



EV Resilient Fleets:

A Guidebook to EV Fleet Resiliency
and Infrastructure





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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Introduction



Why charging resiliency matters for EV fleets

Electric vehicle (EV) fleet operators rely on charged vehicles to keep services running, whether for emergency response, public transit, commercial delivery, or municipal operations. Wildfires, storms, floods, earthquakes, Public Safety Power Shutoffs (PSPS), and maintenance can interrupt charging. EV fleet resilience means preparing your fleet to keep critical vehicles operating when grid power, chargers, or communications are unavailable.

In the following pages, you'll find helpful considerations for selecting, installing, and maintaining a charging solution suited to your fleet's needs. It's our goal to provide you with the information you need to:

- Assess your outage risk and energy needs
- Set up internal processes for outage response
- Choose software and charging strategies
- Compare resiliency hardware technologies in permanent and mobile setups
- Explore resources for transitioning to EVs, including PG&E programs and operational support, funding and financial incentives, and the PG&E Resiliency Assessment Tool and Consultancy Offering

This guide covers resiliency pathways ranging from no-cost, easy-to-implement actions to higher-cost, more complex solutions. You will also find answers to frequently asked questions and real-world case studies to help move from planning to action.

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The six-step EV fleet resiliency process

Use this six-step process to move from outage risk to a tested resiliency plan. The following slides explain what information to collect for vendor discussions, PG&E advisory support, and the Fleet Resiliency Assessment Tool.

PLANNING



1. Assess energy need and outage risk

Analyze relevant fleet data to determine how much energy each site needs during an outage. Assess how likely your site is to lose power from unplanned and planned outages.

Contact PG&E EV Advisory Services (EVAdvisoryServices@pge.com) to discuss outage information and planning resources.



2. Understand the business impact

Evaluate how critical your EV fleet operations are and determine how much downtime your organization can tolerate. Estimate the financial and operational impact of different outage scenarios on your business processes and services.

See slide 17 to understand your business impact and risk tolerance for EV Fleet resiliency



3. Decide if resiliency adoption is needed

Use your fleet data, outage risk, and business impact analysis to decide if your fleet can handle outages as-is or would need resiliency solutions.

See slide 18 for deciding if you need a resiliency solution.

PLANNING



4. Develop your resiliency plan

Based on your energy needs, budget, and risk tolerance, choose the resiliency option (e.g., permanent or temporary backup power, public or private charging, charging software) that fits your operations. Establish a formal process for how to detect, prepare for, and respond to outages.

See Managing EV charging for resiliency and Choosing the right hardware technology sections.



5. Test and implement

Test the solution at one site or with a small group of vehicles. Use a practice outage to confirm that it works. Then expand the solution and train staff on what to do during an outage.



6. Monitor and improve your resiliency plan

Review and update your resiliency plan regularly to stay up to date with your EV operations and fleet size, lessons learned from outage events, and new technologies as they become available.

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Planning resiliency for your EV fleet



Key factors for assessing and planning EV fleet resiliency

The following factors provide detailed guidance for carrying out the six-step EV fleet resiliency process.

Assessment



Vehicle operations & energy use

Use fleet tracking data to record each vehicle's daily miles, type, and operating hours. Estimate energy use in kilowatt-hours (kWh). Then identify sites where an outage could prevent needed charging.

See slides 9–15.



Outage propensity

The appropriate resiliency solution depends on how often and how long both unplanned (e.g., wildfires, storms, floods, earthquakes) and planned outages (e.g., PSPS, scheduled maintenance) occur, available site space, fleet energy needs, and the amount of downtime the organization can accept.

See slide 16.



State of charge (SoC) requirements

Estimate the share of usable battery energy consumed (multiply miles traveled by energy use per mile) and divide by usable battery capacity. Subtract that share from the starting SOC. Compare the expected end-of-shift SOC to outage propensity to confirm vehicles have sufficient stored energy.

See slide 18.

Planning



Off-site charging

Nearby public and partner charging stations offer a simple and cost-effective backup option when internal depots lose power. Check whether off-site chargers are open, close enough to use, and powerful enough to support fleet operations during an outage.

See slide 29.



Backup power sources

Backup power sources can be either stationary (permanent on-site) or mobile (temporary, deployed during outages). The right choice for you depends on outage propensity, site space constraints, EV fleet energy requirements, and risk tolerance.

See slides 31–37.



Upfront costs & ongoing expenses

Upfront costs include purchasing and installing resiliency systems (backup power sources, software, and site equipment). Ongoing costs cover maintenance, inspections, and fuel. Federal, state, and utility programs may help pay part of the upfront cost and lower the project's total cost.

See slide 31.

EV Charging and Resiliency Fundamentals

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Before comparing resilience options, estimate how much energy the fleet needs before its next shift. Four key factors can help you determine your charging requirement:

- Duty cycle
- Energy consumption rate
- Charging window
- Charging load profile

The sequence below scales from one vehicle to the full site, converting vehicle energy into total site energy needs (kWh) and required site power (kW) for electric service, charger, and backup-power sizing. Next, use duty-cycle data to choose the right energy-consumption rate.



TERMS YOU NEED TO KNOW

Power: How quickly electricity is supplied or used, measured in kilowatts (kW).

Average Charging Power: The average rate of power needed during the available charging time.

Charging window: The time a vehicle is parked and available to charge before it is needed again.

Duty cycle: How a vehicle is used during a work period, including its miles, hours, route, stops, and load.

Energy consumption rate: the electricity a vehicle uses to travel one mile, measured in kilowatt-hours per mile (kWh/mile), or more simply the energy use per mile

BEV: Battery-electric vehicle powered only by electricity stored in its battery. In this guide, “EV” refers to a BEV unless stated otherwise.

EV Supply Equipment (EVSE): The equipment that connects an EV to an electricity source, often called a charger

Energy: The total amount of electricity used or supplied, measured in kilowatt-hours (kWh).

Charging load profile: A chart showing how the site’s charging power changes over time.

FIGURE 1:
Progressing from vehicle energy needs to a site load profile

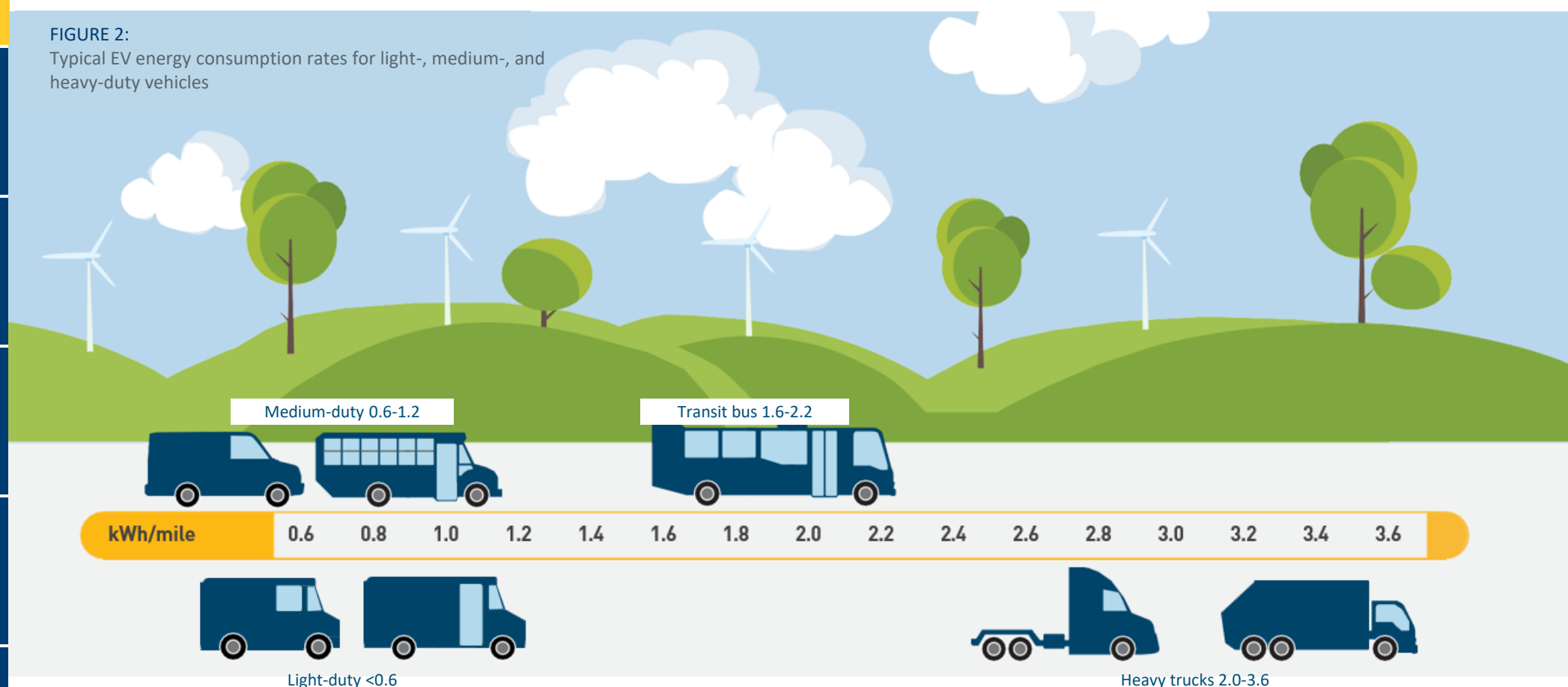


Vehicle duty cycles and energy use

Use vehicle telematics from your fleet to estimate energy use on real routes. A vehicle's energy consumption rate is measured in kilowatt-hours per mile (kWh/mile). For the same daily mileage, a lower kWh/mile rate means less daily energy use and less backup energy needed during an outage.

Figure 2 shows typical energy consumption rates by vehicle type, including smaller light-duty vehicles. Actual energy use can vary based on payload, terrain, weather, auxiliary loads, and driving style. Select an applicable rate from the range shown and combine it with daily miles to estimate how much energy (kWh) your site needs each day, then use the available charging hours to estimate the average charging power (kW) the site must provide.

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



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Calculate the charging baseline for resiliency planning

Once you have estimated each vehicle's energy consumption rate and miles between charges, use these steps to estimate how much energy the fleet needs and its average charging power.

- 1 Calculate each vehicle's energy need by multiplying the miles traveled between charging events by its energy consumption rate.
- 2 Add the energy needs of vehicles charging in the same window to determine the fleet's total charging energy.
- 3 List where and when each vehicle can charge, including at the depot and on its route. Divide the fleet's total energy need by the available charging hours to estimate average charging power.

Resiliency next step:

Apply this calculation to the vehicles that must remain in service during an outage, then account for outage duration and energy already stored in their batteries.

CALCULATE YOUR CHARGING BASELINE



VEHICLE ENERGY NEED

$$\text{Vehicle energy need (kWh)} = \text{VMT (vehicle miles traveled)} \times \text{EV energy use (kWh/mile)} \div \text{Assumed charging efficiency}$$



FLEET ENERGY NEED

$$\text{Fleet energy need (kWh)} = \text{Charging energy requirement} \\ \text{Vehicle 1} + \text{Vehicle 2} + \text{Vehicle 3}$$



AVERAGE FLEET CHARGING DEMAND

$$\text{Average charging demand (kW)} = \text{Fleet energy need (kWh)} \div \text{Selected charging window (hours)}$$

Levers that shape your EV-related electricity bill

Two key operating choices can strongly shape your EV charging costs:

1

Charger power level (kW)

Charger power is the fastest rate a charger can deliver. If several chargers run at the same time, they may raise the site's peak demand - the highest average power used during a billing period. Higher peak demand can require larger electrical equipment and may increase monthly costs tied to power capacity. When vehicles have enough time to charge, lower power or managed charging can meet operational needs while limiting peak demand.

2

Charging window

The timing of your charging window also impacts what you pay, even if total energy use (kWh) stays the same.

Scenario A: Vehicles return to the depot and begin charging while utility peak hours are still in effect, so part of the charging occurs when rates are highest and can increase electricity costs.

Scenario B: Using scheduling controls in the vehicle or charging management software, charging is delayed to an overnight or off-peak window, delivering the same energy during lower cost hours with less exposure to peak rates.



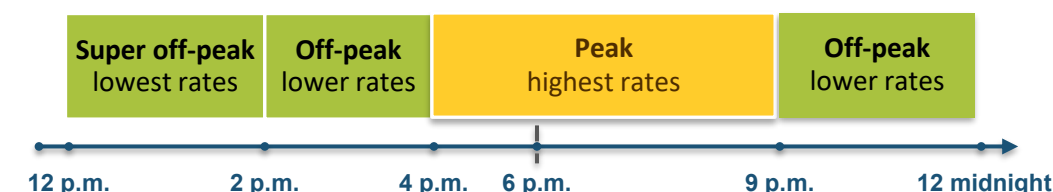
TERMS YOU NEED TO KNOW

Peak demand: Highest average power the site draws during a billing interval, measured in kW

On-peak / off-peak hours: Times when electricity prices are higher or lower under the customer's rate plan.

FIGURE 3:

The same charging energy may cost less when shifted from peak to lower cost hours



Scenario A
Charge on return

Charging begins immediately, so part of the energy is delivered during the highest cost period.

Scenario B
Scheduled charging

Vehicle or charging management software delays charging until lower cost hours.

Both scenarios use the same amount of energy and the same charging power. If electricity prices vary by time of day, charging during lower-priced hours may reduce the energy portion of the bill.

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Comparing charger sizing and backup needs by duty cycle

Use route data to compare charger sizing and backup-power needs

The next three examples show how charger power and the charging window affect cost and help estimate the backup power needed for resilience.

Each example calculates the same three values:

- Total energy demand
- Average power during the charging window
- Per-vehicle charging rate

Use the comparison to test practical charging choices:

- Example 1 shows a low-power overnight duty cycle
- Example 2 shows how heavier vehicles raise kW needs
- Example 3 shows that less charging time between shifts requires more charging power.

If the required kW per vehicle is higher than the EV or charger can support, extend the charging window, change the vehicle or charger selection, or adjust the operating plan.



EXAMPLE 1:
CITY DELIVERY VANS



EXAMPLE 2:
LOCAL CLASS 8 TRUCKS
(SINGLE SHIFT)



EXAMPLE 3:
LOCAL CLASS 8 TRUCKS
(TWO SHIFTS)

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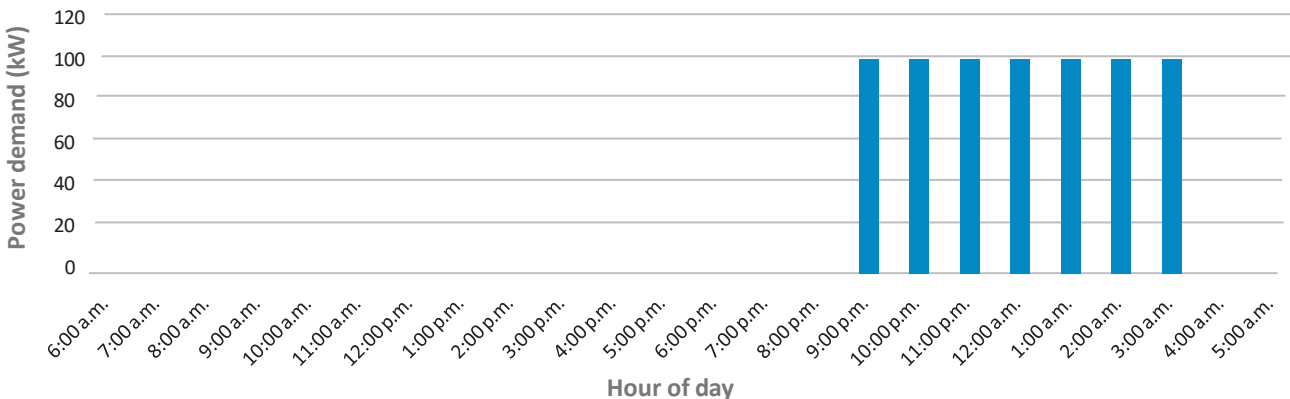
Example 1: City Delivery Vans



EXAMPLE 1:
Ten vans each travel 100 miles per day and use an estimated 0.7 kWh per mile. Together, the vehicles use about 700 kWh of battery energy during the day. If 700 kWh is replaced evenly over the seven-hour charging window, the average power delivered to the vehicles is 100 kW for the fleet, or 10 kW per van.
Electricity drawn at the site will be higher after charging losses and other loads are included.

- **Charger size:** 19.2 kW Level 2 ports; managed to 10 kW per van on average
- **Illustrative minimum backup output:** 100 kW for 7 hours and 700 kWh delivered, before charging losses, reserve margin, auxiliary loads, and equipment constraints. These are average delivered-power values, not equipment ratings
- **Cost minimization levers:** Charge 9 p.m.–4 a.m.; cap fleet demand at 100 kW

FIGURE 4:
Average charging demand for 10 delivery vans overnight. Each bar represents the following hour



Fleet energy requirement	Managed charging window	Fleet charging demand	Per-vehicle charging need
Energy (kWh) = 10 vans x 100 miles/van/day x 0.7 kWh/mile = 700 kWh/day	All vans return by 6 p.m. and depart at 8 a.m. Charging is scheduled from 9 p.m. to 4 a.m., creating a seven-hour charging window and a four-hour departure buffer.	This example assumes load management holds fleet demand at 100 kW across the seven-hour window. Actual charging may vary as vehicle needs change. Average power demand (kW) = 700 kWh ÷ 7 hours = 100 kW	Average demand is 100 kW, or 10 kW per van. Level 2 charging can meet this need, while load management shifts charging off-peak and caps demand. Per-van charging rate (kW) = 100 kW ÷ 10 vans = 10 kW/van

Example 2: Local class 8 trucks (single shift)



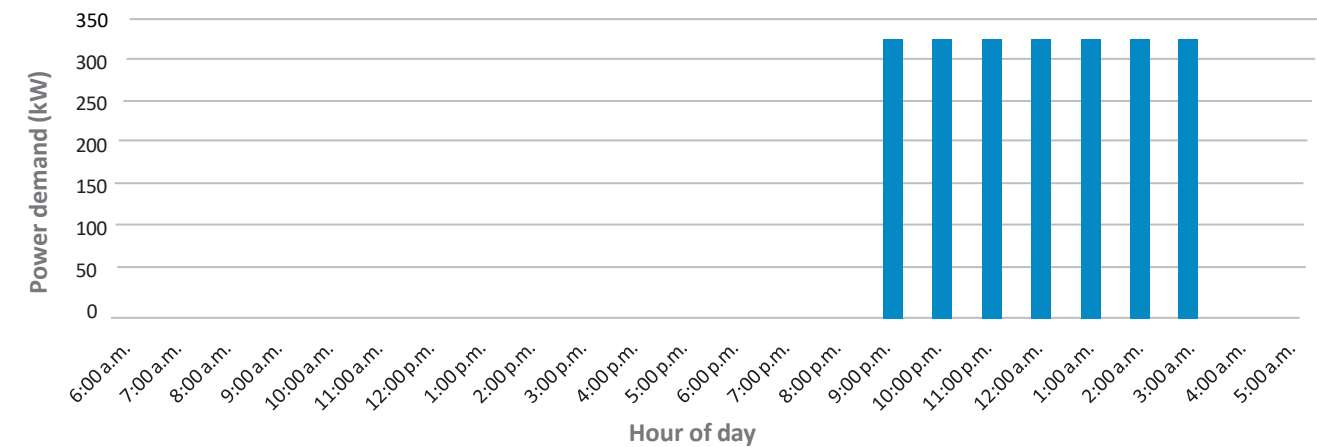
EXAMPLE 2:

Ten Class 8 trucks each travel 100 miles per day and use 2.2 kWh per mile. They return by 6 p.m. and leave by 8 a.m. Charging runs from 9 p.m. to 4 a.m. During this seven-hour window, the fleet needs 2,200 kWh, or an average of 314.3 kW for the fleet and 31.4 kW per truck.

Size the chargers and backup system to account for charging losses, reserve, changing power needs during the session, power sharing, and each vehicle's maximum charging rate.

FIGURE 5:

Managed charging demand for 10 Class 8 trucks overnight. Each bar represents the following hour



- **Charger size:** DC charger rated above 31.4 kW per port
- **Illustrative minimum backup output:** 314 kW for 7 hours and 2.2 MWh delivered, before charging losses, reserve margin, auxiliary loads, and equipment constraints. These are average delivered-power values, not equipment ratings.
- **Cost minimization levers:** Charge off-peak from 9 p.m.–4 a.m.; cap fleet demand near 315 kW

Fleet energy requirement

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

Managed charging window

All trucks return by 6 p.m. and must be ready to depart by 8 a.m.

Charging is scheduled from 9 p.m. to 4 a.m., creating a **seven-hour** charging window and a four-hour buffer before departure.

Fleet charging demand

Load management spreads charging evenly across the seven-hour window.

Average power demand (kW)
=
2,200 kWh
÷
7 hours
= 314.3 kW

Per-vehicle charging need

The 31.4 kW need exceeds common 19.2 kW Level 2 capability, so DC charging is the practical fit.

Per-truck charging rate (kW)
=
314.3 kW
÷
10 trucks
=
31.4 kW/truck

Example 3: Local class 8 trucks (two shifts)

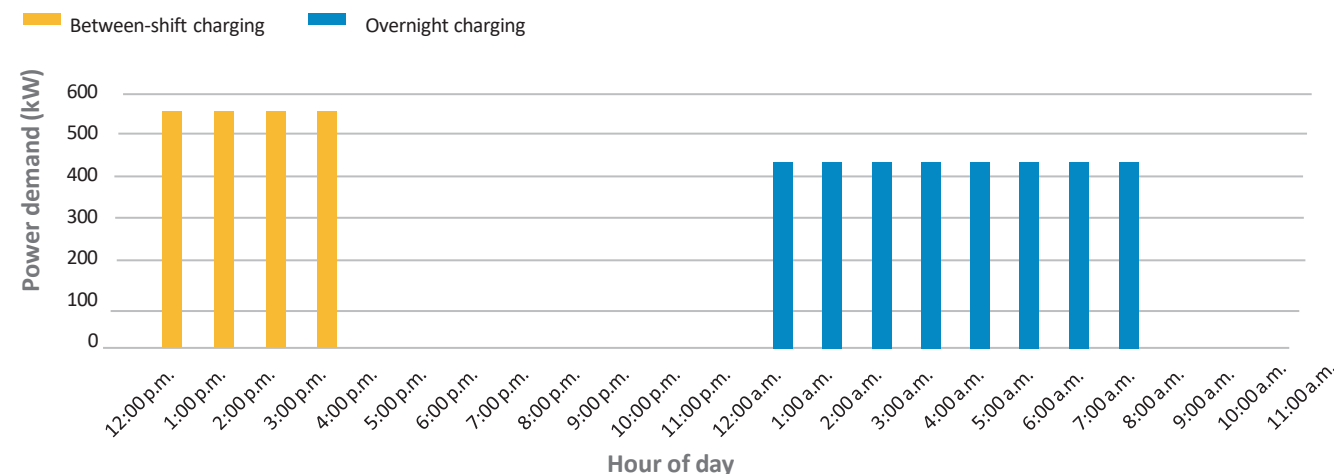


EXAMPLE 3:

Ten Class 8 trucks use 2.2 kWh per mile. Each truck travels 150 miles on the first shift and 100 miles on the second. The trucks charge from noon to 4 p.m. and again from midnight to 8 a.m. The first window restores only the energy needed for the second shift. The rest is restored overnight. This plan limits the highest fleet charging demand to 550 kW.

FIGURE 6:

Average charging demand for 10 Class 8 trucks across two charging windows. Each bar represents the following hour



- **Charger size:** Each truck needs access to a DC charger rated above 55 kW
- **Illustrative between-shift backup need:** 550 kW for 4 hours and 2.2 MWh delivered. A longer outage may require additional energy for the overnight 3.3 MWh recharge when accounting for charging losses, reserve margin, auxiliary loads, and equipment constraints. These are average delivered-power values, not equipment ratings.
- **Cost minimization levers:** Charge only what is needed between shifts; complete remaining charging overnight; cap fleet demand at 550 kW

Fleet energy requirement

First shift energy (kWh)

$$\begin{aligned}
 &= \\
 &10 \text{ trucks} \\
 &\times \\
 &150 \text{ miles/truck/shift} \\
 &\times \\
 &2.2 \text{ kWh/mile} \\
 &= \\
 &3,300 \text{ kWh/shift}
 \end{aligned}$$

Second shift energy (kWh)

$$\begin{aligned}
 &= \\
 &10 \text{ trucks} \\
 &\times \\
 &100 \text{ miles/truck/shift} \\
 &\times \\
 &2.2 \text{ kWh/mile} \\
 &= \\
 &2,200 \text{ kWh/shift}
 \end{aligned}$$

Managed charging window

All trucks return by noon and depart again at 4 p.m., leaving four hours to restore the energy needed for the second shift. They return by midnight and are next needed at 8 a.m., leaving eight hours to restore the remaining daily energy.

Fleet charging demand

The shorter between-shift window creates the higher demand.

Between-shift average power demand (kW)

$$\begin{aligned}
 &= \\
 &2,200 \text{ kWh} \div 4 \text{ hours} \\
 &= \\
 &550 \text{ kW}
 \end{aligned}$$

Overnight average power demand (kW)

$$\begin{aligned}
 &= \\
 &3,300 \text{ kWh} \div 8 \text{ hours} \\
 &= \\
 &412.5 \text{ kW}
 \end{aligned}$$

Per-vehicle charging need

DC charging is needed in both windows; the shorter window requires the higher rate.

Between-shift per-vehicle charging rate (kW)

$$\begin{aligned}
 &= \\
 &550 \text{ kW} \div 10 \text{ trucks} \\
 &= \\
 &55 \text{ kW/truck}
 \end{aligned}$$

Overnight per-vehicle charging rate (kW)

$$\begin{aligned}
 &= \\
 &412.5 \text{ kW} \div 10 \text{ trucks} \\
 &= \\
 &41.25 \text{ kW/truck}
 \end{aligned}$$

Assessing outage risk

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Assess the fleet’s energy needs with the site’s outage risk against the amount of downtime the organization can accept. Decide whether the fleet can keep serving routes during the outage you are planning for or needs storage or backup power.

Compare business needs with historical outages and a reasonable severe-event scenario. Historical data can inform planning but cannot predict the timing or length of future outages.

If expected outages would not disrupt critical vehicles or routes, a resiliency plan may not be needed yet. If outages would disrupt operations and the organization cannot tolerate the downtime, continue to explore your resiliency needs.

If outages may disrupt operations, choose a planning level.

Recent historical average outages

Use the outage length and frequency your site has experienced over recent years, especially events that could interrupt charging before the next shift.

Anticipated worst-case outage

Use the longest recorded outage or a reasonable anticipated severe event, including weather, terrain, longer routes, or emergency-response needs.



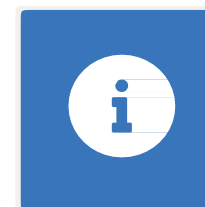
TERMS YOU NEED TO KNOW

Outage propensity: How often outages occur at your site and how long they last

Service configuration: How the depot receives power, and whether all chargers use one electrical circuit or are divided among several circuits

Critical or Essential vehicles: vehicles that must keep running during an outage, such as emergency response, transit, water, or waste vehicles

Acceptable Downtime: How long charging can stop before the outage affects service, customers, safety, or legal requirements



Connect with PG&E EV Advisory Services to assess outage risk.
EVAdvisoryServices@pge.com

Business impact and risk tolerance for EV Fleet resiliency

Business impact is what an outage costs the organization and how it affects service. Examples include missed work, overtime, delayed routes, slower field response, or safety concerns. Acceptable downtime is how long the organization can manage these effects before it needs a resilience solution.



A short interruption may be acceptable when non-critical vehicles can wait, work can be rescheduled, and no safety, service, or customer commitment is at risk.

Examples include delaying non-critical vehicles, recovering a missed route the next day, or notifying customers when the service impact is limited and temporary.



A missed shift may have serious consequences when vehicles support emergency response, public transit, school transportation, utility restoration, or other critical work. Each organization should determine which services must continue and how much disruption it can accept.

Prolonged or repeated outages can also become unacceptable when they create safety risk, service gaps, revenue loss, overtime, penalties, or missed customer commitments.

Start by asking whether your organization can accept a short disruption. Then ask whether it can accept a long or repeated outage. If critical vehicles cannot miss a shift, use the next slide to compare vehicle state of charge with the outage scenario.

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Decide if you need a resiliency solution

EXPECTED RETURNING SoC CALCULATION

$$\begin{array}{lcl} \text{Percent of battery used (\%)} & = & \frac{\text{Charging energy requirement (kWh/charge)}}{\text{Usable battery capacity (kWh)}} \times 100 \\ \hline \text{Returning State of Charge (\%)} & = & 100\% - \text{Percent of battery used (\%)} \end{array}$$

Charging energy requirement = VMT × kWh/mile (see Slide 10).

State of charge requirements

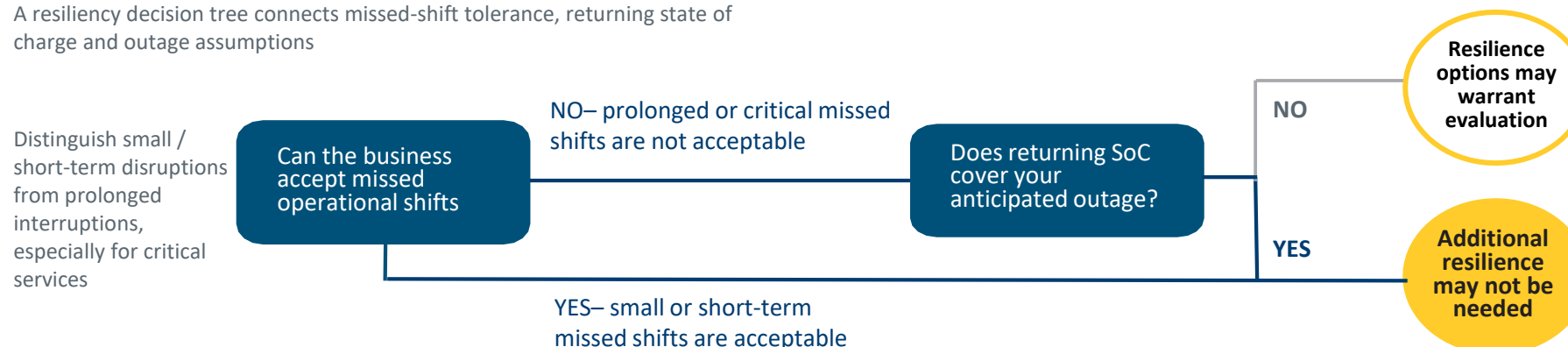
Returning state of charge (SoC) is the charge a vehicle is expected to have at the end of its shift, and it helps determine whether the vehicle can continue operating during an outage. Start by using the charging baseline from slide 10 to estimate each vehicle's battery charge at the end of its shift.

Apply the formula in the Expected Returning SoC Calculation table using worst-case daily VMT for each vehicle in your fleet. Compare the returning SoC to typical and worst-case outage durations at the site to determine whether critical vehicles can cover the next required shift.

Use the anticipated outage that matches the planning and priority of your business. Some fleets plan to a typical outage event based on recent experience, while others choose a worst-case event because missed critical shifts are unacceptable. This customer choice sets the outage length that returning SoC must cover. If missed shifts are tolerable, resiliency may not be needed. If they are not tolerable, check whether your critical vehicles have enough return SoC to keep operating through the outage you plan for. Use returning SoC, energy needed for each required shift, and the minimum operating reserve to estimate how long a vehicle can remain in service without charging.

FIGURE 7:

A resiliency decision tree connects missed-shift tolerance, returning state of charge and outage assumptions



Resilience options may warrant evaluation

Additional resiliency may not be needed

Distinguish small / short-term disruptions from prolonged interruptions, especially for critical services

Can the business accept missed operational shifts

NO— prolonged or critical missed shifts are not acceptable

Does returning SoC cover your anticipated outage?

NO

YES

YES— small or short-term missed shifts are acceptable

Four-phase resiliency operations checklist

Establishing resiliency procedures is often one of the most cost-effective ways to improve fleet preparedness before investing in backup power systems or other infrastructure. The checklist below breaks the processes into four phases your team can follow before, during, and after an outage.

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1. Preparation

- **Assign staff roles and responsibilities** for outage monitoring, incident communication, and fleet coordination.
- **Evaluate charging infrastructure** against emergency capacity needs (e.g., current charging site locations, power capacities, and available EV charging ports).
- **Explore backup charging alternatives** including nearby public charging stations and private charging options, and verify that off-site locations can support your fleet's vehicle types and charging needs.

3. Operational response

- **Categorize disruptions** by how long it may last and how much power is available. For example, identify whether part of the depot has failed or the full depot has lost power and then choose the appropriate response.
- **Prioritize charging** for critical service vehicles (e.g., emergency response, essential delivery) and delay charging for vehicles that support non-essential business operations.
- **Reroute vehicles** to undisrupted internal charging sites, public networks, or contracted depots.

2. Detection and prevention

- **Enroll in automated utility alerts** and maintain an internal communication strategy (e.g., PSPS notifications, critical alerts via calls, texts, or emails).
- **Monitor utility outage notifications and site-level infrastructure alarms** to identify potential disruptions early.
- **Test backup power systems and emergency procedures** through scheduled drills and periodic equipment commissioning tests.

4. Recovery and restoration

- **Regularly check and restore charging equipment**, then verify stable charging operations before resuming business as usual.
- **Use charging management software or vehicle-level controls** to prioritize limited charging capacity for critical vehicles.
- **Verify staff knowledge and coordination** with external partners, then incorporate lessons learned.

Planning factors assessment checklist

Use this checklist to ensure you have the right inputs ready for your planning process and for the assessment tool.

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Outage risk and historical data

- ☒ Gather recent historical outage data for your site (e.g., last several years), including outage length and frequency
- ☒ Define your average (typical) outage based on what your site has experienced historically
- ☒ Define a worst-case outage as a potential severe event (e.g., storms, floods, earthquakes, or other major disruptions)
- ☒ Decide whether your planning will be anchored to average outages, worst-case events or both

Fleet operations and energy use

- ☒ Record how vehicles are used: daily vehicle miles traveled (VMT), schedules, critical routes, and work periods
- ☒ Identify typical depot dwell times and charging windows (when vehicles are parked and available to charge)
- ☒ Calculate site energy needs for the fleet over your planning window (e.g., kWh per vehicle, number of vehicles, and total kWh per day)
- ☒ Determine returning state of charge (SoC) for vehicles at the end of their shifts

Business impact and risk tolerance

- ☒ Identify which services and vehicles are truly critical (e.g., emergency response, essential deliveries) versus those that are less time-sensitive
- ☒ Clarify whether the business can tolerate missed operational shifts at all. If yes, define “small” versus “prolonged” impact
- ☒ Estimate the financial and operational cost of missed shifts (e.g., lost revenue, service disruption, safety)

Charging strategy, cost, and resiliency fit

- ☒ Document existing or planned charger power levels (kW) and verify whether they match real dwell times, namely whether you truly need higher-power chargers or could rely on lower-power options
- ☒ Map charging windows against peak and off-peak pricing periods to understand how timing affects total cost
- ☒ If analysis shows critical operations would be interrupted under your chosen outage scenario and risk tolerance, flag the site as a candidate for resiliency solutions and use the assessment tool



Managing EV charging for resiliency



Charging management and alternatives

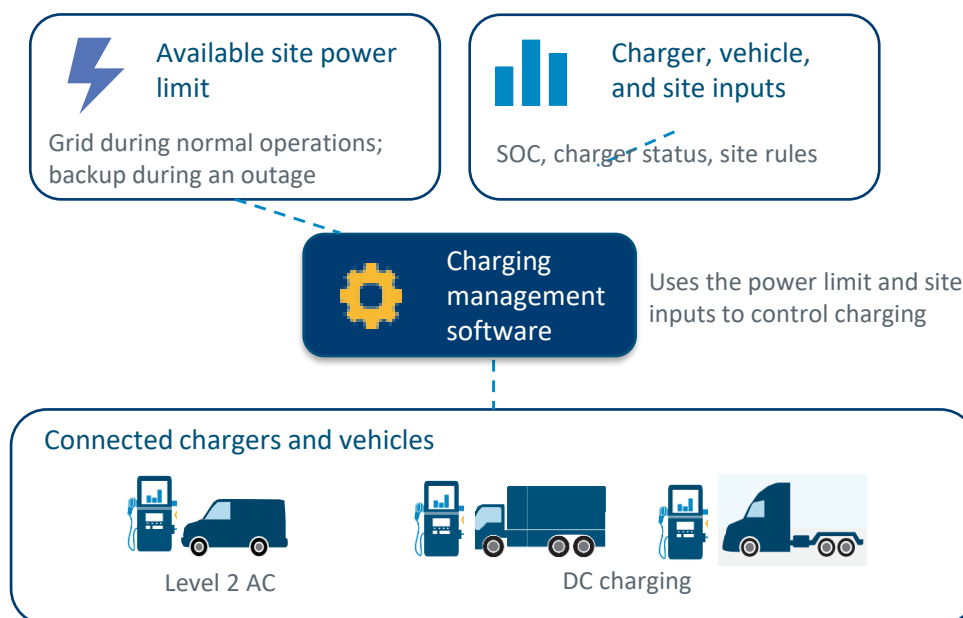
Managing when and how vehicles charge can improve fleet resilience. The goal is not to prevent every brief outage. The goal is to make sure critical vehicles have enough charge before they are needed.

Charging software and related tools can control which chargers receive power first during an outage and how much power goes to each charger, so limited backup power is used where it is most needed.

This section explains how charging design, software controls, vehicle telematics, energy management, and alternative charging options work together to keep fleets operating during both routine conditions and disruptions.

FIGURE 8:

During normal operations or an outage, charging software can use the available site power limit and charger, vehicle, and site inputs to coordinate charging



TERMS YOU NEED TO KNOW

Level 2 Charger: Delivers up to 19.2 kW per port and is commonly used for long dwell or overnight charging

DC Charging: Direct-current charging equipment spans a wide range of power ratings. Choose equipment based on vehicle acceptance limits, dwell time, connector compatibility, and site capacity. Can provide faster charging when Level 2 AC charging does not meet the available charging window.

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From evaluating risk and needs to charging strategy

Before choosing equipment, review each depot's risks and operating needs. Check how often outages occur and how long they last. Identify which vehicles are critical to operations. Record daily miles, energy use, and the battery charge needed at the start and end of each shift.

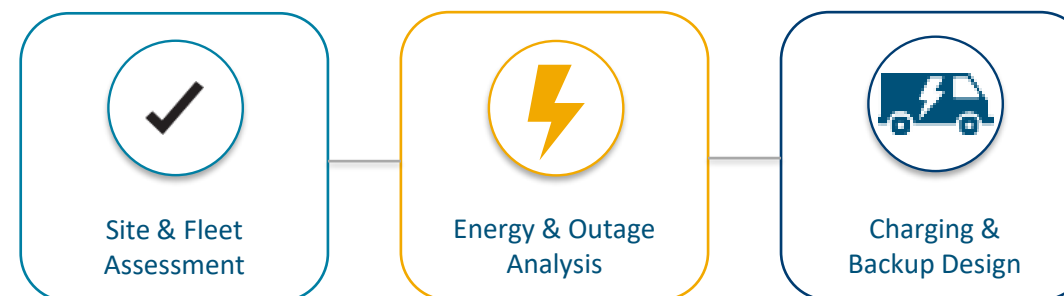
With this information, fleets decide how much on-site and backup charging capacity is needed and which vehicles must be kept operational through short or extended outages.

These risk- and needs-based assessments guide how charging software, energy management systems, and backup power are configured to keep critical vehicles moving during an event. Risk tolerance shapes the planning target. It determines whether the design assumes a recent historical average outage or a reasonable worst-case event.

FIGURE 9:

Site risk, fleet energy needs and risk tolerance guide charging and backup design decisions

Use the assessment results to make four charging decisions: which vehicles charge first, how much charge they need, the site power limit, and what charging must continue during a communications or power outage.



Use outage, vehicle, and charging data to choose a charging plan that meets the fleet's needs without adding unnecessary capacity.

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When compatible controls remain powered and available, charging software or a local controller may prioritize chargers and limit power during an outage. Fleets may send available backup power to selected chargers, either higher-power chargers or designated chargers with the same power rating, while keeping other chargers off or in low-power mode. Vehicle telematics can provide battery level, location, and status data that helps fleet operators and charging software decide which vehicles need charging first. Prioritization can also be set by vehicle ID, so priority vehicles can receive power first regardless of which charger they use.

Choose software and vehicle-tracking tools that support both daily operations and outage needs. Available features may include:

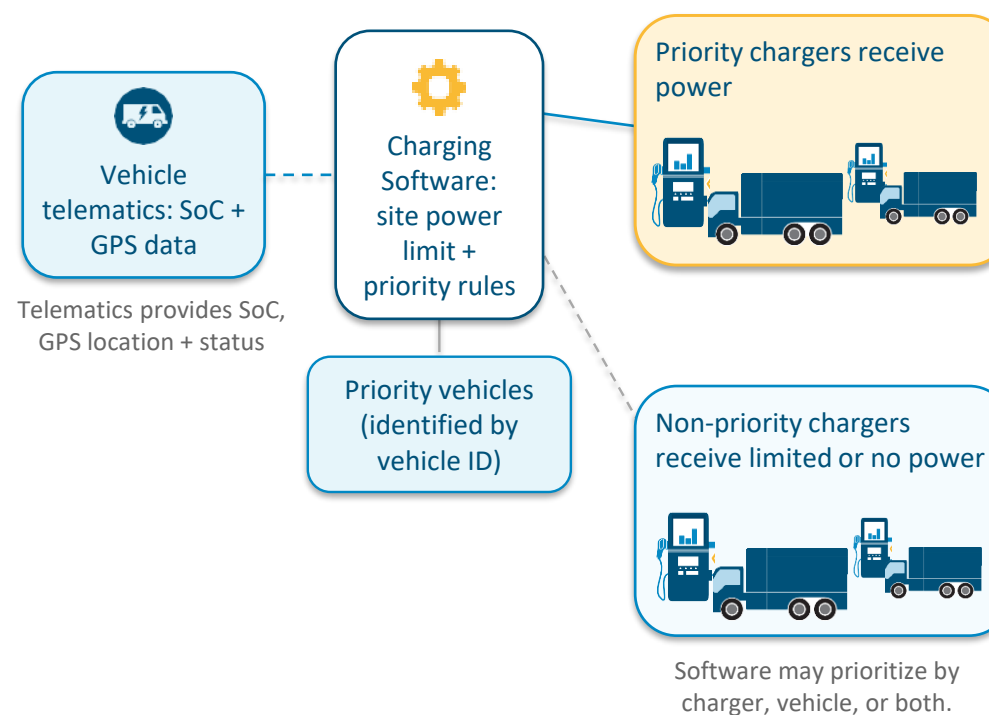
- **Live vehicle status:** Telematics platforms can track each vehicle's State of Charge (SOC), GPS location, and whether it is charging, driving, or parked.
- **SoC- or route-based prioritization:** This data can feed into charging software, which can prioritize charging based on SOC or route assignments.
- **Group vehicles that must charge first:** Some platforms allow fleets to group critical vehicles. If the telematics and charging systems are connected, these groups can inform which vehicles charge first.
- **Targeted mobile resiliency backup:** Telematics data can help identify which sites have the most vehicles running low on battery and where to send mobile backup power first.

Design practice:

Fleets may use charger tiers, for example Level 2 and medium-power DC chargers for routine charging and a smaller set of higher-power chargers for urgent needs, or designate selected chargers, including chargers with the same power rating, to receive backup power first. A site power limit and priority order can help manage constrained backup power.

FIGURE 10:

Example of how software may use vehicle data and site rules to direct limited backup power by charger or vehicle priority. Selected chargers may be higher-power or the same type as other chargers



Automated Load Management and Energy Management System



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Automated Load Management

Automated Load Management (ALM), also called Dynamic Load Management (DLM), shares available power among chargers. It may start chargers at different times or charge vehicles in a set order. With compatible vehicle or telematics integration, some systems can sequence charging using state-of-charge targets. Other systems sequence charging using schedules, charger status, or fixed priorities. Some ALM software can also prioritize certain vehicles or drivers using identifiers (e.g., vehicle IDs, key cards, or PIN codes), so higher-priority vehicles receive power first.

Energy Management System

An Energy Management System (EMS) can apply a configured site power limit and monitor available backup power. With compatible controls, it may adjust charger power, so total demand remains within equipment ratings and approved operating settings. Some systems can automatically adjust the power going to each charger so that total power draw stays within the range of what the backup source can safely provide, helping prioritize charging for the most critical vehicles during an outage.

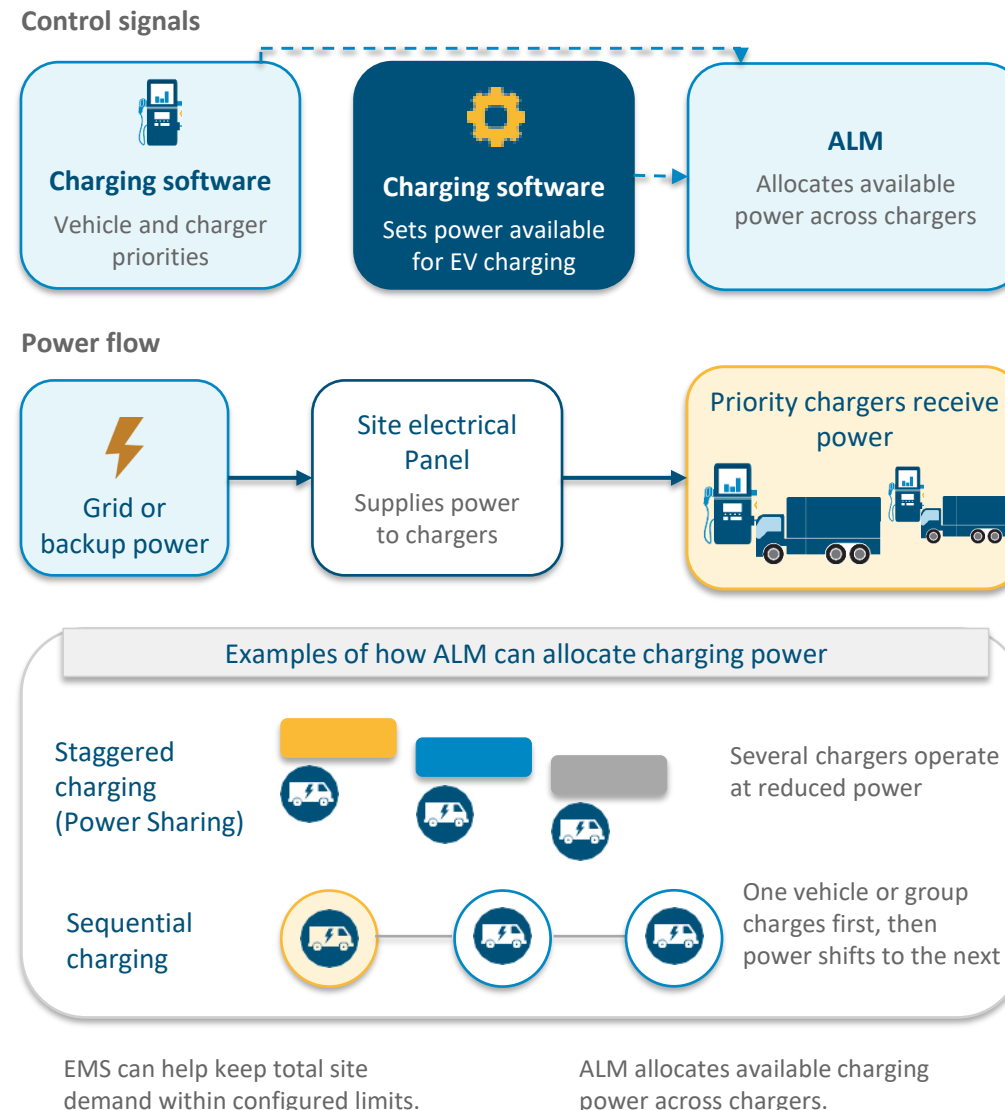
Design practice:

As fleets design their electrical systems, they may wire backup power to a dedicated panel and/or subset of chargers reserved for critical vehicles. EMS and ALM then manage how those chargers share the available backup capacity.

FIGURE 11:

An energy management system limits total site power, while automated load management shares or sequences available charging power among priority vehicles.

Solid arrows = electrical power Dashed arrows = control signals



Microgrid controllers and local energy systems

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A microgrid combines local power sources, such as solar panels, batteries, and generators. An energy management system can control these sources. During normal use, the microgrid stays connected to the utility grid. If designed and approved for islanded operation, a microgrid can disconnect from the utility grid and supply selected loads while adequate generation, storage, or fuel is available.

Design practice:

Coordinate source controls with charger rules so critical charging can continue while non-essential loads are reduced.



TERMS YOU NEED TO KNOW

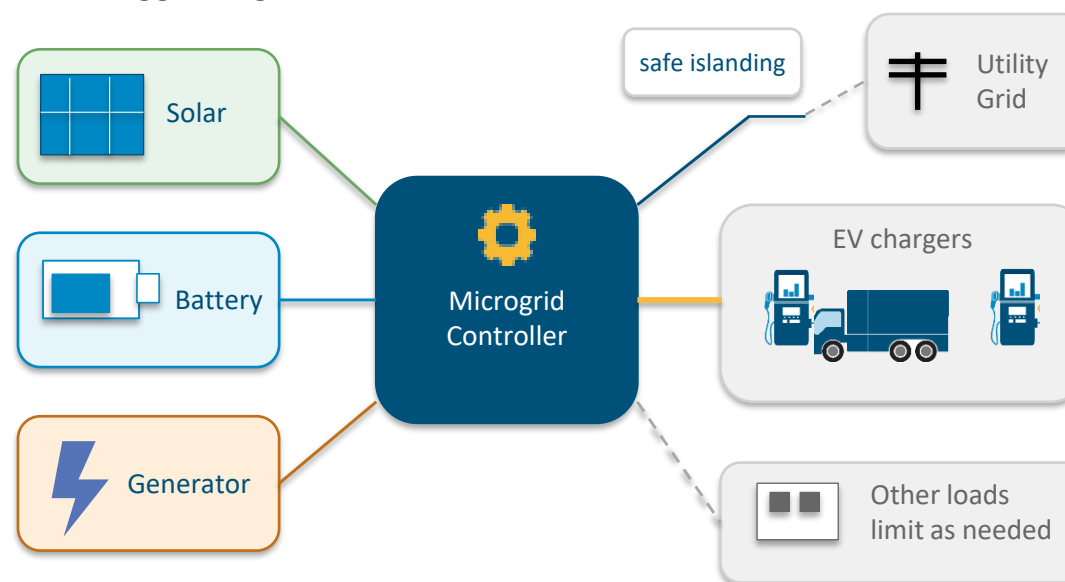
Microgrid: Local energy system that can supply critical or selected site loads using on-site energy resources, with or without the utility grid

Islanding: Disconnecting from the utility grid so on-site power can serve selected equipment

Microgrid controller: Software and equipment that manage local power sources and decide how power is shared

FIGURE 12:

The microgrid controller coordinates local energy resources and site equipment to supply critical loads during grid outages



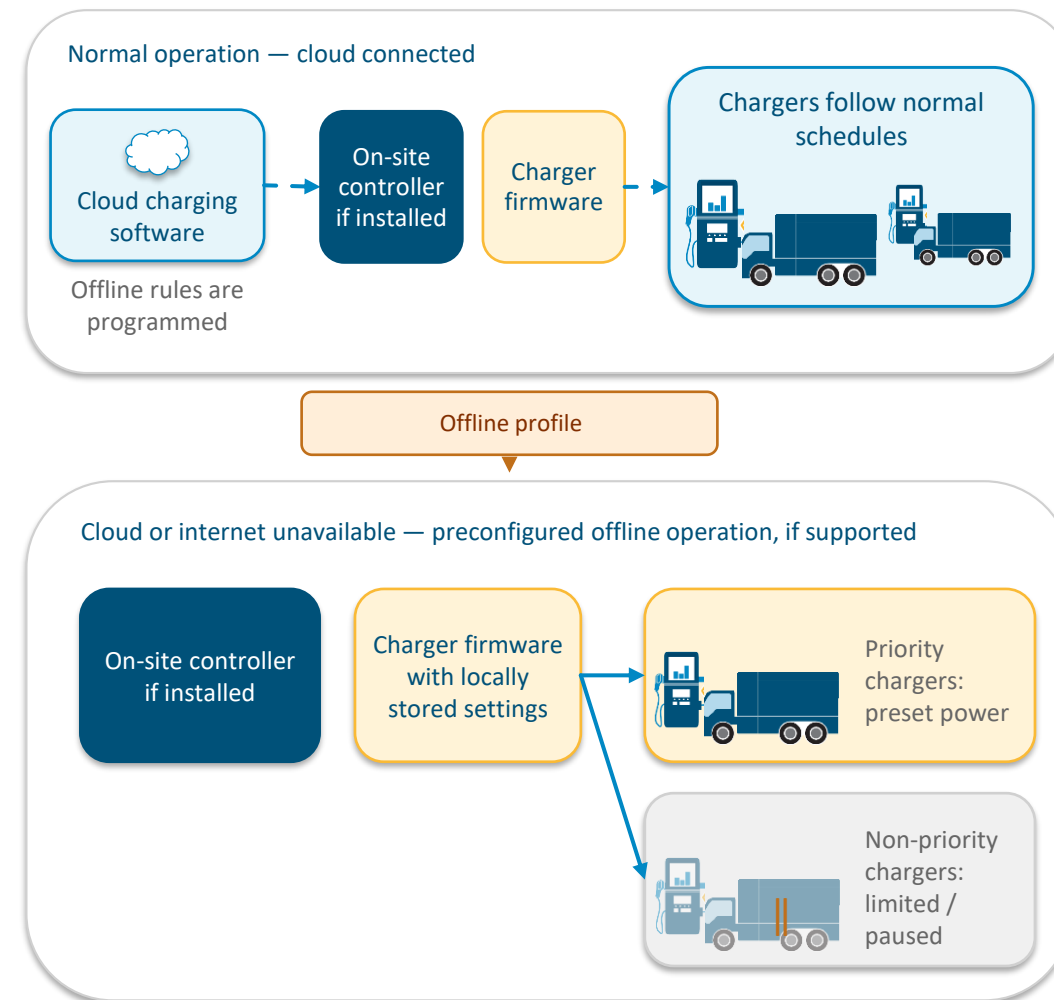
Solar, battery and generator output are coordinated as one local energy system.

Charging controls prioritize available power for critical fleet vehicles and essential facility load.

Local control, cloud outages, and emergency charging profiles

FIGURE 13:

Local controls, charger firmware, and preconfigured charging profiles can help maintain charging operations when cloud services or internet communications are unavailable



Compatible systems may continue basic charging when remote commands stop.

Stored offline profiles may preserve charging limits and priorities.

Many EV charging systems use online software to schedule and track charging. If the internet or online service fails, charging may continue only if the system supports offline use and was set up in advance. Current charging sessions may continue. New sessions and power limits depend on settings stored at the site or in the charger.

Offline settings are programmed through the charging software and sent to compatible charger firmware, software built into a charger, or an on-site controller before an outage. These settings may define which chargers remain available and the preset power limit for each charger. If an on-site EMS or controller is installed and designed to operate locally, it may continue managing site power without a cloud connection. Local-control capabilities vary by system and should be confirmed with the charger and software providers.

Fleets may be able to configure an emergency charging profile in advance:

- **Normal profile:** optimizes vehicle readiness and charging cost.
- **Offline profile:** saved charging rules used when internet service is unavailable that may allow selected chargers to continue at preset power limits while reducing or pausing non-priority chargers.
- **Testing:** confirm the system's behavior when cloud communication, site internet, and grid power are unavailable under separate test scenarios.

Software selection checklist

Software and vehicle-tracking tools affect both daily operations and outage response. Check whether they work offline, set priorities by vehicle or charger, manage charging across equipment operating at different voltage levels, and connect with site energy controls. Some systems may also support local control and preconfigured offline profiles when cloud or internet communications are unavailable. These capabilities vary by charger and software combination and should be confirmed in advance.

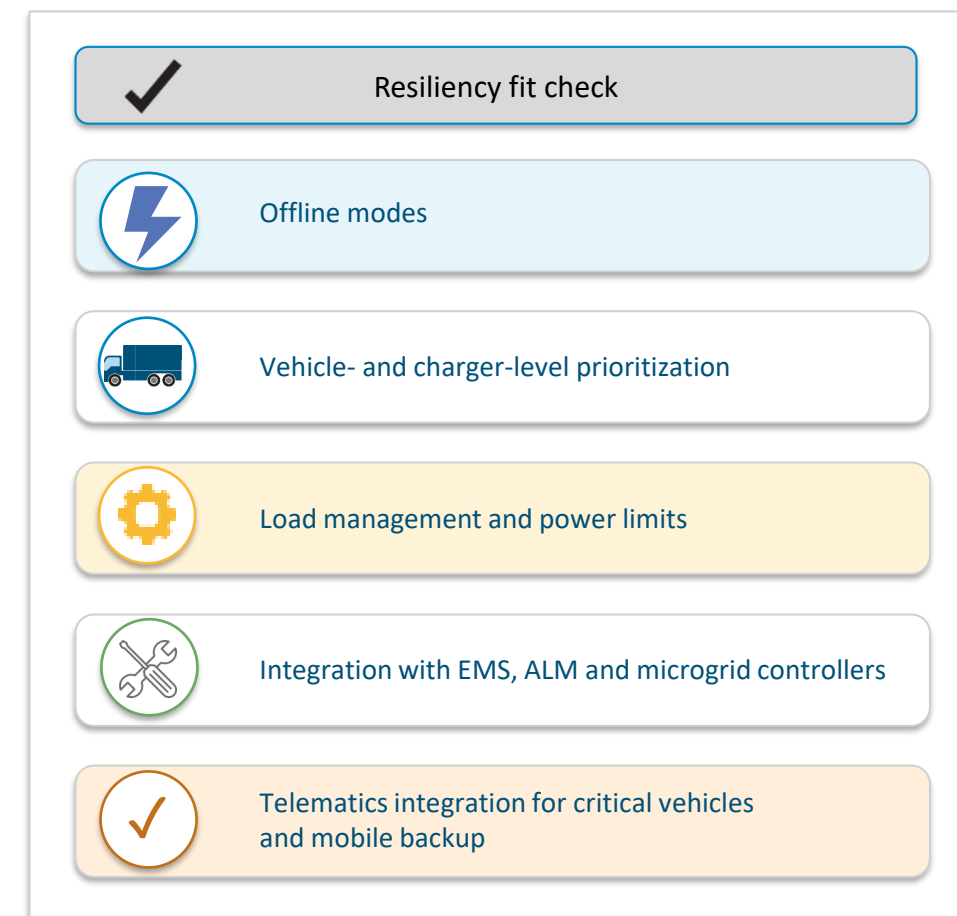
Vehicle telematics platforms can track each vehicle's State of Charge (SOC), GPS location, and operating status. Some platforms may also allow fleets to group priority vehicles, such as emergency response units. When the telematics platform and charging software are connected, this data can help determine which vehicles charge first. For fleets with a mobile backup strategy, telematics data can also help identify which sites have the most vehicles running low on battery and where backup equipment may be needed first.

Design practice:

Test normal scheduling, load management, and offline operation with cloud and telematics connections disabled.

FIGURE 14:

Use resiliency criteria to evaluate how charging software and telematics perform during normal operation, communications loss, and power outages



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Backup charging options: public and private charging

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Public	Private
Off-site charging is a low-cost way to add resiliency by identifying nearby public charging stations that can support your fleet during outages. Confirm vehicle fit, connector compatibility, payment, travel time, available capacity, and likely demand during the outage. When researching options, choose stations that are on a different part of the power grid than your depot. If a station is on the same part of the grid, it will likely lose power during the same outage. Fleets should verify that stations are accessible for their vehicle types and plan for the possibility that public chargers may be occupied during widespread outages. Identifying several backup stations in advance is recommended. When possible, prioritize stations with the highest power chargers (e.g., DC Fast Chargers) to recharge vehicles quickly.	Fleets without on-site backup power may use a Charging-as-a-Service site or arrange to charge at another local organization, such as a fleet yard, school district, or business. Charging-as-a-Service providers operate charging sites under contract. Review each agreement for reserved capacity, response obligations, outage limitations, backup-power capability, and remedies if service is unavailable. This is a well-established and growing service model, especially in California, and can be a lower-cost option compared to purchasing and installing on-site backup power.

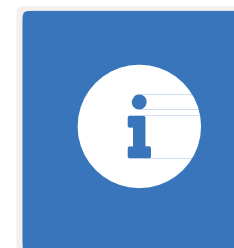


TERMS YOU NEED TO KNOW

Charging as a Service (CaaS): Paying another company for access to fleet chargers

Local grid area: The portion of the power system that serves a site and nearby customers

Partner site: Another organization's charging location arranged for backup use



Find public charging options:
[EV Charging Station Map | PlugShare](#)
[Map of Charging Stations | PG&E](#)



Choosing the right Hardware technology



Choosing the right hardware technology

Adopting new hardware resiliency technologies (generators, batteries, microgrids, hydrogen fuel cells) can improve your fleet resiliency through backup power and energy management. These options require a varied range of upfront capital costs, so it is important to consider operational priorities, available space, and budget before moving forward. Backup power sources can be deployed as either stationary (permanent system installed onsite) or mobile (temporary system rolled in to the site when needed, often mounted on a trailer).

Consider the following factors when evaluating hardware resiliency technologies:



Maturity & reliability

Whether a technology is well-established and widely deployed in commercial fleets can affect how confident you are in its long-term, real-world performance.



Power output & runtime

The amount of power a technology can deliver, how reliable that power is, and the duration power can be sustained determines whether the power output can support your fleet during short or extended outages.



Upfront costs & ongoing expenses

Capital investment, fuel or energy costs, and maintenance all factor into the short-term and long-term cost of a resiliency solution.



Space & site constraints

The space and access available at the site affect whether a permanent or mobile option can be used and how much backup equipment will fit.



Environmental & community impact

Emissions, noise levels, and local air quality regulations may shape which technologies align with your organization's sustainability goals and permitting requirements.



Charging strategy & load management

A technology's ability to manage how and when vehicles charge can affect how well your fleet can prioritize critical vehicles during an outage, shift charging times when needed, and extend limited backup power.



TERMS YOU NEED TO KNOW

Load spikes: Sudden rises and drops in electricity demand. Fast chargers can cause big, quick jumps when a vehicle starts charging

Runtime: How long a backup power system can keep running on a full tank or full battery before it needs more fuel or recharging

Parallel operation: Running compatible generator units together through equipment that synchronizes, controls, and protects the combined system

Modular design: Equipment made from standard units that can be added or removed as power and energy needs change

Peak shaving: Reducing the site's highest grid-power use with stored energy, on-site generation, or load controls

CNG (Compressed Natural Gas): Natural gas compressed to high pressure for storage or transport

LNG (Liquefied Natural Gas): Natural gas cooled into a liquid for denser storage and transport

Upstream emissions: Emissions produced while a fuel or energy source is made, processed, and transported before it is used on-site

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Diesel generators | Summary

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Key Takeaways

- Diesel generators may fit sites with high energy needs, long outages, and limited space. Trailer-mounted units can be moved to a prepared site and connected when needed.
- Well suited to mobile outage response, since trailer-mounted units can be transported to a site, connected, and produce power within minutes of arriving.
- Multiple units can be operated in parallel to combine output when more power is needed.
- Size generator for the expected use and confirm loading and testing needs with the manufacturer.
- Engines can experience harmful buildup under certain conditions, such as prolonged low power output

Specifications

- **Power output:** units up to 1.5 MW are readily available, covering a range of fleet sizes
- **Footprint:** ~60–100 sq ft for the generator itself (500 kW unit); ~200–400 sq ft with space for clearance and fuel storage
- **Runtime:** depends on generator size, stored fuel, and refueling
- **Purchase cost:** ~\$400–\$1,000 per kW (excludes installation)
- **Ongoing expenses:** \$0.30–\$0.60 per kWh (fuel and maintenance)
- **Emissions / noise:** ~40% more CO2 and ~10 dB louder than natural gas
- **Deployment:** stationary or mobile; purchase or rental

Key Benefits	Costs & Risks	Environment & Safety
• Well-established, widely deployed technology with abundant vendor, parts, and service support. • Among the easiest to deploy and lowest upfront cost of the hardware options. • Starts within seconds and absorbs sudden load spikes from DC fast chargers. • Uses less fuel per unit of energy than other combustion-fueled generators. • Available as permanent installations or trailer-mounted mobile units that can roll in and produce power within minutes.	• Does not typically qualify for energy incentives offered to cleaner technologies. • Backup duration depends on on-site fuel storage and a reliable refueling plan. • The generator may produce less power than its listed rating in hot weather or at high elevations. Running it at very low power for a long time can also cause harmful buildup in the engine. • Higher emissions can lead air districts to limit how long the generator can run, reducing available backup time. • Mobile units may still require local permits for placement, electrical hookup, and fire safety before they can be deployed.	• Highest CO2 emissions per unit of energy among generator options. • Loudest among generator options; siting near homes or offices may be limited. • Permitting requirements depend on local air rules and generator size.

Natural gas & propane generators | Summary



Key Takeaways

- Natural gas or propane generators may fit fleets with high energy needs and long outages. The site also needs a reliable fuel supply.
- These generators are usually quieter and produce fewer on-site emissions than diesel units.
- Well suited to sites where a gas pipeline connection allows continuous operation
- Multiple units can be operated in parallel to combine output when more power is needed.
- The generator may produce less power than its listed rating because of elevation, temperature, fuel type and quality, gas pressure, or emissions equipment.

Specifications

- **Power output:** units up to 1.5 MW are readily available, covering a range of fleet sizes
- **Footprint:** ~80–120 sq ft for the generator itself (500 kW unit); ~300–500 sq ft with space for clearance and fuel storage
- **Fuel and runtime:** pipeline may support extended operation; stored fuels vary based on-site inventory and resupply.
- **Purchase cost:** \$550–\$1,200 per kW (excludes installation)
- **Ongoing expenses:** \$0.10–\$0.25 per kWh (fuel and maintenance) at pipeline-fed sites
- **Emissions / noise:** ~25%- less CO2 and ~10 dB quieter than diesel
- **Deployment:** stationary or mobile; purchase or rental

Key Benefits

- Decades of fleet use; parts, service, and fuel infrastructure widely available.
- Sites with a natural gas pipeline can run continuously without refueling.
- Lower operating cost than diesel when connected to a natural gas pipeline.
- Available as permanent installations or mobile units; propane is easy to transport for mobile use.

Costs & Risks

- Does not typically qualify for energy incentives offered to cleaner technologies.
- Delivered CNG and LNG fuel costs are less predictable than pipeline gas prices.
- Natural gas produces less energy per unit of fuel than diesel, requiring more storage or more frequent deliveries.
- Gas pipelines may be shut off during major earthquakes or natural disasters; plan a backup fuel source.
- Larger footprint than diesel for the same power output.
- Natural gas generators may have minimum-load and low-load-duration requirements. Extended operation below the manufacturer’s recommended range can increase deposits, emissions, equipment wear, maintenance, and unplanned downtime.

Environment & Safety

- Lower CO2 emissions per unit of energy than diesel.
- Noticeably quieter than diesel; easier to site near sensitive areas.
- Typically fewer run-hour restrictions from air quality districts than diesel.
- Lower noise and emissions than diesel generators often simplify permitting and community engagement.
- Mobile units may still need local permits for placement, electrical hookup, and fire safety.

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Battery energy storage systems (BESS) | Summary



Key Takeaways

- Battery storage may fit fleets with lower energy needs and mostly short outages.
- Provides quiet backup power with no on-site exhaust or fuel deliveries.
- Well suited to fleets seeking outage backup and lower energy costs by reducing grid use during high-cost periods (peak shaving) and shifting charging to off-peak hours (load shifting).
- Mobile BESS units have limited deployment opportunities.
- Nameplate storage is not the same as usable energy available to the chargers. Backup calculations should include operating reserve and real-world losses.

Specifications

- **Power output:** ~250 kW systems with 1 MWh of storage are commercially available; modular systems can scale higher
- **Footprint:** ~250–400 sq ft (250 kW / 1 MWh system)
- **Runtime:** Runtime depends on the battery energy that can be used and the total power needed
- **Purchase cost:** \$225–\$1,000 per kWh (excludes installation)
- **Ongoing expenses:** ~2–3% of installed system cost per year
- **Energy source:** grid or on-site solar (no fuel needed)
- **Deployment:** stationary or mobile; purchase or rental

Key Benefits

- Commercial battery energy storage systems are available in a range of configurations; deployment experience varies by product and use case.
- Responds almost instantly to load changes; well suited to absorbing fast-charger spikes.
- Modular design lets fleets scale power and energy capacity as needs grow.
- May qualify for tax credits or incentives under current rules.
- Can lower everyday electricity bills through peak shaving and off-peak load shifting.
- Provides immediate backup power with no startup delay.

Costs & Risks

- A standalone BESS cannot recharge during an outage. When paired with an island-capable generation source, it may recharge while that source is available.
- The more power chargers draw at once, the faster the battery drains and the shorter the runtime.
- Peak shaving requires careful planning and a robust EMS to keep enough charge in reserve.
- Cost per kWh can rise with larger capacity, increasing total project cost for big systems.
- Mobile units carry less energy than stationary systems; best suited to a few critical vehicles.
- Allow for a backup reserve, battery aging, hot or cold weather, energy lost in the system, and power used by pumps, fans, controls, and other equipment.

Environment & Safety

- Zero on-site emissions, supporting long-term air quality goals.
- Quiet operation; well suited to sites near residential areas.
- Permitting requirements vary by system size, chemistry, location, fire code, and authority having jurisdiction.
- No on-site fuel storage or refueling logistics required.
- Battery cells contain materials that require proper end-of-life handling.

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Solar + BESS | Summary

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Key Takeaways

- Solar plus battery storage may fit fleets with lower energy needs and mostly short outages. It provides quiet backup power without fuel deliveries.
- The site must have enough roof or ground space for solar panels and battery equipment.
- Best suited to sites with enough footprint for solar panels and battery equipment.
- Can lower energy costs by avoiding high-cost periods (peak shaving) and shifting charging to off-peak hours (load shifting).

Specifications

- **Power output:** ~0.5–1 MW systems with 2–4 MWh of storage are commercially available; modular systems can scale higher
- **Footprint:** ~4–6 acres for solar plus 250–400 sq ft for the battery (1 MW / 1 MWh system)
- **Solar cost:** \$1,000–\$1,200 per kW (excludes installation)
- **Battery cost:** \$225–\$1,100 per kWh (excludes installation)
- **Ongoing expenses:** maintenance costs of \$20–\$45 per kW/year (solar) and ~2–3% of installed system cost per year
- **Energy source:** sunlight; can also charge from grid at off-peak hours
- **Deployment:** stationary

Key Benefits	Costs & Risks	Environment & Safety
• Well-established energy technology evolving as a resiliency option for EV fleets. • During an outage, solar can charge the battery if the system is built and approved to work when the grid is down. • Modular design lets fleets scale power and energy capacity. • Eligible for federal tax credits and state or utility energy-storage incentives. • Can lower everyday electricity bills through peak shaving and off-peak load shifting. • May export eligible solar generation when the system, interconnection agreement, meter configuration, and applicable tariff allow it.	• Among the more expensive hardware options upfront, although tax credits and incentives may reduce the cost. • Battery cost per kWh tends to rise with capacity, raising total project cost for large systems. • Requires large land or rooftop area for solar; tight sites may only support partial fleet charging during outages. • Output varies with sunlight, time of day, and battery capacity. • Permitting for solar, battery, and grid interconnection can take significant time. • Peak shaving requires careful planning and a robust EMS to keep enough reserve for outages.	• Zero on-site emissions, supporting long-term air quality goals. • One of the cleanest hardware options for fleets pursuing sustainability goals. • Solar output will still change with sunlight, weather, season, and shade. • Quiet operation; well suited to sites near residential areas. • Fewer community concerns often mean easier permitting than fuel-powered options. • No fuel storage or refueling logistics required.

Microgrid | Summary



Key Takeaways

- A microgrid can combine generators, renewable power, battery storage, and controls in one system.
- Specifications of microgrid solution vary significantly based on underlying product and its configuration
- May be considered where coordinated on-site generation, storage, and controls can reduce or shift grid demand while meeting fleet needs and interconnection requirements.
- Can be a solution for sites that need to continue operations even when disconnected from the grid.
- Confirm microgrid can start without grid power, control its equipment, and supply the selected chargers and other key loads.

Specifications

- **Power output:** systems up to ~1.5 MW are commercially available, covering a range of fleet sizes; total output varies by hardware mix
- **Footprint:** varies by selected components and required clearances
- **System components:** solar, battery storage, generators, and optional wind; managed by an EMS
- **Purchase cost:** varies by design and hardware mix (excludes installation); can be upward of \$2M depending on system
- **Ongoing expenses:** \$120,000–\$350,000 per year, depending on hardware, fuel use, and outage frequency
- **Deployment:** stationary

Key Benefits

- A microgrid can combine generators, renewable power, battery storage, and controls in one system.
- A microgrid can run during an outage only if it is designed, approved, and tested to disconnect safely from the grid.
- EMS gives operators control over which chargers run and at what power level.
- Battery handles fast-charger load spikes while other sources recharge it over time.
- The system may reduce emissions by using solar, wind, or stored battery energy before fuel-powered generators.

Costs & Risks

- Highest purchase cost among the hardware options.
- Ongoing operating cost is significant due to fuel, maintenance, software, and insurance.
- More complex to design, build, and permit than single-technology solutions.
- Each component may require separate approvals from local authorities.
- Charging capacity and runtime depend on the hardware mix; systems with generators also depend on a continuous fuel supply.
- Still relatively new for EV fleet resiliency; vendor experience varies.

Environment & Safety

- Environmental impact varies with the mix of components selected.
- Solar, wind, and battery components produce zero emissions and run quietly.
- Permitting is generally more complex than for single-technology solutions.
- Site planning must allow clearance and maintenance access around each piece of equipment.

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Hydrogen fuel cell | Summary

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Key Takeaways

- Fuel cells may be considered for fleets with high daily energy needs or long outages. They may also support goals for low on-site emissions.
- Still emerging technology for EV fleet resiliency, with limited pilot deployments and demonstrations.
- Among the most expensive hardware options upfront, with limited hydrogen infrastructure and specialized vendor support adding planning challenges.
- Suitability for EV-fleet resilience depends on system design, hydrogen supply, site requirements, and operating conditions.

Specifications

- Power output:** modular 125 kW units can be combined to provide ~1 MW; total output varies by system design
- Runtime:** depends on stored hydrogen and how much power the system delivers
- Purchase cost:** upwards of \$7,000 per kW (includes hydrogen storage); varies by system size and storage capacity
- Ongoing expenses:** ~\$100 per kW per year maintenance; hydrogen fuel costs ~\$16 per kg
- Footprint:** up to ~10,000 sq ft, including storage and safety clearances (1 MW system)
- Deployment:** stationary

Key Benefits	Costs & Risks	Environment & Safety
- Commercial fuel-cell systems are available - Can provide continuous backup power for a full day or longer when enough hydrogen is stored. - Modular design allows multiple units to be combined for larger power needs. - Federal Investment Tax Credit (ITC) can help offset high upfront costs.	- Among the most expensive hardware options to purchase. - Hydrogen supply infrastructure remains limited; availability varies by region. - May respond slowly to sudden increases in charging demand, so it may need to be paired with a battery that can provide startup power immediately. - How long the system runs and how much power it provides depend on the amount and quality of hydrogen, weather, the system’s own energy use, and fuel delivery. - Storage tanks drive a larger footprint than other hardware options. - Strict safety requirements apply to storing and handling high-pressure hydrogen.	- No combustion emissions at the point of use; the fuel-cell system produces electricity, water, and heat. - Life-cycle emissions depend on hydrogen production and delivery. - Runs significantly quieter than fuel-burning generators. - Upstream emissions can be significant if hydrogen comes from nonrenewable sources. - High-pressure hydrogen storage requires strict safety protocols due to flammability. - Permitting is complex; coordinate with local authorities on storage and handling.

How fleet charging and resiliency assets can affect site power needs

EV charging changes how much grid power a depot uses and when it uses it. Batteries, solar, and generators may lower, shift, or add demand. PG&E reviews the expected demand and how the equipment will operate to determine whether service upgrades or a separate grid-connection review may be needed.

Three impacts to evaluate when adding fleet charging and resiliency assets



Fleet charging can raise site demand

EV charging adds to the site's existing building demand and may create a new peak when many vehicles charge at once. Managed charging can shift or spread charging to reduce the combined peak.



Resiliency assets can reshape grid demand

Battery storage can discharge during high-demand periods, while solar can reduce grid demand during daylight. However, a battery charged from the grid can also add load. The overall effect depends on when each asset charges, generates, or discharges.



Higher grid demand may require utility upgrades

Utility upgrades are driven by the project's expected peak grid demand. EV charging may raise that peak; battery storage may lower it through peak shaving or raise it when charging from the grid. PG&E reviews the combined load to determine whether the transformer, service equipment, or upstream grid needs upgrades.



TERMS YOU NEED TO KNOW

Demand Charge: A fee based on the site's highest average use of electric power during a set period. Whether it applies and how it is calculated depend on the rate plan

Transformer: Equipment that changes electricity from one voltage level to another for delivery or use.

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Vehicle-grid integration: managed charging and bidirectional power

Vehicle-grid integration (VGI) helps EV charging work with fleet, site, and grid needs. It includes managed charging, which changes when or how fast a vehicle charges. It may also include two-way charging, which sends power from a compatible EV to a building or the grid.

Managed charging—V1G

Charging software schedules when and how fast vehicles charge based on factors such as departure needs, electricity prices, and grid conditions. This can lower charging costs and reduce peak site demand, but it does not provide backup power during an outage.

Bidirectional charging—V2X

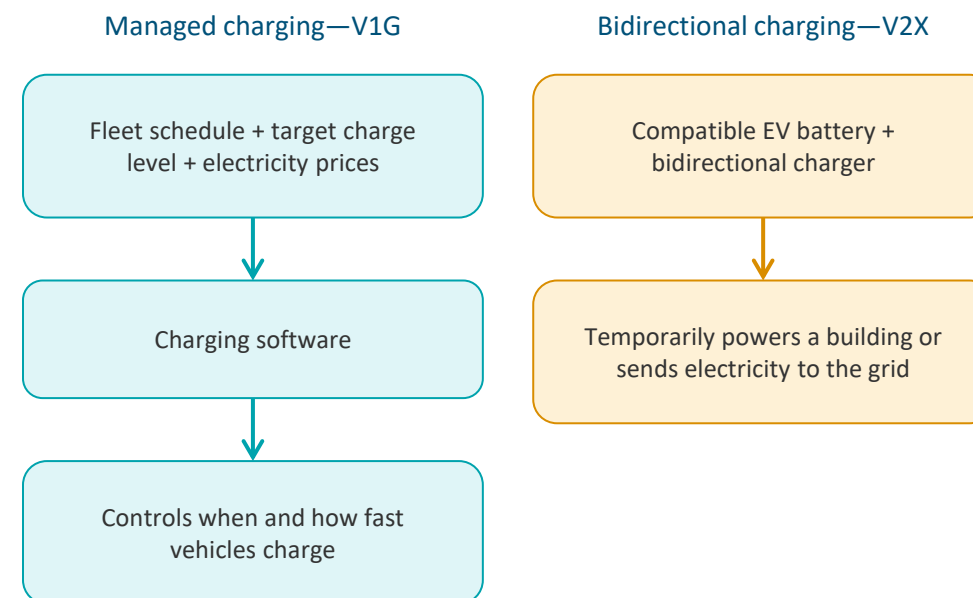
With compatible vehicles and chargers, an approved interconnection, islanding and transfer equipment, site controls, and sufficient vehicle availability, stored vehicle energy may temporarily supply approved building loads or export to the grid.

Fleet-planning consideration

Before relying on V2X for resiliency, confirm that vehicles will be plugged in with enough stored energy when an outage occurs and that the selected vehicles, chargers, and site design support backup operation.

FIGURE 16:

VGI includes one-way managed charging and, where compatible equipment and approvals are in place, two-way power from an EV battery



TERMS YOU NEED TO KNOW

Vehicle-grid integration (VGI): Coordinating EV charging with fleet, site, and grid needs; includes managed and bidirectional charging

Managed charging (V1G): One-way control of when and how fast vehicles charge

Bidirectional charging (V2X): Sends power from an EV battery to a building (V2B) or the grid (V2G)

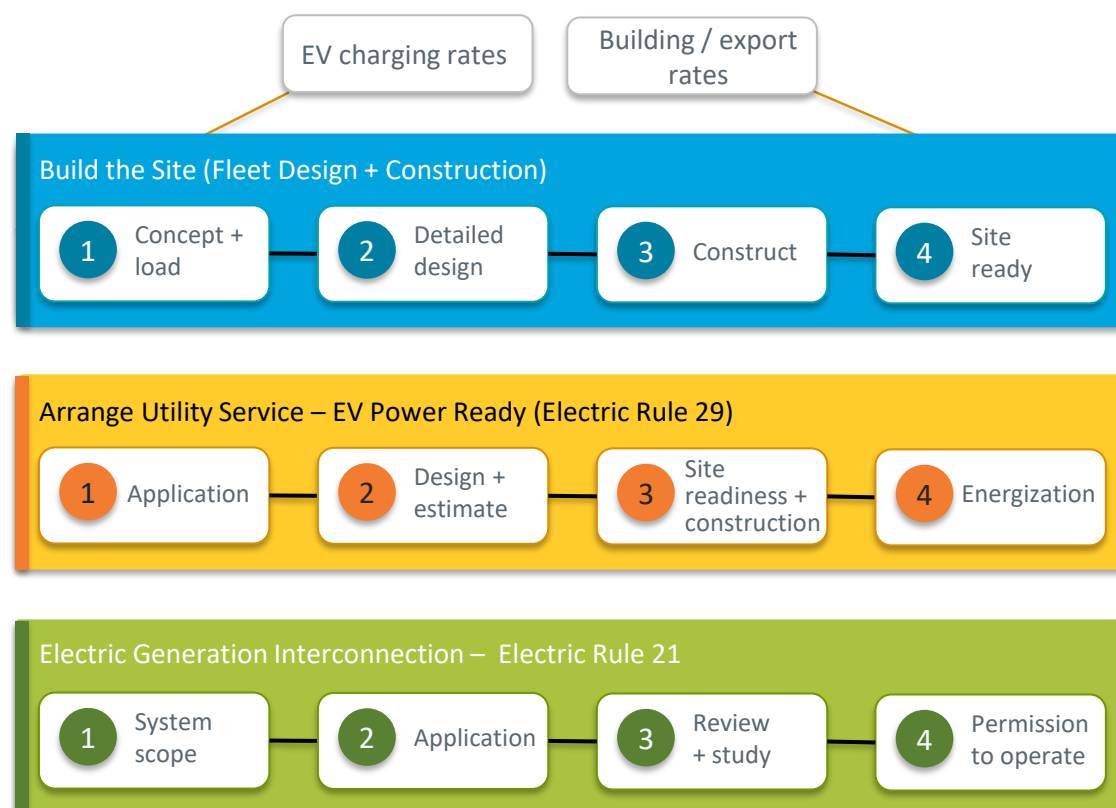
Permits, interconnection, and rates

Permitting, interconnection, and rates can shape project timing and cost. Before selecting equipment, define current and future EV charging, building loads, and the portion of site operations that must remain powered during an outage.

Two PG&E processes may need to move in parallel. EV Power Ready (Electric Rule 29) supports new, separately metered EV-charging service and utility-side infrastructure up to the EV service meter. Electric Rule 21 applies when on-site generation or storage will interconnect and operate in parallel with PG&E's grid. Utility review may identify system upgrades that affect project costs, construction sequencing, and energization timing.

FIGURE 15:

Plan utility service, grid connection, construction, and electricity rates at the same time.



Permanent equipment may require building, electrical, fire, and environmental approvals. Mobile equipment can reduce permanent site work but still requires connection, safety, staging, and dispatch planning. Select rate schedules early: identify which meters serve EV charging and building loads, account for any planned energy export, and compare time-of-use prices and other recurring charges. Revisit the rate strategy as the fleet grows.



TERMS YOU NEED TO KNOW

Electric Rule 21: PG&E tariff governing how on-site generation and storage connect to and operate in parallel with the grid

EV Power Ready (Electric Rule 29): PG&E pathway for new, separately metered EV-charging service and the utility-side infrastructure serving it

Permission to Operate (PTO): PG&E's written approval allowing an interconnected generation or storage system to operate in parallel with the grid

Tariff/Rate schedule: Billing rules and prices that apply to a meter, type of electricity use, or energy-export arrangement

Rate Plan: The prices and billing rules for an electric account

Electric Vehicle Rate Considerations and Bill Optimization Strategies

Fleet electrification changes electricity use and cost. EV rates and incentive programs may help manage those costs. PG&E provides several rate structures designed for EV fleets, along with incentive programs that pair with on-site storage and generation. Review the rate, meter, charging schedule, and on-site energy options that apply to your fleet.

Rate structures and bill-management considerations

● Applicable rate schedule

PG&E offers two business EV rates. BEV-1 is intended for fleets with monthly peak demand below 100 kW. BEV-2 is intended for fleets above 100 kW. Both replace traditional demand charges with a monthly subscription. Customers without separately metered EV charging loads typically remain on their standard commercial service tariff and applicable Time-of-Use rate structure.

● Bill reduction with on-site battery or solar

A battery installed on the customer's side of the utility meter, behind-the-meter, can supply power during high-use periods and may lower the peak used to calculate demand charges. On-site solar offsets energy during midday. PG&E's Self-Generation Incentive Program (SGIP) may provide incentives that offset a portion of eligible battery storage project costs, and Net Energy Metering (NEM) credits solar generation sent back to the grid.

● Resiliency-specific savings opportunities

A resilient depot may reduce the operational cost of missed shifts during an outage when the selected solution is available and sufficient for the required fleet load. Demand response programs may pay or credit the fleet for reducing electricity use when the grid is under strain. In some situations, temporary mobile energy assets may be an applicable alternative, potentially reducing the need for permanently installed backup generation.



TERMS YOU NEED TO KNOW

BEV-1: PG&E's Business Low Use EV Rate; designed for smaller fleets and slower charging

BEV-2: PG&E's Business High Use EV Rate; designed for larger fleets and DC fast charging

Time-of-use (TOU) rate: A rate with electricity prices that change by time of day

Subscription Charge: A monthly charge based on the amount of charging power selected for the account

SGIP: A California incentive program administered by utilities for eligible distributed-energy projects

Solar export compensation: Credits or payments under the customer's applicable export tariff

Demand response (DR): A program that provides bill credits for cutting load when the grid is stressed

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Decision framework: choosing a technology

Use the information already collected about energy needs, outages, site limits, critical vehicles, and budget. List the chargers and site equipment that must keep running during the outage you are planning for.

These five questions help narrow the options and identify which main and backup solutions should be reviewed in more detail.



Energy requirement

How much energy (kWh) must be supplied to the critical load during the expected outage?

Lower energy needs may require a smaller system; higher needs may require more capacity or combined resources.



Critical-vehicle share

What share of the fleet must remain in service during an outage?

If more vehicles must keep running, the site may need more backup power or extra equipment that can take over if one part fails.



Ownership vs. service model

Would the fleet rather buy and own equipment or pay a provider for access and service?

Charging as a Service (CaaS) is introduced on slide 29.



Outage duration / risk

How long have recent outages typically lasted, and what severe event should the plan anticipate?

Longer outages require more backup energy or a way to keep supplying power.



Site footprint

What space, access, and safety clearances are available?

Available space and site constraints can limit the size and type of solution that can be installed.

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Frequently asked questions



Q How do I keep my fleet charging if the internet connection or cloud software goes down?

Most EV charging systems use cloud software (programs that run on remote servers and manage your chargers over the internet) for tasks like scheduling, reporting, and monitoring. If the internet connection or cloud system goes down, charging may continue only when the chargers and controls support offline operation and were configured and tested in advance. Many chargers also connect through multiple paths (e.g., network cable, Wi-Fi, or a cellular signal), so losing one connection does not always mean all communication is lost.

When chargers operate without the cloud

At a private depot, chargers may be set up to keep charging if the internet or online software fails. The chargers still receive grid power, but they cannot receive new commands from the online system. This setup ensures critical vehicles stay charged through an internet or cloud disruption.

On-site systems that run without the cloud

If the online connection is fully lost, software and controls at the site may continue basic charging tasks. A local energy management system or a microgrid controller can continue to manage power limits and vehicle prioritization without needing a cloud connection. Each charger also has its own software built in (charger firmware) that can follow pre-set rules on its own, such as giving priority to critical vehicles or limiting how much power goes to any single charger.

Emergency charging profiles

Load management software can allow fleets to establish emergency charging profiles in advance. Under normal conditions the system follows regular schedule and prioritization. But when an outage occurs, the operator can switch to the emergency profile, which automatically applies different power limits and charging priorities. If the emergency profile is set up ahead of time, the fleet manager does not need to manually adjust every setting during an emergency.

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Q How do I get backup power equipment ready to keep my fleet charging during an outage?

Many EVs return to the depot with energy still in their batteries. Depending on route needs and the required reserve, this energy may give staff time to connect or start backup power.

Securing backup power equipment

Fleets can either own a generator, battery system, or other backup technology and keep the equipment on-site, or sign an agreement with a reputable vendor ahead of time. A vendor agreement may reserve capacity and define response, delivery, connection, and fuel terms. Review force-majeure limits, regional-event priorities, site-access requirements, and remedies for nonperformance. During widespread outage events, many organizations compete for the same limited pool of rental generators and crews, so having an agreement signed before an outage is essential.

Planning for mobile deployment

If your plan relies on mobile backup (e.g., generator on a trailer, mobile battery charging unit), define in advance who will request the equipment, who will manage the setup, and who will connect it at the site. Travel time, safety checks, and which vehicles should charge first all affect how quickly the fleet goes back to normal operations.

Preparing your site to connect backup power

To connect a backup power source quickly during an outage, a site needs the necessary electrical hardware installed in advance. Common equipment includes quick-connect electrical ports (often called cam locks), a manual transfer switch that safely disconnects the facility from the utility grid and routes backup power to the EV chargers, and switchgear sized to handle the backup power source. Even sites with a permanently installed generator may benefit from cam lock ports, which allow mobile assets to be connected if the permanent generator is unable to meet the site's needs.

Transfer switches

A transfer switch safely disconnects the site from the grid and sends backup power to the chargers during an outage. It can be a Manual Transfer Switch (MTS), where someone on site operates the switch, or Automatic Transfer Switch (ATS), where the device detects the outage and makes the connection on its own. When grid power returns, the transfer switch reconnects the site to the grid.

Q How can resiliency upgrades also help with grid capacity and electricity costs?

Some resilience technologies may reduce site peak demand or electricity costs during normal operations when they are designed and operated for the applicable tariff and grid conditions.

Lowering electricity bills

Most utility pricing plans charge more during certain hours, typically late afternoon and evening. Many tariffs also add extra fees when a site's highest power draw in a billing period goes above a set threshold level (demand charges).

Fleets can use solar panels, battery storage, and smart charging controls to shift more charging to hours with lower pricing rates and away from higher price periods, use stored energy during the most expensive time windows, and set a safe upper limit on how much power all chargers can draw at once. Automated Load Management software can set a limit for total charger power. As the site nears that limit, the software slows charging or starts chargers at different times.

Together, these steps can lower the monthly electricity bill while also reducing strain on the grid.

Reducing pressure on the grid

Resiliency hardware can change the way a depot draws power from the grid.

Microgrids with solar and batteries can serve chargers and site loads during the busiest hours of the day instead of pulling all power from the grid at once. This smooths out the highest spikes in power use (peak shaving).

Battery energy storage systems (BESS) work in a similar way. They can charge when overall power use is low, then release that stored energy when many vehicles plug in at once, so the grid does not experience one large spike in demand.

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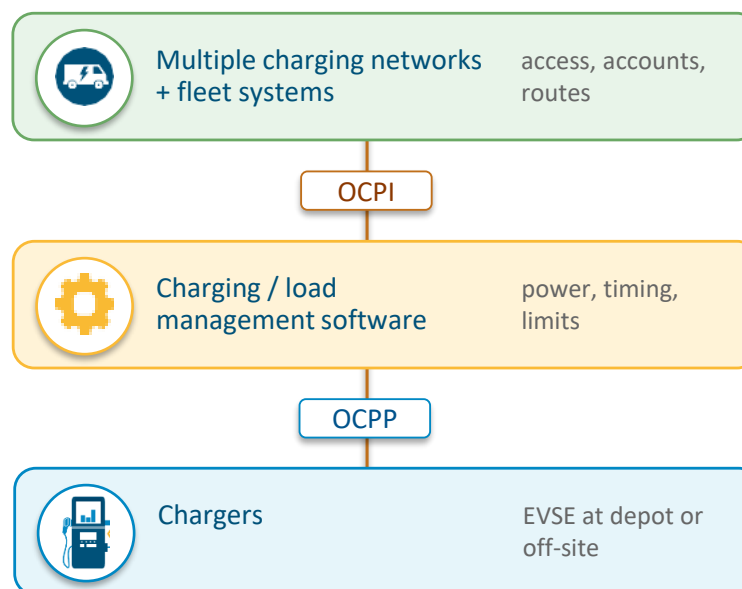
Q How can fleets avoid being locked into a single charging vendor?

Charging systems depend on chargers, control software, and fleet data tools working together. If one provider controls every part, a product or business failure may force the fleet to replace equipment that still works. Choose systems that allow hardware, software, and data tools to be changed separately.

Interoperability is a resiliency decision because EV charging systems depend on several layers working together: chargers, software that controls power and timing, and fleet tools that track vehicles, battery levels and routes. If those layers are tied to one provider, a discontinued product, weak software or business failure can force replacement of equipment that still works.

FIGURE 17:

Open standards help separate charging-system layers so fleets can change one layer without replacing the whole system



TERMS YOU NEED TO KNOW

OCPP: An open protocol for communication between chargers and management systems. OCPP-ready chargers can stay in place if you change software providers, helping to keep charging online without replacing hardware

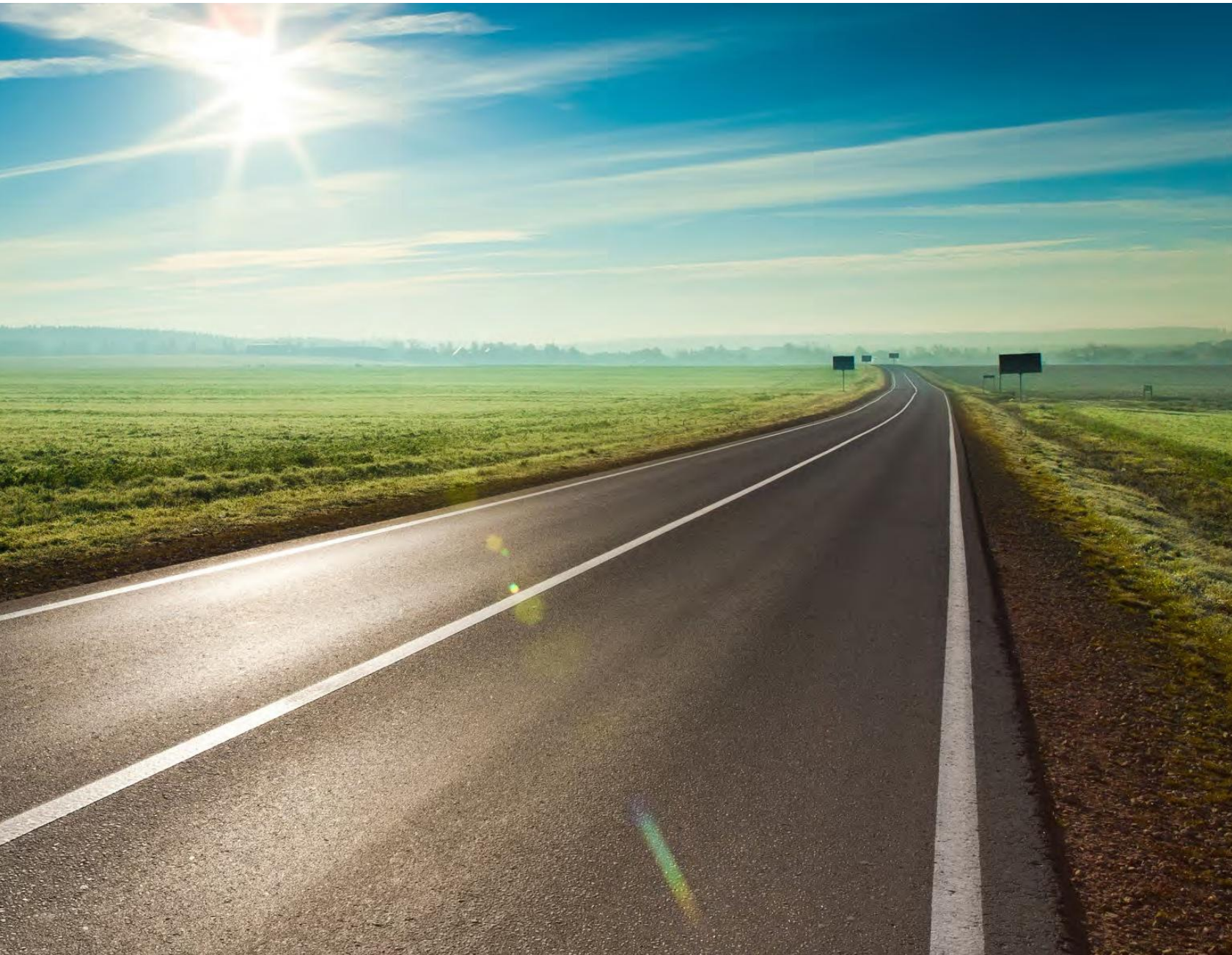
OCPI: An open protocol for communication among charging-service platforms. Confirm supported versions, certification, required features, data access, and contractual portability. Protocol support alone does not guarantee a vendor change without additional work.

Roaming: Charging across connected networks using one account or access method

Planning practice:

For fleets selecting new equipment, OCPP compliance should be treated as a requirement, not an optional feature.

Use OCPI to keep network access flexible as roaming becomes more common in California and off-site charging plans expand.



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Tools and resources to support resilient fleet operations

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Learn & Get Support

■ PG&E Energy Centers

PG&E offers free workforce education and training for businesses on energy efficiency, decarbonization, and electrification.

[Visit PG&E Energy Centers](#) →

■ Community microgrids

PG&E provides technical and financial support to help communities develop resilient, localized energy systems that can continue serving critical facilities during outages.

[Get started with a community microgrid](#) →

Fleet Operations & Outage Preparedness

■ Public Safety Power Shutoffs

Information on Public Safety Power Shutoff (PSPS) events, including outage preparation resources and customer support programs.

[View PSPS policy & procedures](#) →

■ Business EV rate calculator

Compare PG&E's two business EV rates (BEV-1 vs BEV-2) to estimate monthly bill impact.

[Open Business EV rate calculator](#) →

■ NREL System Advisor Model (SAM)

NREL's System Advisor Model (SAM) helps evaluate the performance and economics of solar, battery storage, and other distributed energy systems.

[Open NREL SAM](#) →

Tariffs & Connection Rules

■ Electric Rule 29 (program named EV Power Ready)

New service pathway for qualifying separately metered EV charging projects

[Read Electric Rule 29](#) →

■ Electric Rule 21

Requirements for connecting solar, storage, and other generation resources.

[Read Electric Rule 21](#) →

■ Electric Rule 15

Requirements and cost responsibilities for electric distribution line extensions serving new or expanded electric loads.

[Read Electric Rule 15](#) →

■ Backup Power Options

PG&E offers resources to help explore additional backup power options that may be available to customers.

[Explore Backup Power Safety](#) →

■ Commercial Battery Storage Resources

PG&E offers Commercial battery storage resources to businesses, including the Elkhorn Emergency Action Plan (EAP)

[Explore Commercial Battery Storage](#) →

Funding, financial incentives and customer programs

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U.S. government programs

Department of Energy funding & grants

Federal funding opportunities for vehicle electrification, charging infrastructure, and resiliency projects.

[Browse DOE funding opportunities](#) →

Federal clean energy Investment Tax Credit (ITC)

Federal tax incentives for qualifying clean energy and energy storage investments. Confirm current eligibility and requirements with a qualified tax professional.

[Read about the Federal ITC](#) →

STATE

California programs

Self-Generation Incentive Program (SGIP)

California incentives for qualifying battery energy storage and resiliency projects.

[Apply for SGIP](#) →

PG&E

PG&E customer programs

EV advisory services

Provides no-cost, one-on-one guidance to medium- and heavy-duty fleet operators at any stage of fleet electrification, from initial planning through charger installation and fleet operations.

[Request EV advisory support](#) →

Electric Vehicle Power Ready program

New service pathway for qualifying separately metered EV charging projects,

[Visit EV Power Ready](#) →

