

The Fundamentals of Managed Charging

What is an Automatic Load Management System?

An automatic load management system (ALMS)¹ allows electric vehicle supply equipment (EVSE) to share electrical capacity. Many ALMS can also automatically manage power to the EV by adjusting electric vehicle charging rates to reduce charging times and utility costs.

¹ Also known as EV load management system, managed charging system, power management system, or under the more generic term energy management system (EMS).

What are the Benefits of Automatic Load Management Systems?

The use of ALMS systems come with a host of benefits such as:

- **Reduced electric infrastructure costs.** ALMS systems allow building owners to double the amount of EVSE for a given electrical capacity, thus reducing costs for expensive electrical upgrades. By reducing costs, especially for existing buildings, ALMS allow for the broader adoption of EV charging especially in communities with older buildings and infrastructure.
- **Reduced charging costs.** Intelligent ALMS can benefit the building owner or charging customer by shifting charging from times when electricity costs are high to times when electricity costs are low.
- **Improved safety.** By ensuring the EVSE never overloads circuits, ALMS can protect local electrical infrastructure at the circuit, panel, building, or transformer level.
- **Climate and grid benefits.** Intelligent ALMS systems can shift charging to the times of the day when renewable energy supply is high, reducing carbon emissions from vehicle charging. During brownouts, ALMS can stop vehicle charging so that buildings with critical electrical needs can maintain power.

What are different Automatic Load Management System Approaches to Managing Electrical Capacity?

| STRATEGY | CHARACTERISTICS | CONSIDERATIONS |
|--------------------------|--|--|
| No Load Management | Each location gets a fixed amount of capacity regardless of activity at other locations. Capacity is 'stranded' at stations that have finished charging but remained parked | This method provides the lowest up-front cost for buildings that have neither electrical capacity constraints or a need for a large number of EV parking spaces. But it provides little opportunity to manage ongoing loads and costs. |
| Equal Capacity Splitting | This system distributes power equally to connected vehicles. For example, if two charging stations or a multihead EVSE with two charging receptacles share a single 40-amp circuit, the first vehicle that plugs in will draw full power (32A). When a second vehicle plugs in, both vehicles will draw half power (16A). Full power will be allocated to the second vehicle if the first vehicle finishes charging. | This is a simple, inexpensive approach for small-scale installations that but not as efficient as more sophisticated systems with monitoring capabilities. However, these systems can accommodate more EVSE with the same electrical capacity compared to buildings with no load management. |

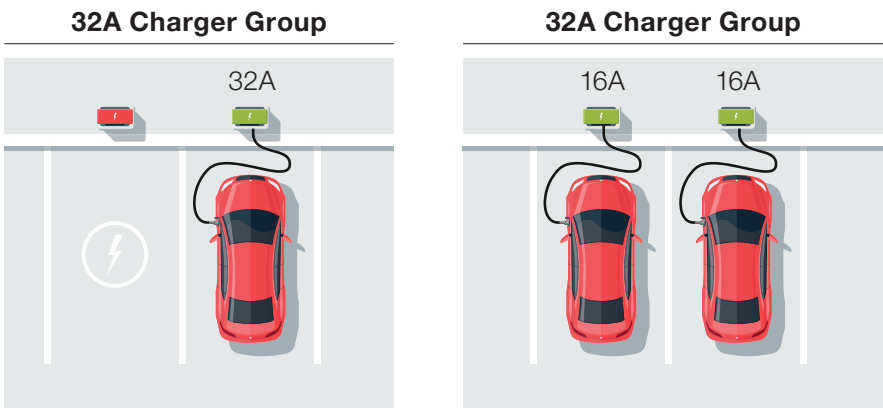


Figure 1: Equal Capacity Splitting



STRATEGY

CHARACTERISTICS

CONSIDERATIONS

Dynamic Load Management

This approach allows the ALMS to reduce or increase power to the EVSE based on the available power from the panel or building based on both internal monitoring within the EVSE and external monitoring at the building site. Available capacity is dynamically shifted and split, sometimes unequally, based on vehicle charging behavior. As an EV charging session slows, requiring less power, the ALMS can supply less power to the vehicle, allowing another vehicle to consume more power.

This type of load management system can result in a reduction in average charging time compared to equal capacity splitting. However, these systems may be more costly or require monthly service fees.

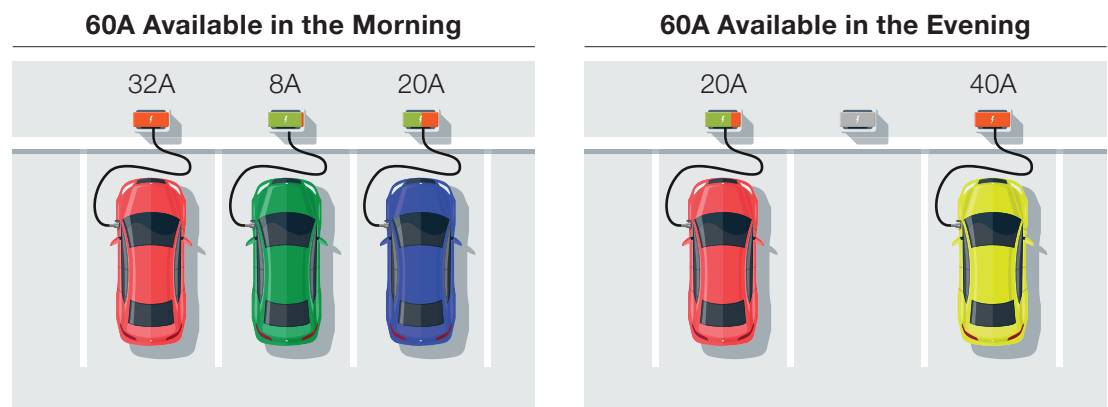


Figure 2: Dynamic Load Management

Rotational Load Management/First-In/First-Out

This system allows system operators to schedule charging for a certain duration. The most common rotational load management scheme is First-In/First-Out which allocates maximum power to new vehicles until electrical capacity is reached. Cars that arrive later only begin charging when first arrivals complete charging.

This approach is recommended for fleets or long-term parking scenarios so that organizations or individuals have fully charged vehicles available when needed.

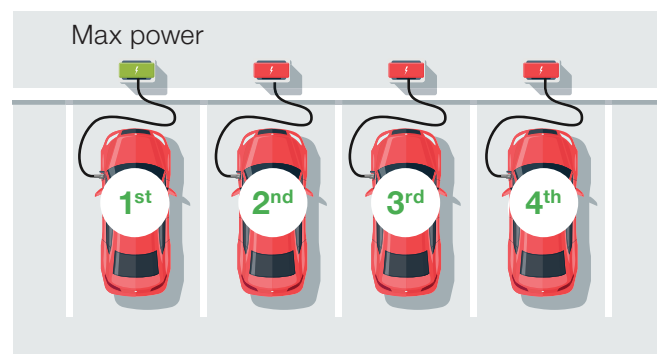


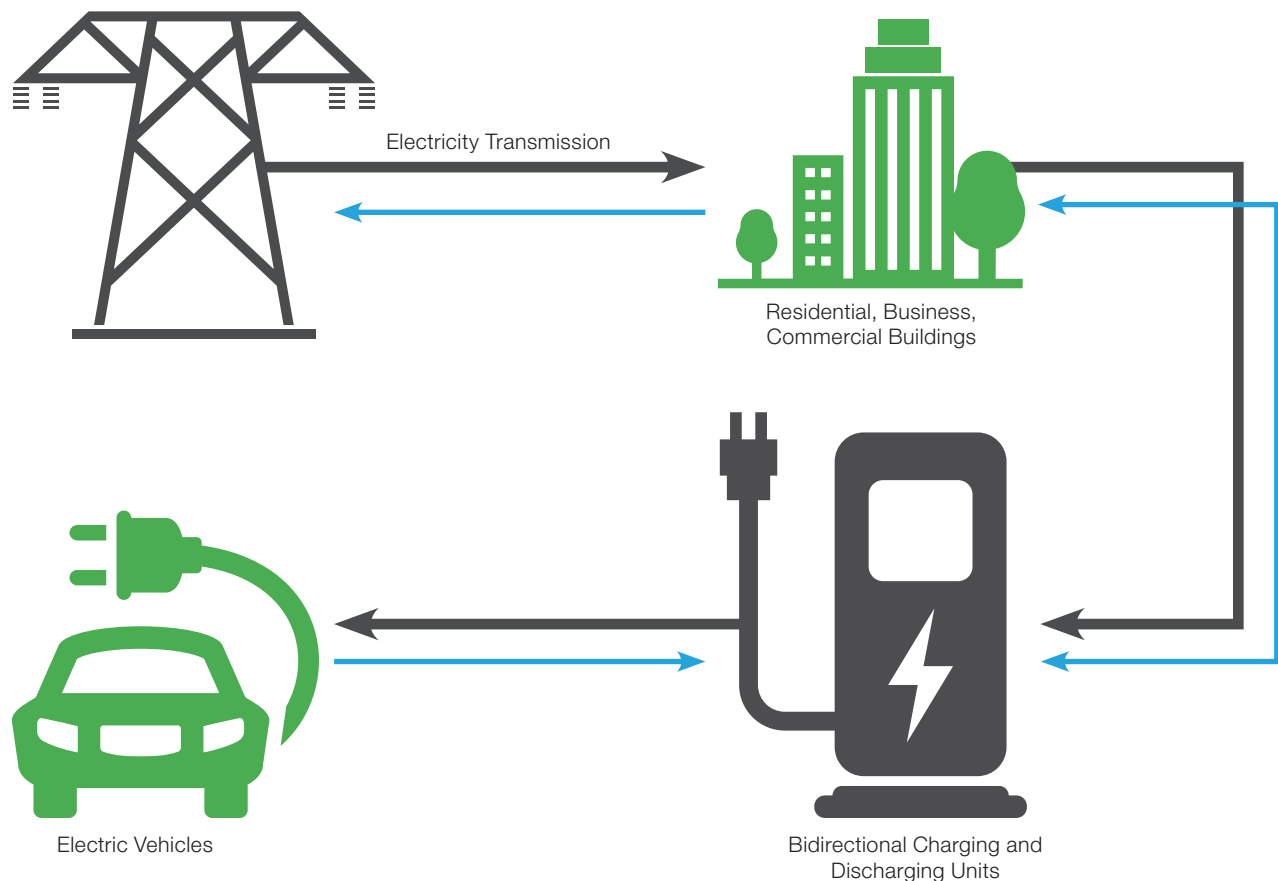
Figure 3: First-in/First-Out

Can an Automatic Load Management System Manage Costs and Interact With the Electricity Grid?

The most sophisticated ALMS can dynamically change the power allocated to the EVSE based on a number of factors such as utility rate schedules, signals from the grid, or real time production of solar photovoltaic (PV) to reduce utility costs and even carbon emissions from EV charging. This approach results in reduced charging times and reduced operating costs. However, because they are the most sophisticated system they may be more costly than other load management system types.

Certain ALMS and EVSE are also able to interact with the electricity grid using established standards, which defines the communication messages and sequence

requirements for grid interaction. ALMS and EVSE that are capable of communication will be able to charge vehicles based on electricity prices or other signals from the grid. This standard also allows vehicles to engage in bidirectional charging so that EVs can serve as backup power, take advantage of lower utility rates, or engage in vehicle-to-vehicle charging. To speed the transition to grid-integrated EVSE, the California Energy Commission (CEC) may require EVSE funded by the CEC to be capable of grid communication. The CEC may also offer additional rebates to private entities for installing EVSE capable of grid communication.





How Do We Ensure ALMS Are Safe and Properly Maintained?

To ensure that an ALMS functions as intended while protecting the safety of a building's occupants, consider the following:



Commissioning

ALMS must be commissioned after installation to ensure that it operates safely and minimizes nuisance tripping of electrical breakers. Performance tests must be performed at the site under various use cases to ensure that electrical circuits will not be overloaded and circuit breakers tripped during regular operation.

The CSA Group (formerly known as the Canadian Standards Association) has developed standard CSA SPE-343:21 released in 2021, to provide guidance on the appropriate way to commission ALMS. An update to this standard will be released in 2023.



Maintenance

ALMS are simple to maintain if nothing changes. However, this is unlikely to be the case for very long. If an EVSE port is installed, replaced or relocated, the ALMS must undergo retro-commissioning to ensure the system continues to operate as designed. Continued commissioning may also be needed if problems occur under routine software updates.



Life Safety Systems

Life safety systems such as fire pumps should have a calculated load reserve that is added to the actual monitored load to ensure that the ALMS does not use that load in emergency situations.



Fail-Safe Mode

In addition to commissioning an ALMS, it is important to install an ALMS that will go into “fail-safe” mode. For example, if connection to the ALMS is lost, the system could begin to utilize equal capacity splitting or simply disconnect power to the EV.

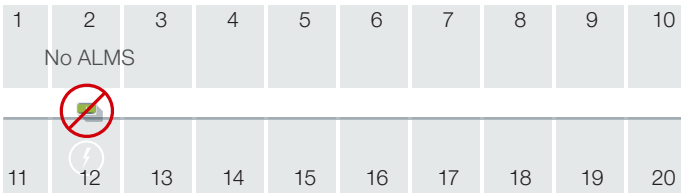
What Are the Minimum Code Requirements for ALMS?

2022 CalGreen and the 2022 California Electrical Code, which are both effective January 1, 2023 require that ALMSs meet the following code requirements:²

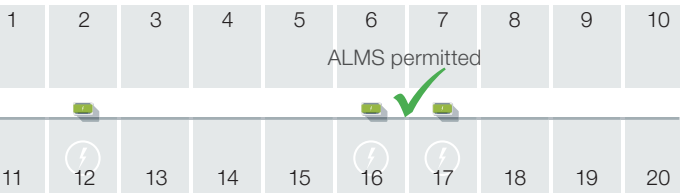
Multifamily, Hotel, and Motel Restriction

CalGreen 2022 states that ALMSs can be used in any non-residential building. An ALMS is also allowed in multifamily buildings, hotels, or motels with twenty or more dwelling or sleeping units if the building exceeds the requirement that 5% of the parking spaces have EVSE or Level 2 outlets. For **nonresidential buildings**, there is no similar restriction for the use of ALMS. However, all ALMS regardless of building type must meet the minimum power delivery requirements and minimum branch circuit and electrical capacity requirements described below.

Meets requirement: No ALMS (1 out of 20 meets the requirement)



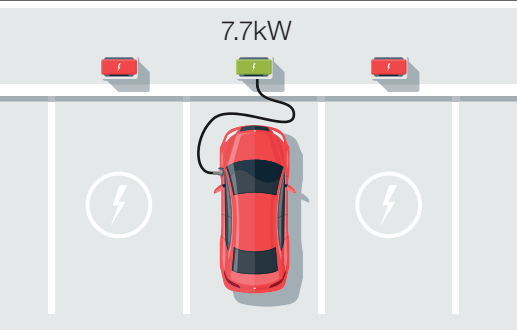
Exceeds requirement: ALMS



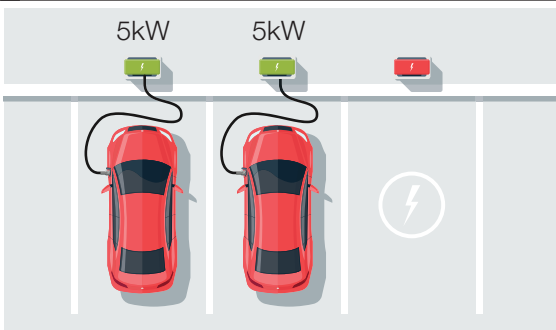
Minimum Power Delivery

A connected EV will stop charging if charging dips below a minimum power transfer rate. Therefore, it is critical that an ALMS ensures that this lower charging limit is not reached when electricity is shared between multiple vehicles. CalGreen 2022 requires that ALMSs provide at least 3.3 kW of power simultaneously to each EVSE served by the ALMS (50% of the full charging rate assumed by CALGreen). Providing 3.3 kW of power to an EV is equivalent to adding 6-10 miles of range every hour. Therefore, utilizing an ALMS can effectively double the number of EVSE installed at a building (otherwise known as an oversubscription ratio of 2:1). Larger oversubscription ratios (8:1 or 4:1) are not compliant with California’s code.

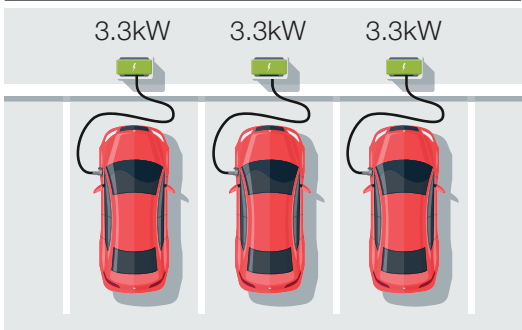
10kW Charger Group



10kW Charger Group



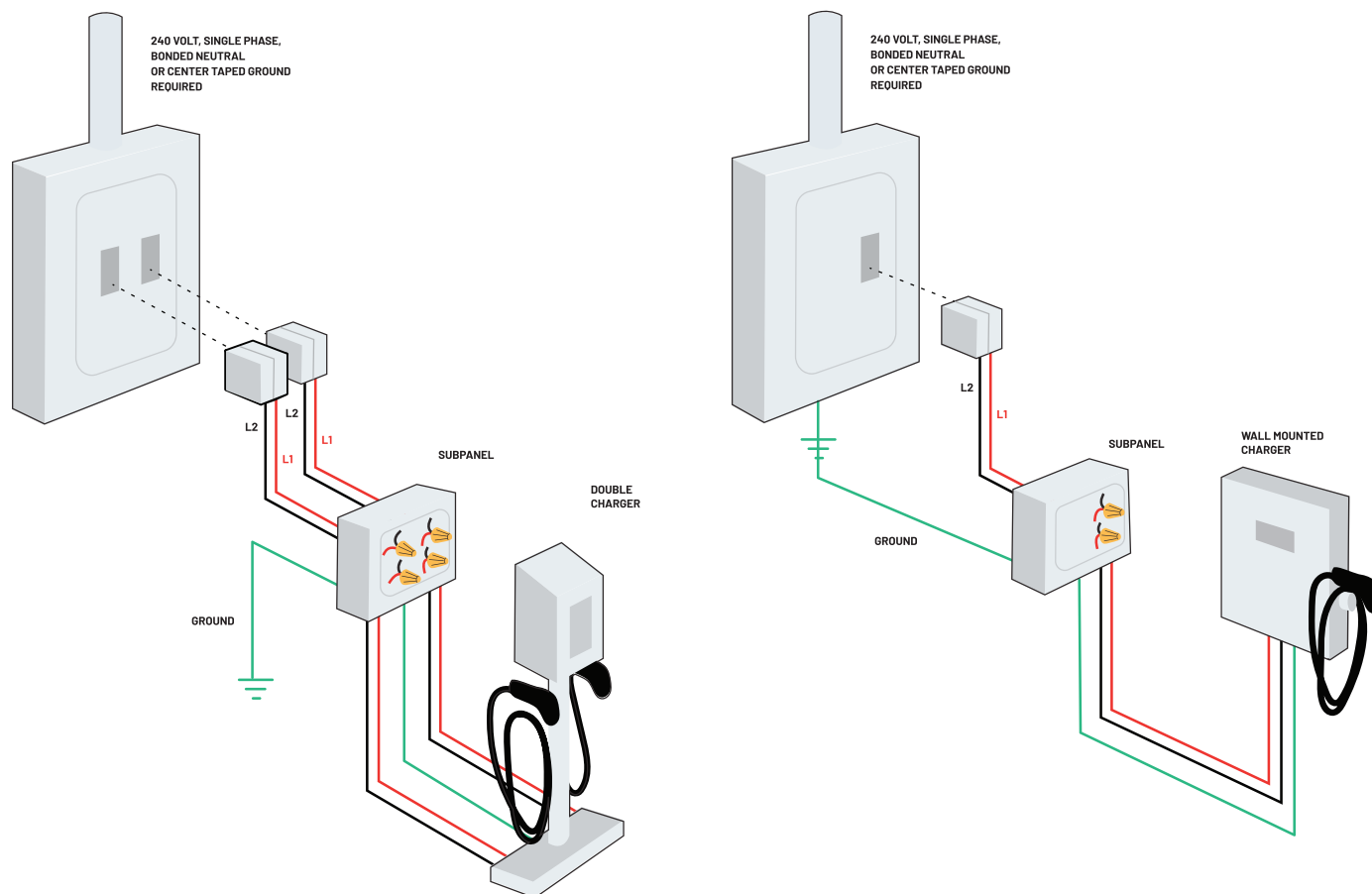
10kW Charger Group



² CALGreen is currently undergoing development of modifications for the intervening code cycle (updates between the major 2022 and 2025 releases) so these specific requirements could change.

Minimum Branch Circuit and EVSE Requirement

CalGreen 2022 requires that branch circuits to EVSE have a minimum size of 40A at 208/240V. This requirement ensures that the branch circuit can support Level 2 charging that can deliver up to 7.7 kW of power and thus faster charging rates (12-20 miles of range every hour) to vehicles with shorter anticipated parking times or greater energy needs.



Electrical Capacity



Section 625.42 of the 2022 California Electrical Code states that EV charging loads must be considered continuous loads, which must follow the 80% rule and be 20% below breaker capacity. However, if an ALMS is used, the maximum equipment load on the service and feeder is the maximum load permitted by the ALMS. Because the ALMS can set limits on the EVSE, the ALMS can ensure that EVSE loads are always 20% below breaker capacity. Therefore, using an ALMS that meets the minimum power delivery requirements in CalGreen will allow you to install approximately twice as many EV chargers for any given electrical capacity. CalGreen 2022 also states that an ALMS cannot be used to reduce the minimum required electrical capacity to the required EV-capable spaces. For example, CalGreen requires that an ALMS deliver a minimum of 30 amperes to an EV when charging one vehicle and a minimum of 3.3 kW or 14A at 240V while simultaneously charging multiple EV.

2022 CalGreen:

4.106.4.2.2 Multifamily development projects with 20 or more dwelling units, hotels and motels with 20 or more sleeping units or guest rooms. The number of dwelling units, sleeping units or guest rooms shall be based on all buildings on a project site subject to this section.

- 3. EV Chargers.** Five (5) percent of the total number of parking spaces shall be equipped with Level 2 EVSE. Where common use parking is provided, at least one EV charger shall be located in the common use parking area and shall be available for use by all residents or guests.

When low power Level 2 EV charging receptacles or Level 2 EVSE are installed beyond the minimum required, an automatic load management system (ALMS) may be used to reduce the maximum required electrical capacity to each space served by the ALMS. The electrical system and any on-site distribution transformers shall have sufficient capacity to deliver at least 3.3 kW simultaneously to each EV charging station (EVCS) served by the ALMS. The branch circuit shall have a minimum capacity of 40 amperes and installed EVSE shall have a capacity of not less than 30 amperes. ALMS shall not be used to reduce the minimum required electrical capacity to the required EV capable spaces.

Non-residential mandatory measures:

5.106.5.3.3 Use of automatic load management systems (ALMS).

ALMS shall be permitted for EVCS. When ALMS is installed, the required electrical load capacity specified in Section 5.106.5.3.1 for each EVCS may be reduced when serviced by an EVSE controlled by an ALMS. Each EVSE controlled by an ALMS shall deliver a minimum 30 amperes to an EV when charging one vehicle and shall deliver a minimum 3.3 kW while simultaneously charging multiple EVs.

2022 California Electrical Code:

625.42. Rating. The power transfer equipment shall have sufficient rating to supply the load served. Electric vehicle charging loads shall be considered to be continuous loads for the purposes of this article. Service and feeder shall be sized in accordance with product ratings. Where an automatic load management system is used, the maximum equipment load on a service and feeder shall be the maximum load permitted by the automatic load management system.

Resources:

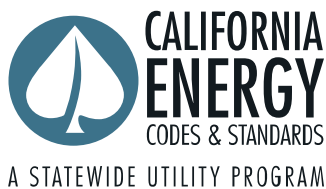
2022 California Green Building Standards Code, Title 24, Part 11 (CALGREEN), ICC Digital Codes. <https://codes.iccsafe.org/content/CAGBC2022P1/index>.

CSA SPE-343:21: Electric Vehicle Energy Management Systems, CSA Group, 29 Aug. 2021, <https://www.csagroup.org/store/product/2705181/>.

Electric Vehicle Energy Management Systems, May 2019, https://www.csagroup.org/wp-content/uploads/CSA-RR_ElectricVehicle_WebRes.pdf.

ISO 15118-20:2022: Road Vehicles—Vehicle to Grid Communication Interface—Part 20: 2nd Generation Network Layer and Application Layer Requirements, ISO, 26 Apr. 2022, <https://www.iso.org/standard/77845.html>.

ISO 15118-2:2014: Road Vehicles—Vehicle-to-Grid Communication Interface—Part 2: Network and Application Protocol Requirements, ISO, 19 Nov. 2021, <https://www.iso.org/standard/55366.html>.



The Codes & Standards program is designed to improve compliance with the state's building and appliance energy codes and standards. The program aims to advance the adoption and effective implementation of energy efficiency measures and building practices to lock in long-term energy and GHG savings to meet California's ZNE, decarbonization and climate goals. The program recognizes that codes and standards are one of the most effective pathways to ensuring sustained market transformation—and that key to making them work well are well-informed industry professionals and consumers.



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