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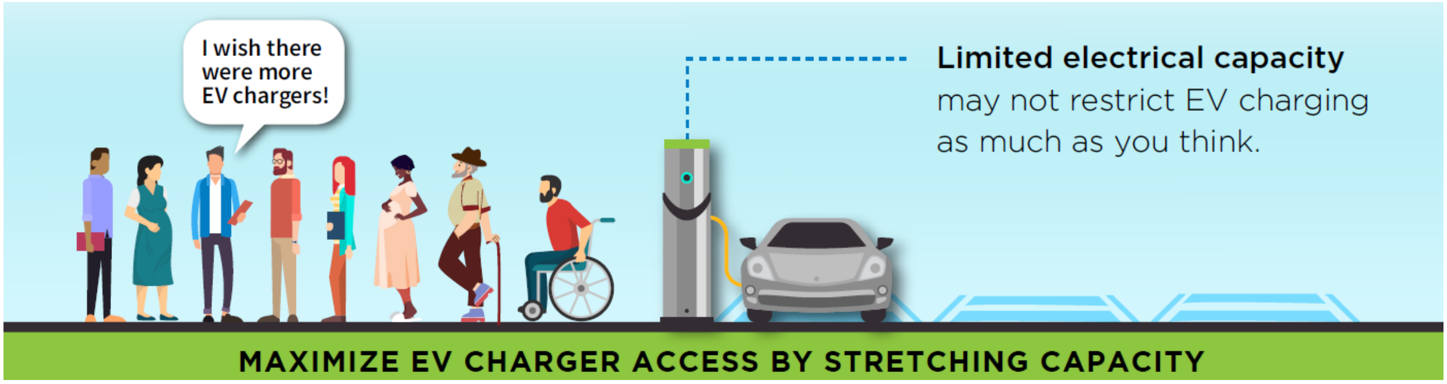
Power Sharing for More EV Stalls

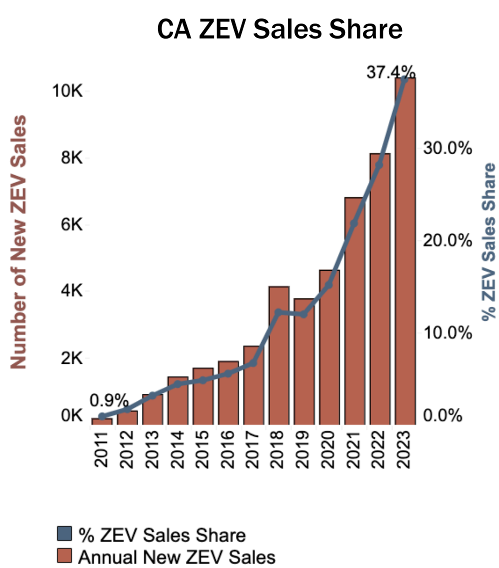


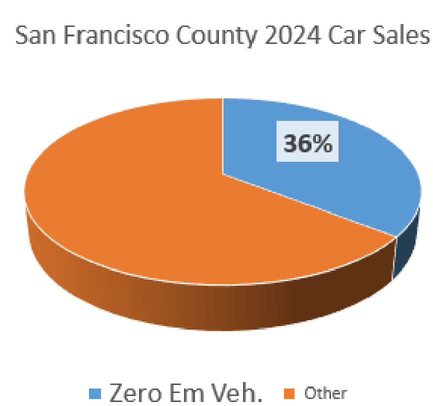
Power Sharing AKA Automated Load Management Systems (ALMS) and Why it Matters

- Project developers know that a site's available electrical capacity, including the size of the site's main transformer, is a major limiting factor for installing electric vehicle (EV) charging.
- Power sharing through ALMS allows sites to increase the quantity of EV parking stalls while using the same electrical capacity.
- The two main categories of power sharing are circuit sharing and panel sharing.

Why Understanding Power Sharing Matters

San Francisco Bay Area drivers are buying EVs (also known as zero emission vehicles or ZEVs) at unprecedented rates; this means buildings with adequate electric vehicle infrastructure (EVI) will have a competitive edge for years to come. For example, ZEV sales share in California and San Francisco County in 2023 and 2024 were just under 40%:





Source: https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/new-zev-sales

EV project developers already know that planning for EV charging with a new or existing building will ultimately be limited by the size of the site's electrical service and electrical transformer. The good news for this design constraint is that power sharing through ALMS allows the same amount of electrical capacity dedicated to EV charging to serve more parking stalls.

For example, an electric panel with the capacity to add EV charging to 20% of parking stalls might instead allow for electrifying 40% of stalls, or even 60-80% of stalls through power sharing technologies. By incorporating power sharing strategies into a project's planning phase, EV project developers can create more EV charging on day one and can enable scalability for more charging spaces in the future.

How can we install more EV charging than what we have capacity for – e.g., more than 100 amps of EV charging on a 100 amp panel? The key is that EV charging equipment almost never need to all operate at full load at the same time. One EV may need a full 40 amps of capacity for Level 2 charging, but the EV in the next stall only needs 10 amps because the driver just returned from a short errand and still has a mostly full battery; and the EV in the next stall is already fully charged because the driver took transit or telecommuted today; and the next stall is empty at the moment. If all four stalls have a 40 amp charger, that's 160 amps installed on a 100 amp panel, and only 50 amps of load at the moment.

So, what happens when all four stalls need power that totals more than the 100 amp panel capacity? That's where the ALMS comes in.

The current National Electric Code (NEC) allows EV project developers to oversubscribe their building's electrical capacity with extra EV charging equipment if they incorporate ALMS controls into the project. **Power sharing through ALMS caps the total amount of power available to a site's EV charging equipment and distributes the available power to each without exceeding the existing electrical capacity.** See below for more details.

Types of Power Sharing

Currently, there are two main strategies to design EV charging projects with power sharing:

1. Circuit Sharing - Multiple EV chargers or outlets share a single circuit
2. Panel Sharing - Multiple EV chargers or outlets share the maximum power allocated to the EV charging equipment (often from an EV charging subpanel)

Regardless of the strategy, all power sharing requires both a knowledge of the available capacity of the electrical system and communication with the EV charging equipment on that system.

For installations where a single EV charger or outlet is installed on a residential panel, a third strategy is using an energy management hardware device that monitors the overall power use on the panel, and temporarily pauses or decreases the power to the EV charging circuit when the power draw could exceed the panel's maximum rating.

Power sharing strategies illustrated in the following figures are based on Level 2 EV chargers that include a charging station and a cable ending in a connector. That said, some (but not all) "smart" EV outlets can also use a form of power sharing.

Strategy #1: Circuit Sharing

Circuit sharing, the most frequently deployed ALMS, describes when two or more EV chargers or outlets are wired to a single circuit and the circuit's available current is split between them. The EV charging equipment software allows the installer to assign each EV charging equipment to a group and define the amount of current available to each group. EV charging equipment in the same group communicate, typically via a network connection, and determine how to split the available power.

A common installation has two EV charging ports sharing a single 40 amp circuit (a 2:1 ratio). When only one EV plugs into a 2:1 circuit-shared charger, the EV receives 100% of available power (see Fig. 1), and when a second EV begins charging, the power is split between the two EVs (see Fig. 2).

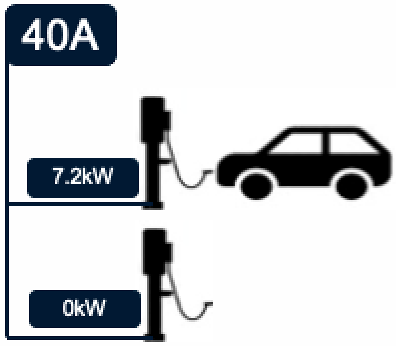


Figure 1

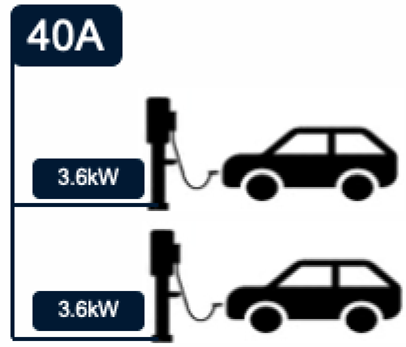


Figure 2

Circuit sharing is a simple and effective form of ALMS. This strategy also reduces costs since half as many circuits are needed in a 2:1 ratio compared to dedicated circuits.

To maximize the number of electrified parking stalls, circuit sharing can go up to a 4:1 ratio, depending on the circuit amperage and minimum amperage required by the EV charging equipment (typically 8 amps). However, the more EVs charging on the same circuit, the less power each EV gets since the total output for each circuit doesn't change. As we can see in Figure 3, each EV is receiving 25% of the 40A circuit's available power when all four ports are being used at the same time, resulting in slower charging times.

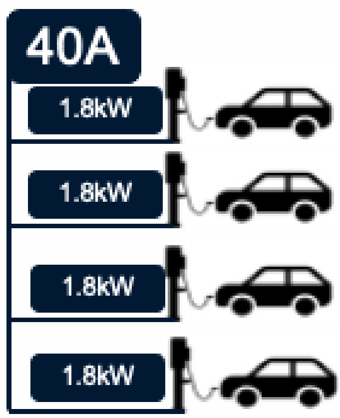


Figure 3

Strategy #2: Panel Sharing

Panel sharing is also a strategy to share available capacity. However, unlike circuit sharing, in panel sharing, each charging port has its own dedicated circuit which allows the ALMS to coordinate more than one circuit on the panel at a time. Sharing of available capacity at the panel is controlled by the EV charging equipment software and networked communications between the EV charging equipment sharing a panel. In Figure 4, two EVs simultaneously charge at the full 40A because each EV charger has its own dedicated circuit coming from the same 80 amp panel.

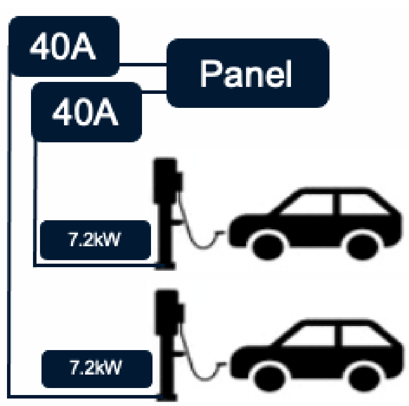


Figure 4

Figure 5 shows the same 80 amp panel that is over-subscribed with circuits totaling 160 amps. As more EVs begin simultaneously charging and the panel reaches its capacity, the figure shows how the ALMS kicks in to limit the amount of power going to each EV and keep the total power draw within the limit of the panel.

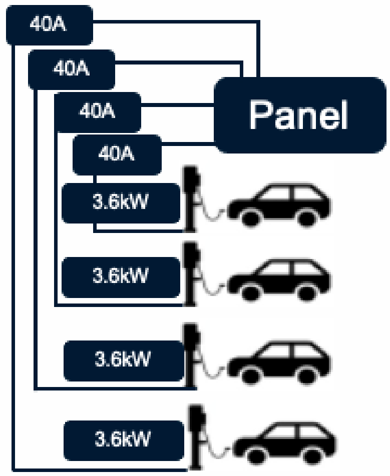


Figure 5

This gives the ALMS increased flexibility to spread available power across more charging equipment, but costs more upfront because of the additional wiring, conduit, and breakers needed for individual circuits tied to each EV charging equipment.

Energy Management Hardware Device

Figure 6 illustrates a simple hardware device approach to power sharing for a single Level 2 EV charger, where the EV charger circuit is split off from a panel serving a residence. With this hardware device, when the overall residential electrical panel approaches its limit, 80 amps in this case, the device turns off the circuit serving the EV charger. When the non-EV loads drop back down for a period of time, the device restores the connection to the EV charger. Other devices may modulate the load to the EV charger within the panel's safety range rather than fully disconnecting. These strategies can be useful in multifamily buildings where EV chargers are "direct wired" to an individual dwelling unit's electrical panel.

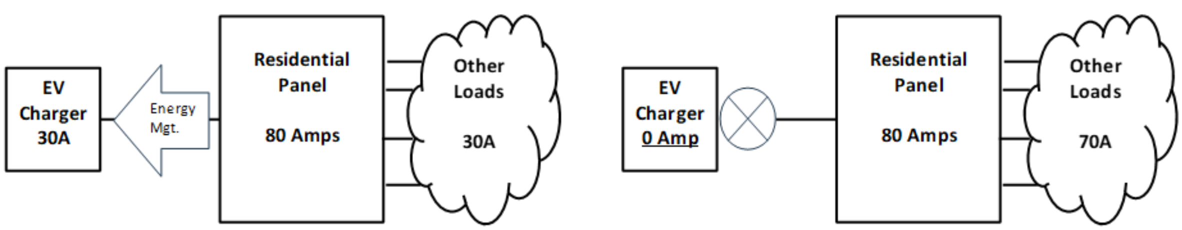


Figure 6

Power Sharing Implementation Strategies

Power sharing strategies vary from relatively simple hardware settings to highly sophisticated software solutions. At its most basic, two EV chargers sharing a 40 amp circuit might both be permanently derated so the maximum amperage for each charger is 20 amps, regardless of whether both EV chargers are being used simultaneously.

A big performance boost comes if either charger can access the full 40 amps any time the other charger is not being used. Figures 1 through 5 illustrate this style of "static" power sharing using ALMS and a "first in, first out" strategy for allocating power. Alternatively, some software rotates available capacity to all chargers being used.

"Dynamic" power sharing refers to a more sophisticated approach where the ALMS can vary the amount of charge going to each EV based on individual charging session needs. For example, an EV with a battery depleted down to

20% might be allocated 30 amps, while in the next stall an EV that is almost fully charged might be allocated 8 amps.

Additional Information

Having covered the basics of power sharing, the next sections provide additional information. In addition to two common use cases of power sharing with ALMS, the sections include a look at the market and future prospects for this important technology.

Use Case Examples

A project's specific use case will influence the decision of whether to use power sharing with ALMS. The main factors in determining this strategy are: 1) how long the EVs will be charging, and 2) how many EVs will be charging at the same time. Let's look at some examples.

Example 1: Fleet charging

A laundry service has 20 electric delivery vans in their fleet and 10 Level 2 chargers. A fleet manager may wish to provide full power to all chargers simultaneously, so that all vans can be fully charged as quickly as possible (similar to a conventional fuel depot model). However, this approach would require substantial electrical capacity, and that capacity requirement may require utility service upgrades. Service upgrades would mean higher installation costs and possibly installation delays. Charging all vans at full power simultaneously could also lead to higher electric bills due to demand charges.

As an alternative, an ALMS with a "first in, first out" strategy would allow the fleet manager to plug in multiple vans and know the ALMS will immediately begin charging the next van as soon as one finishes charging and capacity becomes available. This could get the vans on the road sooner, with less upfront investment, and keep them on the road at a lower operating cost. Modeling of fleet energy requirements can be used to determine the optimal capacity and ALMS strategy.

Example 2: Apartment building

A multifamily apartment building has 10 Level 2 chargers serving residents in assigned parking stalls, with most residents driving less than 50 miles per day. Since the daily commutes require minimal daily charging (only 1-2 hours per EV) and the EVs typically have dwell times of 10-14 hours per day, it is highly unlikely that all 10 EVs will need to charge at the same time. In this lower utilization scenario, rather than installing full capacity for 10 40 amp circuits (i.e., 400 amp), an ALMS can use just 100 – 200 amps of available electrical capacity to make sure all EVs are sufficiently charged by spreading out the charging at lower power over the course of the night. For the EV charging project developer, using an ALMS in this scenario results in a much lower EV infrastructure investment and shorter project timeline, especially if increasing electrical capacity would trigger the need for a utility service upgrade.

Market Status

The EV charging equipment market has a growing number of vendors offering ALMS designed to work with their EV charging systems. However, it is not always clear whether a certain charging equipment product does or does not support power sharing/ALMS. Vendors may use other terms to refer to power sharing or ALMS or may use similar terms like "load management" to refer to features that are not true power sharing.

Given the lack of standard terminology, it pays for customers considering an EV charging project to ask prospective EV charging equipment vendors how their specific power sharing solution works to reduce infrastructure, operational, and/or future EV readiness costs. EV charging equipment vendors commonly charge ongoing fees to access their software platforms and some vendors offer different pricing tiers, with the power sharing/ALMS being included in the higher cost tier.

Note: Some ALMS can gauge the available capacity of the electrical system and communicate with the EV charging equipment on that system on-site, while others use cloud-based computing and require an internet connection. If an EV charging vendor's ALMS requires an internet connection, the vendor should be able to explain to the developer how their ALMS will fail to a safe operating condition if the connection is lost.

Looking Ahead

ALMS solutions are in their early days, with new products becoming more sophisticated. Numerous EV charging vendors are developing "smart" ALMS that prioritize charging by communicating with the EVs to gauge each EV battery's state of charge ("SOC") and/or using an EV driver's specified input, such as their next expected trip distance and time of departure.

Codes and standards are evolving to address product changes and to enable developers to harness these capabilities, without sacrificing safety or reliability. For example, according to NEC 2020 625.42, developers are currently only allowed to share the amount of power allocated to the EV charging infrastructure, rather than the capacity available for the entire building's electrical service. NEC 2023, which goes into effect in 2026, changes the terminology from ALMS to Energy Management System (EMS) and may provide flexibility for sharing power with non-EV charging loads.

The potential benefits of the technology are already clear and continued industry progress will make power sharing with ALMS an attractive feature for a wide range of project types.

Questions?

Contact the EV Charge SF program team at (415) 554-0773 or email PowerPrograms@sfwater.org.

For more information about SFPUC's **EV Charge SF program**, please visit our program website.

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