EVSE users to share data and even payments over a wireless connection. Networked EVSE allow fleet managers to collect a smaller set of data from their EVSE.

Terms to Know

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

Energy Management Best Practices

The previous sections described ways that managed charging, dedicated meters, and networked or cloud-based services can help fleets electrify in a cost-effective and operationally feasible manner. Energy storage and emergency preparedness are additional strategies to consider.

Energy Storage

Energy storage refers to any technology that can store electrical energy over a period of time. Having a steady power reserve (e.g., a large battery) can be valuable to fleets that need to charge during peak times but would like to avoid demand charges, or that receive 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 pre-paid power when prices are high or electricity is not available. This behavior reduces the fleet's exposure to volatile prices and operational interruptions.

Batteries are the most common form of energy storage technology, and they are available in a range of capacities, physical sizes, and chemistries. Some fleets are exploring recycling EV batteries to serve their on-site storage needs, as well. Depending on your basic load profile, EVSE options, and level of power supply, energy storage may be a useful option.

Emergency preparedness

SDG&E has made extensive investments to protect its customers from outages, but interruptions do occur. Developing an emergency preparedness plan can protect your EV fleet during an outage. When developing the right plan for your fleet, consider the following points:

- Under emergency conditions, your fleet may not require the same amount of energy as you identified in your basic load profile. A backup energy source should be sized appropriately.
- Energy storage and on-site generation are two ways that many companies are adding resiliency to their operations. A variety of technologies are available to help you keep your fleet charged during an outage.
- Outages occur for a variety of reasons. Consult with your Customer Solutions Team Member to understand the level of risk in your area.

Understanding Your EVSE Options

There are multiple EVSE styles and configurations, each offering different tradeoffs between depot space, equipment cost and charging time. Identifying the right fit for your fleet is critical to maximizing your cost saving opportunity. This section describes the key components of an EVSE project that you should consider when designing for your fleet's charging facility.

EVSE Interfaces

There are three basic types of EVSE: plug-in, overhead, and wireless. Each type is briefly described in Figure 9 *(right)* with supporting details in the paragraphs below.

	Plug-In	Overhead	Wireless
Activation	*Manual*	*Automated*	*Automated*
Connection	*Conductive*	*Conductive*	*Wireless (Inductive)*
Power Range	*Up to 350 kW*	*Typically 350-500kW*	*Up to 500kW*
Voltage Type	*AC, DV, and AC+DC*	*DC*	*AC*

Figure 9: Basic EV charging interface types.

Plug-in charging is done by manually plugging a charging cord into an EV's charging receptacle. This is by far the most common interface used today. These EVSE are considered "conductive" systems, because power is transferred to the vehicle by conductors in the plug and receptacle. 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 charge EVs by connecting to a DC fast charger using an overhead connecting arm, or pantograph. Because the pantograph can handle large conductive equipment that would be difficult for a person to handle, overhead systems can charge at higher power levels than most plug-in systems. Currently, overhead charging is mostly used in certain 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 non-conductive interface that transfers power from a ground-mounted "transmitter" coil to a receiving coil attached 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 or is used to directly charge the battery using additional power electronics on the vehicle. Wireless charging systems with power levels as high as 500 kW have been demonstrated, but lower power levels down to 3 kW are also possible. Wireless charging typically requires retrofitting the receiving coil to an EV because vehicle manufacturers do not currently offer wireless EV charging interfaces as an integrated option.

Understanding Your EVSE Options (Continued)

	Plug-in	Overhead	Wireless
	Manual Conductive	Automated Conductive	Automated Wireless (Inductive)
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	• No delay waiting for personnel to connect EV • Similar subsurface work as manual systems • Improved worker safety • Reduced operator error	• No delay waiting for personnel to connect EV • No cable management • Reduced vulnerability to damage • Improved worker safety
Cons	• Requires personnel to connect vehicle before charging • Cable management	• Cable management/connection • Higher capital cost per port • Large footprint • Parking misalignment can prevent charging	• Higher capital cost per port • Requires vehicle retrofit to incorporate interface • Parking misalignment can prevent charging • Requires extensive subsurface work

Figure 10: Advantages and disadvantages of EV charging interface types.

Charging Levels: AC versus DC

In addition to the physical interface types described, EVSE are further divided according to whether they provide AC (alternating current) or DC (direct current) charging.

AC chargers essentially pass power from the utility to the vehicle, where on-board electronics convert the AC power to the DC format 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. This charging level is frequently referred to as Level Two.

Above 20 kW, the electronics required to convert power from AC to DC are placed outside the vehicle. This is a DC Fast Charger (DCFC), which does the work of converting power into a DC format so that it can be delivered directly to a vehicle's battery at relatively high speeds.

Currently, most MD/HD EVs in the U.S. are equipped with at least one of three plug-in charging interfaces, commonly referred to as charging standards.

Lower power charging (<20 kW) is typically specified with a J1772 AC interface while higher power charging (25 - 50 kW) is often specified with either a Combined Charging System Type 1 (CCS-1) or CHAdeMO standard.

Above 50 kW, most vehicles will be equipped with a CCS-1 DC charging standard. These interfaces are summarized in Figure 11 *(next)*, alongside other current and emerging non-proprietary standard.

Charger Interfaces in the U.S.

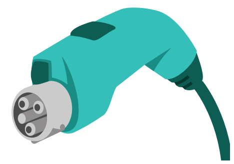
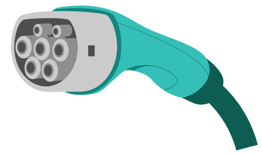
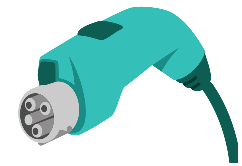
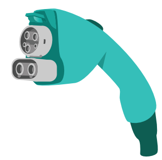
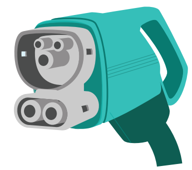
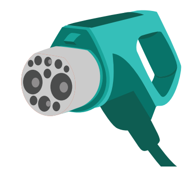
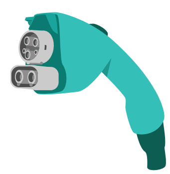
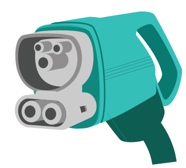
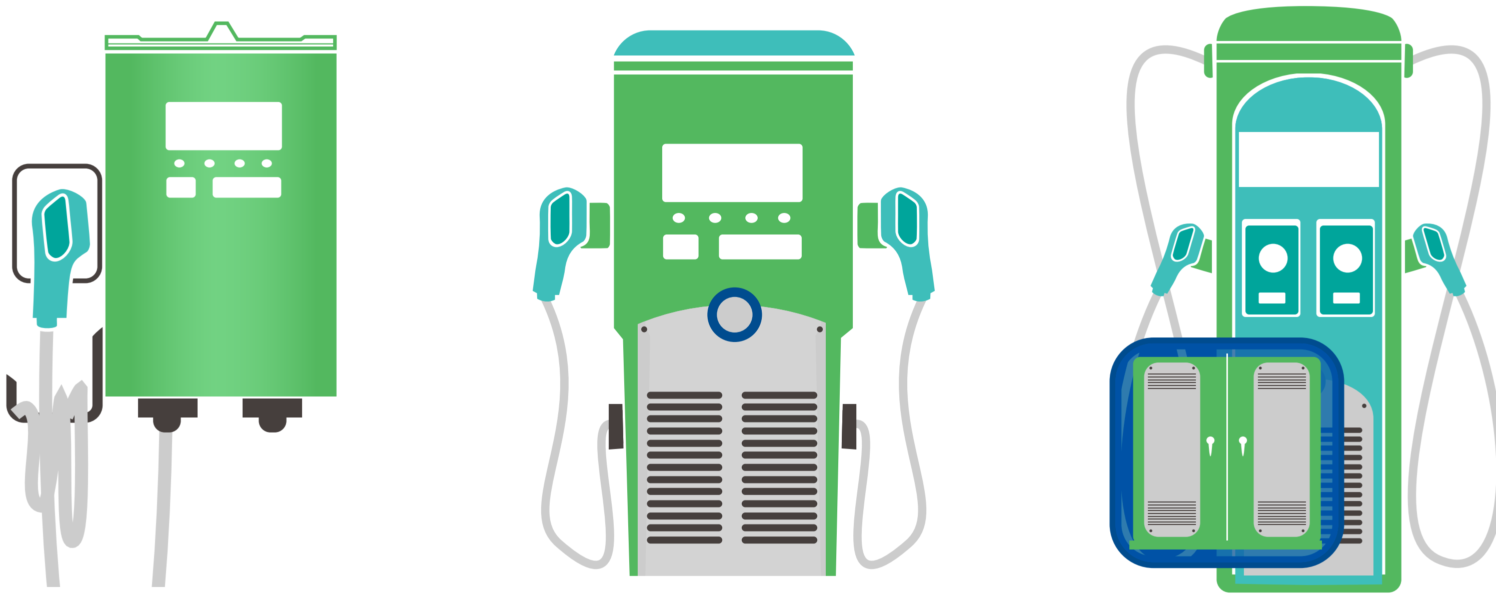
	SAEJ1772	SAEJ3068	CHAdeMO	GB/T 20234
AC	 **SAE J1772 AC** **Charging Rate:** Up to 20 kW **Supply Voltage:** 120/240V/208V **Supply Amperage:** Up to 80A	 **SAE J3068 AC_6** **Charging Rate:** Up to 133 kW **Supply Voltage:** 208-480V 3P **Supply Amperage:** Up to 160A	**NOT AVAILABLE**	 **GB/T 20234 AC** **Charging Rate:** Up to 40 kW **Supply Voltage:** 240V/480V **Supply Amperage:** Up to 63A
DC	 **Combined Charging System** (CCS Type 1) **Charging Rate:** Up to 350 kW (DC) **Supply Voltage:** 480V **Supply Amperage:** Up to 500A	 **SAE J3068 DC_8** **Charging Rate:** Up to 200 kW (DC) **Supply Voltage:** 480V 3P **Supply Amperage:** Up to 200A (DC)	 **CHAdeMO** **Charging Rate:** Up to 400 kW (DC) **Supply Voltage:** 208-480V 3P **Supply Amperage:** Up to 500A	 **GB/T 20234 DC** **Charging Rate:** Up to 238 kW **Supply Voltage:** 480V 3P **Supply Amperage:** Up to 300A
AC + DC	 **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	 **SAE J3068 AC_6/DC_8** **Charging Rate:** Up to 133 kW (AC) or 200 kW (DC) **Supply Voltage:** 208-480V 3P **Supply Amperage:** Up to 160A (AC) or 200A (DC)	**NOT AVAILABLE**	**NOT AVAILABLE**

Figure 11: EVSE Connection Standards; while the DC and AC+DC connector nozzles look idential in the SAE category, the AC pins are only installed in the AC+DC version.

DC Fast Chargers

DC fast charging is often preferred by commercial fleets because it reduces the charging duration. These chargers are available in a various sizes and power capacities, with maximum power ratings currently ranging from 25 kW to over 350 kW. Wall box or pedestal-mounted units are typically available in the lower end of the power range while integrated power 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 split power among multiple dispensers. A DC charger that is rated for more than 150 kW typically requires liquid cooling of the cable assembly, increasing the charger's footprint and often shortening the cable length. Keeping charging power levels below 150 kW will increase your options for equipment style and cable length as well as reduce equipment costs.



Wall Box / Pedestal Mount | **Integrated Dispenser** | **Modular System (power cabinet + dispenser)**

Figure 12: EVSE equipment configurations for DC fast chargers.

Visit **sdge.com/evfleets** and download the list of approved EVSE eligible for the program, and see if your site qualifies for rebates.

To calculate your potential rebate, check out the **Rebate Calculator Tool**

Fleet Charging Examples

Previously, we used three examples to identify different per-vehicle charging rates: 7 kW, 27.5 kW, 82.5 kW and 55 kW. The following examples illustrate how this information can help you identify an appropriate charging interface.

❶ EXAMPLE 1: CITY DELIVERY VANS

In Example 1, we determined that the per-vehicle charging rate for 10 delivery vans would be 7 kW/van:

Per-Vehicle Charging Rate (kW) =
70 kW / 10 vans = 7 kW / van

This rate is well within the power range for the J1772 AC standard that is commonly used in the U.S. J1772 AC EVSE are available at several power levels to meet common circuit breaker ratings and electrical code requirements. According to these requirements, the continuous load on a circuit should not exceed 80% of the circuit's rated capacity. For example, and as shown in Figure 13, 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 fleet's minimum charging requirements.

Minimum Breaker Rating (Amps)	Maximum Continuous Draw (Amps)	Power Rating (kW at 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

Figure 13: Common Level 2 EVSE power ratings and their supporting circuits.

The following formula is helpful for understanding these relationships:

Watts = Volts x Amps

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

32 amps x 240 volts = 7,700 watts, or 7.7 kilowatts

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

Fleet Charging Examples (Continued)

❷ EXAMPLE 2: LOCAL CLASS 8 TRUCKS (SINGLE SHIFT)

Previously, we determined in Example 2 *(page 14)* that a fleet of Class 8 trucks running local routes on a single-shift schedule would require a charging rate of 27.5 kW per truck:

Per-Vehicle Charging Rate (kW) =
275 kW / 10 trucks = 27.5 kW / truck

This charging rate exceeds the J1772 AC standard rating, and would likely require a DC charger based on either the CCS-1 or CHAdeMO standard. Figure 14 illustrates the circuit sizing requirements for the wide range of DCFC power ratings currently advertised. Vehicle manufacturers will typically specify which standard is available on their vehicles, and very few manufacturers offer more than one. For this reason, the standard of your charging equipment is determined by the standard on your EVs. If a fleet plans to purchase a mix of vehicles using the CCS-1 and CHAdeMO standards, DC chargers are available with multiple cables, and can be configured to support both CCS-1 and CHAdeMO standards on a single dispenser.

Minimum Breaker Rating (Amps)	Maximum Continuous Draw (Amps)	Power Rating (kW at 240V)
40	30	25
75	60	50
150	120	100
225	180	150
300	240	200
530	420	350

Figure 14: Common DCFC power ratings and their supporting circuits.[2]

[2]These minimum breaker ratings are estimated based on an 80% continuous load rating. Breakers can be rated for 100% continuous loads.

Fleet Charging Examples (Continued)

❸ EXAMPLE 3: LOCAL CLASS 8 TRUCKS (TWO SHIFTS)

Previously, we determined in Example 3 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 per truck) sets the minimum required charging rate. 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 charging 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 DCFC 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 between 50 kW and 100 kW. As a two-part system, the modular option also offers more flexibility for your layout because their power cabinets can be sited at a distance from the dispensers. This is valuable at sites with significant space constraints.

EVSE Selection Takeaways

Keep the following points in mind when designing your charging plan and choosing your EVSE:

- AC chargers are less expensive than DC chargers and are supplied by 240V single phase or 208V three phase circuits commonly available in most commercial facilities. Where AC charging is sufficient for your fleet's needs, it is likely to be the most cost-effective option.

- Choosing EVSE with charge rates that are greater than the calculated average required charge rate will help avoid incomplete charging cycles. Regardless of your charge rate, most EV batteries currently available charge more slowly when they are nearly depleted or nearly full.

- Keeping charge rates below 150 kilowatts will increase your equipment options, reduce equipment and electricity costs, and allow greater flexibility with respect to cable lengths.

- Rightsizing (neither under- nor over-sizing) your EVSE can 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 plan for extended charging times and shorter vehicle ranges during seasonal cold periods.

- Contact SDG&E early in the process to understand your site's power supply options, and where chargers can be sited. Your utility may also be able to advise on available funding programs.

Cost Guidelines and Funding Solutions for Your EVSE

While EVSE designs and costs vary, Figure 15 *(right)* presents average cost ranges that you can use to begin estimating your capital cost, exclusive of extended warranties, maintenance service contracts, or utility and on-site electrical upgrade costs. Electrical infrastructure upgrade costs may range from a few hundred to a few thousand dollars for lower-power EVSE, and in the tens to hundreds of thousands of dollars for higher-power EVSE. Ultimately, your project's overall EVSE costs are tied to the specific conditions of your site.

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 DCFC	20-30 kW	Yes	10,000-40,000
Level 3 DCFC	50-150 kW	Yes	50,000-100,000
Level 3 DCFC	>150 kW	Yes	150,000+

Figure 15: Per unit EVSE average cost ranges by power level and networkability. Note: The power level ranges presented cover the standard offerings based on 2018 market data. These costs do not include extended warranties, maintenance service contracts or subscription feeds. There are currently few standard DCFC offerings between 30 kW and 50 kW.

SDG&E's Power Your Drive for Fleets program offers rebates to some customers for EVSE rated between 19.2 kW to over 150 kW ***(eligibility and other details on page 34).*** **Visit sdge.com/evfleets to learn more.**

SDG&E's Customer Solutions Team Members are available to discuss your EVSE project and its eligibility for the Power Your Drive for Fleets program. School buses, transit buses, and sites located in disadvantaged communities that are not a Fortune 1000 company are eligible for rebates on a variety of Level 2 and DCFC EVSE from select providers; a complete list is available for download at sdge.com/evfleets. Other funding resources exist, and are summarized in the Appendix. As the customer, you are responsible for procuring and installing this equipment, a process that is described in more detail in the following sections.

SDG&E

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Power Your Drive *for* Fleets

SDG&E's POWER YOUR DRIVE FOR FLEETS PROGRAM

SDG&E's Power Your Drive for Fleets Program

SDG&E's goal is to make it easier for organizations to transition to an electric fleet, which can reduce operating costs, eliminate tailpipe emissions, and simplify maintenance.

As part of the commitment to clean transportation and clean air, SDG&E is implementing the Power Your Drive for Fleets program to install the charging infrastructure needed to electrify medium- and heavy-duty (MD/HD) vehicles.

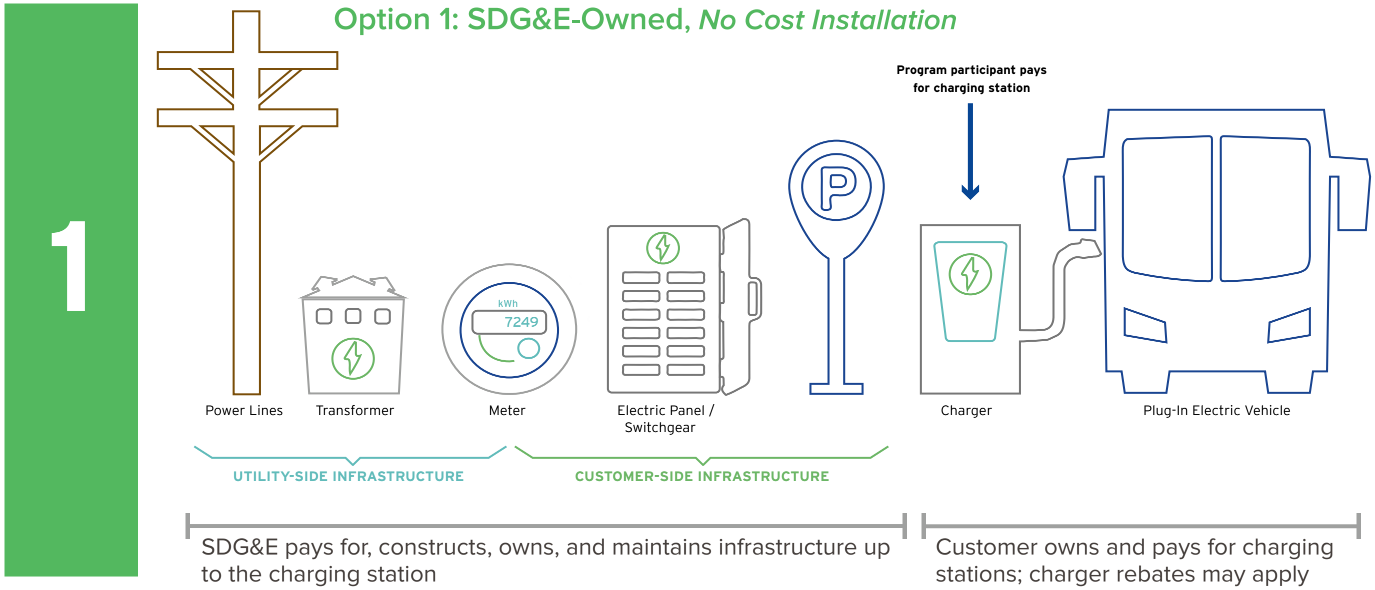
Power Your Drive for Fleets is applicable to Class 2-8, on-road and off-road vehicles, including:

- Medium- and heavy-duty trucks and vans
- Transit, commuter, and school buses
- Transportation refrigeration units
- Airport ground support equipment
- Port equipment
- Forklifts and other equipment

The goal of the program is to serve a minimum of 3,000 medium- and heavy-duty on-road and off-road class 2-8 vehicles at 300 customer sites throughout the SDG&E service area.

SDG&E's Power Your Drive for Fleets Program (Continued)

As part of the program, customers have two options to construct and pay for charging infrastructure.



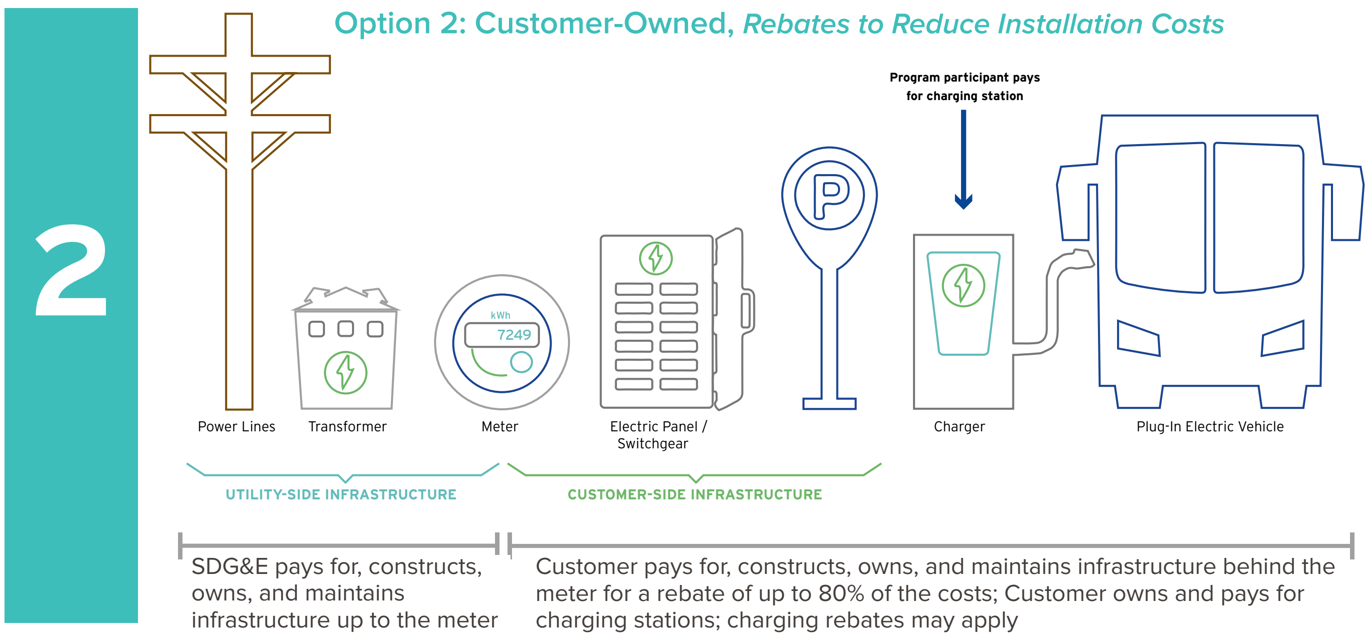


Figure 16: Power Your Drive for Fleets installation and ownership options.

SDG&E's Power Your Drive for Fleets Program (Continued)

To be eligible to receive funding through the Power Your Drive for Fleets program, fleets must first meet the four basic criteria in Figure 17 *(right)*.

You can select from a variety of EV charger options from the **approved vendor list**. School buses, transit buses, and sites located in disadvantaged communities that are not a Fortune 1000 company are eligible for the EVSE rebates in Figure 18 *(below)* based on the power output of the charger.

Use the rebate calculator to see how much you could save.

Maximum rebate amounts per charger power level

EVSE power	Max. rebate amount*
Up to 19.2kW	$3,000 per charger
19.3kW up to 50kW	$15,000 per charger
50.1kW up to 150kW	$45,000 per charger
15.10kW and above	$75,000 per charger

*Figure 18: Power Your Drive for Fleets maximum EVSE rebates. *Eligible sites will receive a rebate for each qualified charger for the lesser of 50% of the cost of the charger or the maximum amount based on power output as detailed above, not to exceed 50% of the cost of the charger.*

PROGRAM REQUIREMENTS

- Demonstrate commitment to procure **a minimum of 2 electric vehicles**
- Demonstrate **long-term electrification growth** plan and schedule of load increase
- **Provide data** related to charger usage for a minimum of **5 years**
- Own or lease the property where chargers are installed, and operate and maintain vehicles and chargers **for minimum of 10 years**

Figure 17: Power Your Drive for Fleets program eligibility requirements.

Visit sdge.com/evfleets to learn more.

SDG&E's EVSE Installation Process

Engaging your utility early is the most important first step to a successful fleet electrification project. Your business' needs will define the vehicles, equipment and design of your project, and our Customer Solutions Team Member are ready to offer their expert guidance and resources to make your fleet's transition efficient and cost-effective. The figure below illustrates the steps and timeframes that you can expect once you engage with SDG&E.

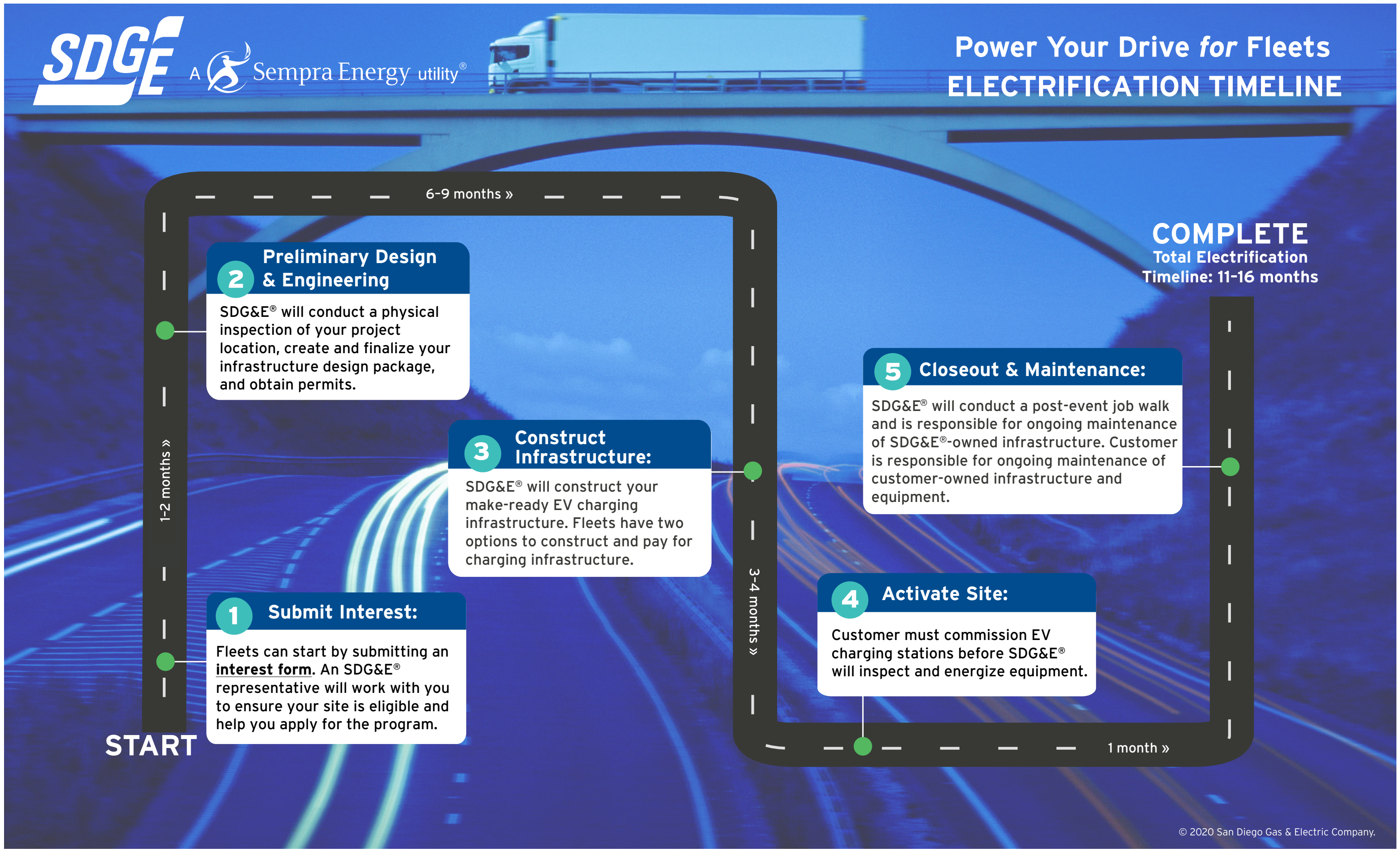


Figure 19: Power Your Drive for Fleets electrification timeline.

Site Design for Your EVSE

Deciding where to site and install the charging infrastructure you need to accommodate your EV fleet requires pre-planning to optimize your facility's logistics and operations. In California, you are required to notify your utility of any electrical additions or upgrades, regardless of scope or scale.

Engaging SDG&E early and regularly throughout your project will help ensure that your team considers all design options, and that the outcome is serviceable, durable and cost-effective. Gathering information from SDG&E as well as prospective vendors during the steps described in the previous sections gives you an important foundation for your site plan.

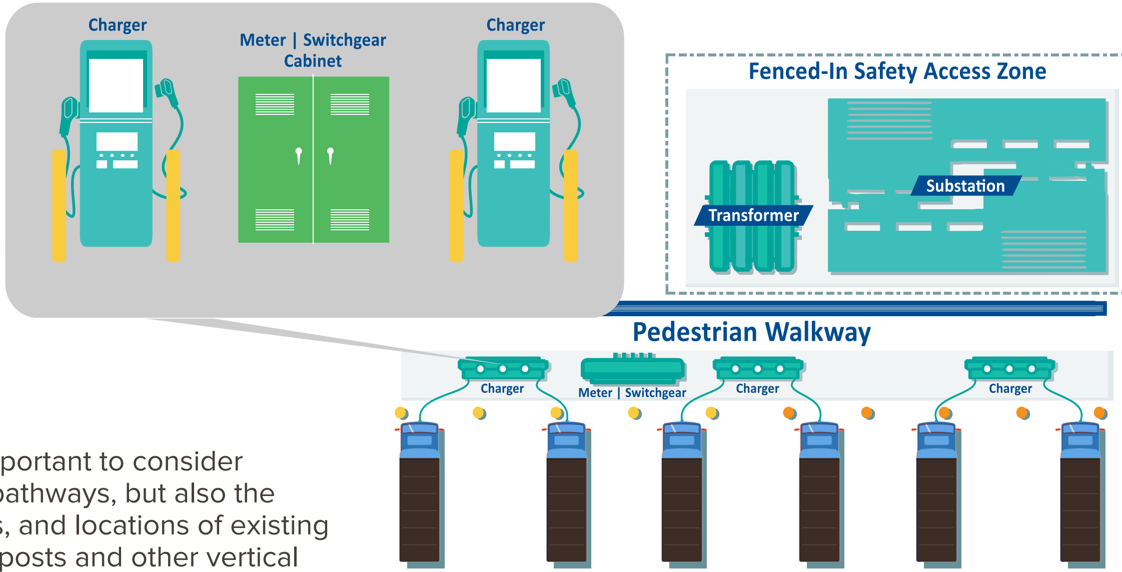


Figure 20: Electrical equipment layout at a charging depot.

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; some may 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 (Figure 21). If your existing surface is far from your electrical panel, the construction to extend the wired connection may be costly and disruptive. Some new technology can offer design benefits - solar canopies provide shade and protection for charging equipment, in addition to renewable power. 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.

Site Design for Your EVSE (Continued)

The EVSE you choose plays an important role in your site's electrical design. If your selection requires an electrical upgrade, you may be installing a new meter, transformer, and electrical panels/switchgear. The size of this equipment depends on its capacity, and may require modifications to your building or lot. Planning for this upgrade should take into account the equipment's 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, notify SDG&E so that any design choices account for that larger future upgrade cost. Keep in mind that the nature or size of a project may trigger certain regional building code requirements for facility upgrades. SDG&E can help you navigate this, and ensure that these costs are included in your budget development.

When designing your EVSE site and discussing it with SDG&E, use the following questions to guide your process:

Question	Things to Consider
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 of your facility are commonly used as walkways?	• EVSE hazards to current walkways • Personnel traffic as a hazard to EVSE layout

Figure 21: Guiding questions for designing your EVSE layout.

EXECUTIVE SUMMARY
INTRODUCTION
TRANSITIONING TO ELECTRICITY FOR YOUR FLEET
SDG&E'S POWER YOUR DRIVE FOR FLEETS PROGRAM
ONGOING MAINTENANCE AND SUPPORT FOR YOUR EV CHARGING INFRASTRUCTURE
CONTINUING THE PROCESS
APPENDIX
GLOSSARY

Permitting Process and Timeline

EVSE installations require a building permit or similar nondiscretionary permit from your local jurisdiction. In California, jurisdictions must adopt an expedited approval process for EVSE projects, and provide the public with a checklist of the information required to qualify for expedited review. Your electrical design firm or contractor can help you verify what details you need to provide and how to prepare the necessary forms.

EVSE permit applications typically require information on the proposed site, equipment (including manufacturer), utility service, and expected use. This information is collected from vendors and contractors during the technology and site assessments previously described; 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 project. Permit approvals typically take at least a couple of months, but the actual timeline varies by jurisdiction and project complexity. Once approved, a building inspector will conduct a final site visit before beginning construction and commissioning.

Although permit applications may require detailed information on your EVSE, it is advised that you wait to purchase equipment until your permit 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, 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.

7 Steps to Permit Your EVSE

1. Prepare Application
2. Submit to Local Jurisdiction
3. Revise as Needed
4. Final Site Visit
5. Complete Site Construction
6. Commission EVSE Equipment
7. Use Your EVSE

Installing and Electrifying Your EVSE

Once your permit application has been approved, you may begin construction. Construction timelines 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 a matter of weeks.

If customer-side infrastructure electrical work is required then the construction period may extend over several weeks or months. When your construction is complete and has passed inspection, SDG&E will complete any utility-side infrastructure construction required under your project to connect your facility, and activate your electrical service. You and your electrical contractor will complete final testing of your EVSE. Once you have confirmed that your equipment is fully operational, SDG&E will issue the appropriate rebates for your equipment.

A fleet electrification project can take approximately 11–16 months, however timelines vary with power requirements and project complexity. A small project without infrastructure upgrades may be executed in a few weeks, while a larger project requiring electrical upgrades and site construction–a common scenario for EV fleet facilities–will likely require several weeks or even months. For example, planning and construction for a transformer upgrade is typically a three-month process. Cabling can take six- to nine-months, with substation modifications requiring up to eighteen months.

Equipment selection is also a factor. While many vendors offer Level 2 equipment off-the-shelf, order fulfillment times for some DCFC equipment may be longer. Your electrical contractor and EVSE vendor can advise on their timelines, and suggest approaches that minimize disruption to your existing operations, such as staggered delivery and construction.

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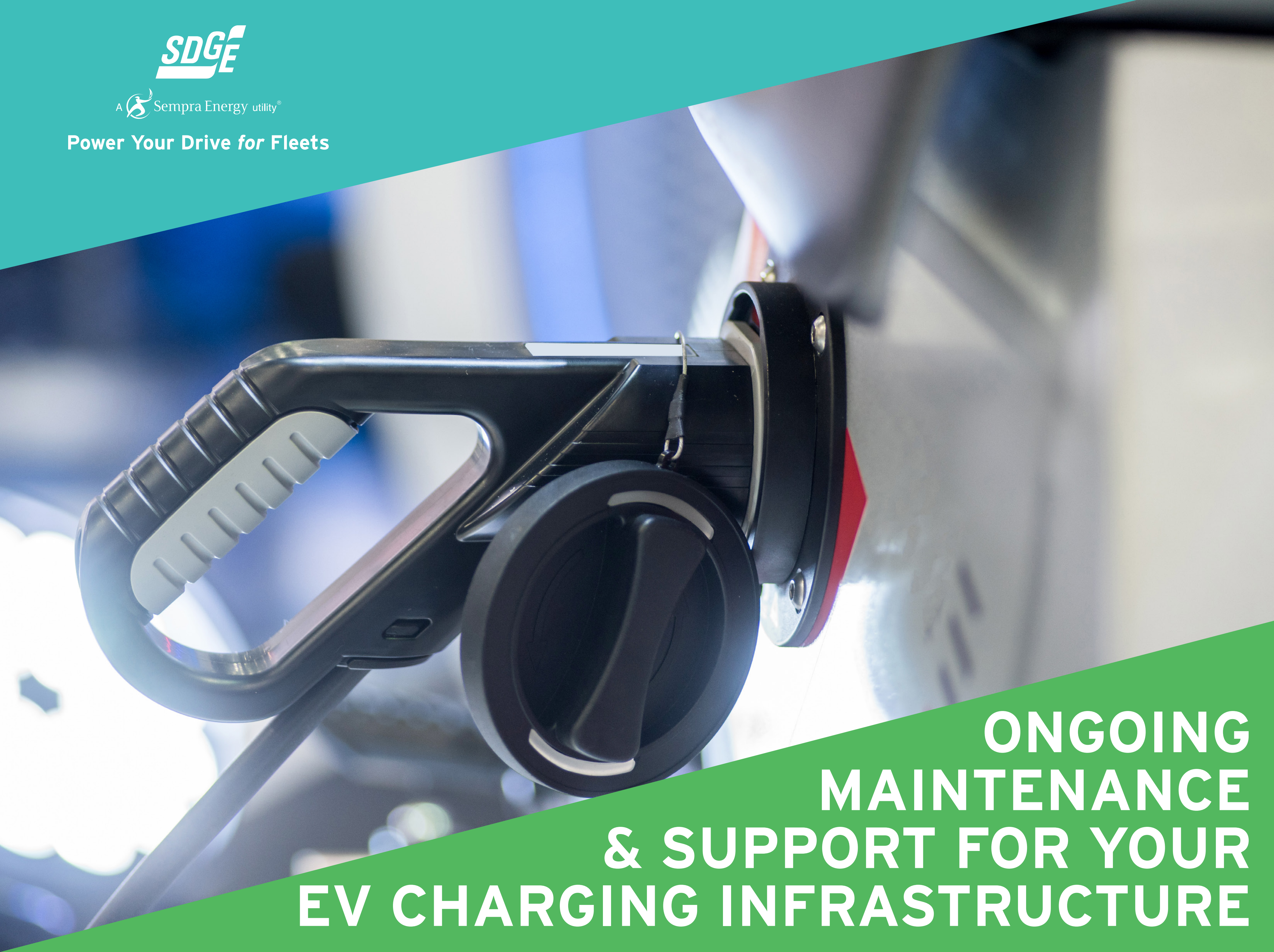

ONGOING MAINTENANCE & SUPPORT FOR YOUR EV CHARGING INFRASTRUCTURE

Maintaining Your EVSE

Maintenance is generally considered to be simpler for EVSE than for diesel fueling equipment. Still, maintaining your EVSE will initially involve unfamiliar components and procedures, which may require new training, knowledge and/or skills. You can significantly reduce your EVSE maintenance load by incorporating preventative designs into your site plan as you develop it. During the design stage, ask prospective EVSE vendors about the following features:

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 their exposure to moving vehicles and people.

Cord management: Safely storing cords on EVSE dispensers or using cord retractors when not in use will improve the safety of your equipment and personnel.

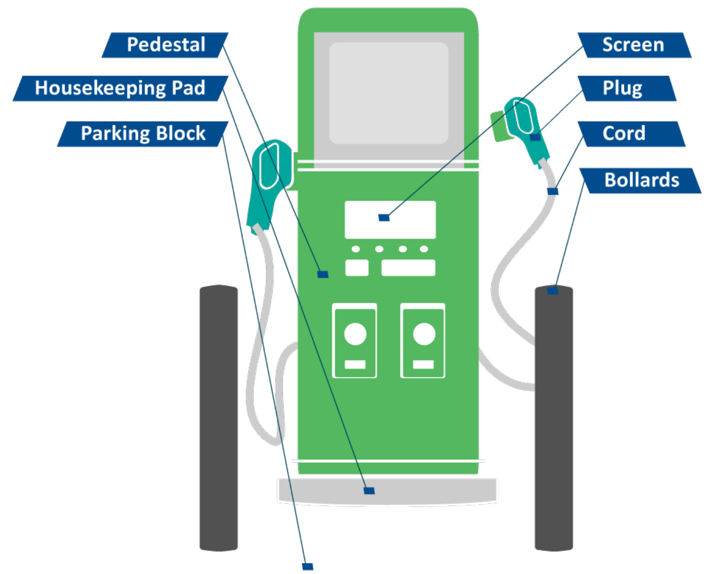

Figure 22: Anatomy of an EVSE

Maintaining Your EVSE (Continued)

Once your EVSE is up and running, adopting a regular maintenance schedule can help maximize your EVSE's useful life. The following list of best practices should be included, and your vendor can help you understand additional criteria to manage your new facility. If you have adopted a networked or cloud-based communications system, you may be able to incorporate alerts for problems or scheduled cleaning.

- Turn off the power to your EVSE equipment before conducting maintenance.
- Inspect cords, plugs, and cord storage devices for wear and tear, or mis-use.
- Clean plugs, including the pins, with a light detergent and non-abrasive washcloth to eliminate buildup of grit or grime, which can compromise your EVSE's efficiency.
- For DCFC, inspect A/C or other cooling filters for clogging or buildup.
- Inspect the 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).
- If using a networked or cloud-based system, review data reports for unusual results or other signs of an error in the network or cloud-based communications platform, as applicable. Comparing data with your utility bills is another way to confirm that the equipment is functioning as intended.

Most EVSE vendors currently offer at least a three-year warranty on their equipment, and the warranty on networking and/or cloud-based communications services may be separate. If you are participating in SDG&E's Power Your Drive for Fleets program, then you are expected to maintain your chargers for at least 10 years. Ask your EVSE vendor to clearly explain what components of your EVSE are covered under warranties, and their timeframe.

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Power Your Drive *for* Fleets

CONTINUING THE PROCESS

Continuing the Process

The State of California has set clear goals to increase the numbers of EVs in MD/HD fleets by the year 2030 and beyond. To support this transition, SDG&E is investing **$107 million** to build supporting infrastructure at over 300 private and commercial fleet sites by 2025. Municipalities are also providing EV-supportive funding, as well as accelerated project reviews. Additional programs are likely to emerge as needs become more defined over time.

Your first EVSE project will likely be the most time-intensive, since you will be working on this with your utility, vehicle manufacturers, and EVSE vendors for the first time. You will likely find that subsequent projects – whether follow-on phases of your first project or projects at new facilities – become more efficient through established relationships. In either case, the following best practices will help you optimize results.

- Notify SDG&E early and often: not only are you required to notify your utility, but SDG&E can be a valuable resource for discovering new equipment solutions and cost-saving opportunities.
- Know your vehicle and fleet: communicate your vehicle's charging standards and your fleet's logistical needs clearly so that your team can design a project that meets these requirements.
- Faster is not always better: consider the cost/benefit tradeoffs of all charging scenarios.
- Plan for the future: design your layout and electrical infrastructure today to support your fleet's needs tomorrow, minimizing future construction and connection costs.
- Look for funding: EVSE-supportive programs exist from a variety of sources, and will continue to evolve. Review the Appendix to this Guidebook and track the programs relevant to your business for right-sized opportunities.

Interested in electrifying your fleet and learning more about SDG&E's Power Your Drive for Fleets program?
Fill out the **interest form** to engage with a Customer Solutions Team Member, or **just sign up for updates.**

SDGE

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APPENDIX

Electric Vehicle Funding Programs

The below summarizes funding opportunities for EV projects that are either open or under development. You can filter through these programs with the **Funding Finder Tool**. Note that these programs may have specific requirements such as public access, or may require that projects include vehicle purchases as well as infrastructure, and that these requirements are subject to change over time.

LOCAL PROGRAMS

SDAPCD Grant Program (formerly the Carl Moyer Program)
Eligible Applicants: Public and private entitites
Eligible Location: Funded vehicles must operate at least 50% of the time within San Diego County
Amount Available: $9.2 million
Maximum per Medium or Heavy-Duty EV: $200,000
Learn More

SDAPCD Voucher Incentive Program (VIP)
Eligible Applicants: Private entitites
Eligible Location: San Diego County fleets with 10 or fewer on-road heavy-duty diesel fueled vehicles
Amount Available: $510,000
Maximum per Medium or Heavy-Duty EV: $60,000
Learn More

FEDERAL PROGRAMS

Voluntary Airport Low Emission Program (VALE)
Eligible Applicants: Airports
Amount Available: $10 million
Maximum per Medium or Heavy-Duty EV: Up to 95% of the incremental cost based on airport size
Learn More

National Clean Diesel Program
Eligible Applicants: Public entities
Amount Available: ~$40 million expected for next fiscal year
Maximum per Medium or Heavy-Duty EV: Up to 45% of the total vehicle cost
Learn More

Targeted Airshed Grant Program
Eligible Applicants: Local, state, and/or tribal air pollution control agencies
Amount Available: Greater than $50 million annually
Maximum per Medium or Heavy-Duty EV: No maximum
Learn More

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Electric Vehicle Funding Programs (Continued)

STATE PROGRAMS

Clean Off-Road Equipment Voucher Incentive Program
Eligible Applicants: Public and private entitites
Eligible Location: Statewide
Amount Available: To be determined for future funding cycles
Maximum per Medium or Heavy-Duty EV: $200,000 for yard trucks; other vehicle types are also eligible for additional funds

Learn More

SDAPCD Proposition 1B (Prop1B)
Eligible Applicants: Private entities
Eligible Location: Four corridors throughout the state (Bay Area, Central Valley, LA, and San Diego) with some activity in San Diego required.
Amount Available: Under development
Maximum per Medium or Heavy-Duty EV: $200,000

Learn More

Volkswagen Program for Zero Emission Class 8 Freight and Port Drayage Trucks
Eligible Applicants: Public and private entitites
Eligible Location: Statewide; 50% of funds are expected to benefit low-income, disadvantaged communities.
Amount Available: $27 million
Maximum per Medium or Heavy-Duty EV: $200,000

Learn More

Zero Emission Drayage and Regional Haul Truck Pilot Program
Eligible Applicants: Public entities
Eligible Location: Project must be in or provide benefits to disadvantaged communities
Amount Available: $40 million
Maximum per Medium or Heavy-Duty EV: No maximum established; however, a 50% match is required

Learn More

Electric Vehicle Funding Programs (Continued)

STATE PROGRAMS CONTINUED

Clean Mobility Options Voucher Pilot

Eligible Applicants: Government entities, nonprofits, and tribes (private companies may participate as a member of the project team)

Eligible Location: Projects must occur in a disadvantaged community (DAC), on tribal land, or serve deed-restricted affordable housing facilities

Amount Available: $20 million

Maximum per Medium or Heavy-Duty EV: Vehicles must be on the HVIP or CVRP approved technology list; they are eligible for the same incentive amount as they are under those programs.

Learn More

Hybrid and Zero Emission Truck and Bus Voucher Incentive Project (HVIP)

Eligible Applicants: Public and private entities

Eligible Location: Statewide

Amount Available: Under development for FY 2020-2021

Maximum per Medium or Heavy-Duty EV: $150,000 ($165,000 if located in a disadvantaged community)

Learn More

Rural School Bus Program

Eligible Applicants: Eligible Applicants: Public School Districts, Public Charter Schools, County Offices of Education, Joint Power Authorities (JPAs), Division of State Special Schools of the State, and Department of Education

Eligible Location: Rural school districts within California

Amount Available: $3 million

Maximum per School Bus: $400,000

Learn More

Clean Mobility in Schools Program

Eligible Applicants: Public school districts and County Offices of Education

Eligible Location: Must be located within a disadvantaged community as defined by CalEnviroScreen 3.0

Amount Available: Up to $10 million

Maximum per School Bus: No maximum established

Learn More

The Electric Grid: An Overview

A basic understanding of how electricity is produced and purchased can help you make informed decisions about transitioning your fleet and developing your EVSE facility. This information is particularly valuable for fleets who expect that their use of electricity will increase over time, either through a phased transition or total fleet expansion. The following sections address the fundamental characteristics of the electric grid and market.

Figure 1: Most of California's electric grid is managed and maintained by nearly a dozen utilities.

Terms to Know

Amperage: A measure of the flow of electrical charge

Circuit: The path along which electricity flows

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

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

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

Transformer: An electric device that changes the voltage level of electricity

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

Voltage: Electrical pressure created by a difference in electrical potential

Watt: The speed at which power is consumed, measured as energy per second

The Electric Grid: An Overview (Continued)

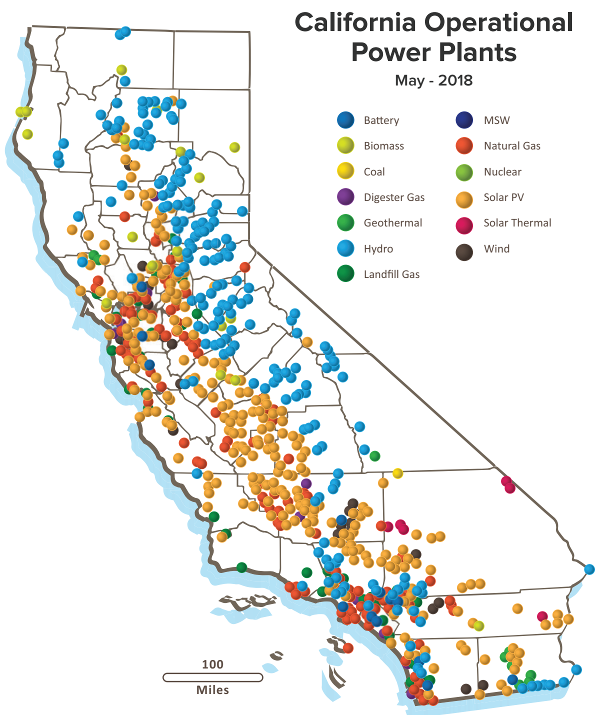

Figure 2: California Operational Power Plants, May 2018.

Electric Grid 101: Generation to Distribution

In the simplest terms, electricity is "the flow of electrical charge."[4] It is transported over the electric grid, an interconnected group of power lines and associated equipment that delivers electricity from where it is generated (at high voltage), to where it is distributed to customers (usually at much lower voltage). SDG&E serves 3.6 million people over 4,100 square miles, managing thousands of miles of power lines supported by over a million subsystems and components. Through careful management and regular maintenance of this complex system, SDG&E ensures that its customers receive reliable and affordable electricity, 45% of which comes from renewbable resources.

The grid carries electric power, as measured in watts. This refers to the rate at which electric energy is (or can be) consumed in an electrical circuit. To avoid outages or infrastructure damage, the amount of power on the grid must equal the amount of power demanded by customers at any given time. Maintaining this critical balance is an important task that involves many entities moving quickly in regulated markets.

The electric grid serves as the bridge between power producers and electricity consumers. Most traditional power plants generate electricity by burning fuel–typically coal or natural gas–to release heat that powers large generators.

These centralized thermal (heat-based) power plants typically have large space requirements, and are located close to their fuel source (e.g., near a natural gas pipeline or rail terminal). Electrical power can also be produced in plants that use other mechanical or thermal energy to turn generators, such as hydro, wind or nuclear power. Solar plants work differently; they use photovoltaic cells to absorb sunlight and prompt electron flow, thereby generating power. California's electric grid utilizes all of these types of power generation and will increasingly use more power from zero-carbon sources to achieve the State's goal of producing carbon-free electricity by 2045.

[4] "Electricity 101". United States Department of Energy. https://www.energy.gov/oe/information-center/educational-resources/electricity-101#sys1

The Electric Grid: An Overview (Continued)

To reach consumers, power producers feed electricity into their local grid's network of transmission lines. As shown in Figure 3, step-up transformers prepare electricity for transmission in large quantities over long distances by increasing the voltage at which the power is transmitted. 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. Distribution lines complete localized delivery of electricity to the customer by passing power from a substation (step-down transformer) so residences and businesses can receive the power at the lower voltages suitable for their equipment. The voltage at which your facility receives power will depend on the needs of your facility. Commercial site requirements can range from low voltages (208 V or 240 V) to very high voltages (>50 kV).

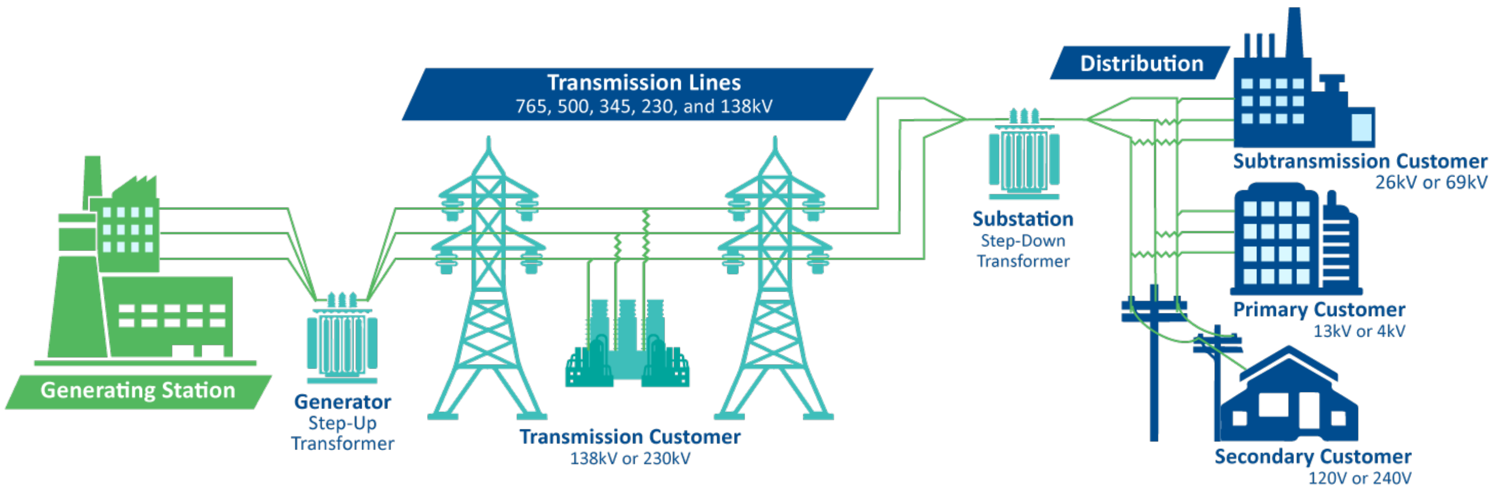

Figure 3: The electric grid carries electrical energy from generators to the end user.

Generating, transmitting, and delivering power involves multiple entities, which means that ownership structures vary across the electricity supply chain. Power plants may be publicly or privately owned, while electric grid is managed by Independent System Operators (ISOs) and utilities. Utilities, like SDG&E, provide maintenance service and collect revenues from consumers.

Utilities are responsible for expanding the grid's capacity to deliver power, while minimizing delivery interruptions. This includes ongoing grid maintenance and new infrastructure development. 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/operate EVSE are responsible for conducting regular maintenance to ensure that their equipment safely and successfully receives power and transmits it to vehicles.

Power Market 101: Buying and Selling Electricity

Many stakeholders coordinate to buy and sell electrical power on the grid. The fuel provider is at the base of the supply chain, selling fuel to the power producer at a market-determined price; the power producer may also be the fuel provider. Power producers 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 (spot market). These transactions are brokered by ISOs, which ensure that the power flow across the grid's transmission lines is balanced. This is done by constantly and rapidly matching utility purchase requests with power plant sales bids. Utilities may also buy power through a Community Choice Aggregator (CCA), an entity that buys electricity from a select set of suppliers and sells it to customers through their utilities. Utilities typically use PPAs to supply baseload power, or the minimum amount of power that they expect to provide at any given time. To meet additional 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.

Terms to Know

CCA: Community choice aggregator, a local entity that buys electricity on behalf of customers in a geographic area

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

IOU: Investor-owned utility

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

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

POU: Publicly-owned utility

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

While utilities pay a range of prices to maintain balance in their service territories, they bill their customers at a pre-determined rate that accounts for these fluctuations over the course of a billing cycle. Utilities' approaches to establishing these rates vary by their structure (Figure 4). As an investor-owned utility (IOU), SDG&E proposes rates for approval from the California Public Utilities Commission (CPUC), while publicly-owned utilities (POUs) apply rates set by their governing board or city council. Rate adjustments are time-intensive and require input from multiple stakeholders.

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

Figure 4: Key structural differences between IOUs and POUs.

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

CCA: Community choice aggregator, a local entity that buys electricity on behalf of customers in a geographic area

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

Circuit: The path along which electricity flows

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).

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

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

Demand: The amount of power that a site or piece of equipment requires to charge at a given time, also referred to as "load"

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

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

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 a fleet requires on an hourly basis over the course of a day

LCFS: Low Carbon Fuel Standard, a carbon credit market established in California

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

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

PPA: Power purchase agreement, a contract for one entity to deliver 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

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 the voltage level of electricity

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

Voltage: Electrical pressure created by a difference in electrical potential

Watt: The speed at which power is consumed, measured as energy per second