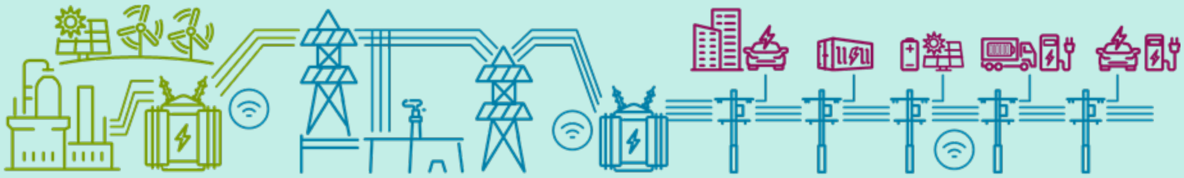
Decarbonized | Reliable | Resilient | Cost-effective

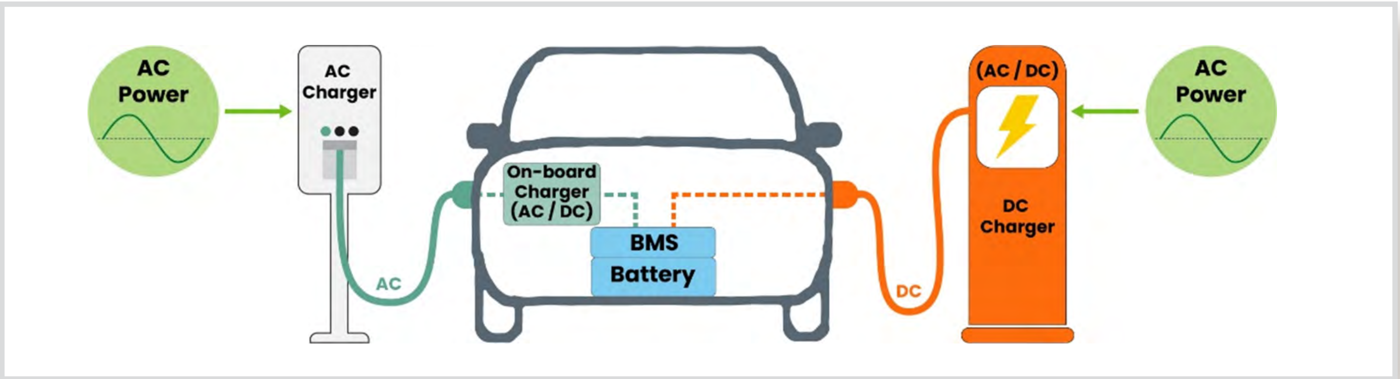


EVGrid Assist Webinar Highlights

U.S. DEPARTMENT OF ENERGY
EVGrid Assist
ACCELERATING THE TRANSITION

Fast Charging for Light-, Medium-, and Heavy-Duty Vehicles

There's more than one way to charge an electric vehicle (EV). Both alternating current (AC) and direct current (DC) have their own advantages and disadvantages, but both will be needed to electrify transportation in the United States.



AC charging uses lower power, which makes it easier to integrate into existing grid infrastructure, but is only suitable for situations where a vehicle will have a long dwell time. Prime candidates for Level 1 (L1) or Level 2 (L2) AC charging are home charging, at-work charging, and even some light- and medium-duty fleet charging where vehicles will sit idle overnight.

In situations where a vehicle must charge quickly and get back on the road, or where heavy-duty vehicles are involved, DC charging is imperative. DC can charge the vehicle's battery directly instead of needing to be converted to AC, allowing energy to be transferred at a higher rate. Renewable energy resources also produce direct current, meaning that DC chargers can easily be integrated with such resources. However, costs can be higher due to more components and additional cooling and communications requirements.

While DC chargers are more expensive to purchase, to install, and to operate than an AC Level 2 charger, DC fast charging (DCFC), extreme fast charging (XFC), and even megawatt charging (MCS) will be necessary to meet the demands of the coming wave of EVs. Faster charge times will make long-distance, interstate travel possible, permit EV owners in multi-unit dwellings to share chargers thanks to shorter charge times, and make electrified commercial long-hauling possible. There are many factors to take into account when installing a public DC fast charger and it is important to choose the right charger for the application.

Different charging types, different demands, different purposes

AC L1 & L2 (3-19 kW): Ideal for light-duty vehicles with long dwell times, light operations, and duty cycles

DCFC (50-100 kW): Light- and medium-duty vehicles with short to moderate dwell times and lower energy requirements. Some heavy-duty vehicles with larger packs and long dwell times

XFC (150-400 kW): Light- and medium-duty vehicles with very short dwell times and high energy needs

MCS (1-3.75 MW): Heavy-duty vehicles with short dwell time and high energy demand

Coordination is essential

The load profile of the vehicle and, therefore, its charger will impact the grid and how a utility must plan for the energy requirements. An L1 or L2 charger can be installed almost anywhere by most electricians without disrupting normal grid operations; however, DC chargers require close working relationships with utilities to ensure the chargers are supplied with all the power they are capable of delivering.

Involve regional utilities as early as possible. They are essential partners because they understand the constraints and capacity of their systems. In some cases, such as those involving travel centers or fleets, it might be less expensive to move an existing operation to a new area of a city than to try to build out the infrastructure necessary to convert the current location. And, even when building out the infrastructure is deemed the best choice, upgrading a transformer can take more than a year to complete.

High levels of EV penetration require further assessment to determine potential challenges to the transmission and distribution systems. Magnitude, randomness, and impact of EV loads on transmission and distribution systems must be considered together. Fast charging may cause thermal overloading of distribution assets. Legacy infrastructure, especially in rural or dense urban areas, will likely face transmission and distribution constraints. Charge management is a possible solution to help mitigate these challenges.

Some challenges will be operational in nature. When dealing with vehicle-grid Integration, several variables will come into play, such as seasonal changes in load and generation; varying EV charging rates, differences in distribution systems' voltages, sizes, age, etc.; competing objectives of transmission/distribution systems, and the impact of DERs on capacity and operations.

Charging Profiles

Another variable that can affect a charger's impact on the grid is the vehicle's charging profile. Different EVs have different charging characteristics that go beyond battery size and the highest rate at which they can charge. Vehicle batteries do not charge at maximum capacity until they are full. Instead, onboard instruments will regulate the flow of electricity, typically with the aim of maximizing charge to a certain level, then drawing less power when nearing a full charge.

Utilities determine the interconnection that will deliver power to a charger, but there are more factors and more stakeholders who will play a role in deploying EV infrastructure. Involve them early on in the process, long before ordering equipment or finalizing a site. Other stakeholders and authorities, such as permitting officials, will be important. Involving different stakeholders upfront can help identify additional challenges or opportunities.

Mitigating the spikes

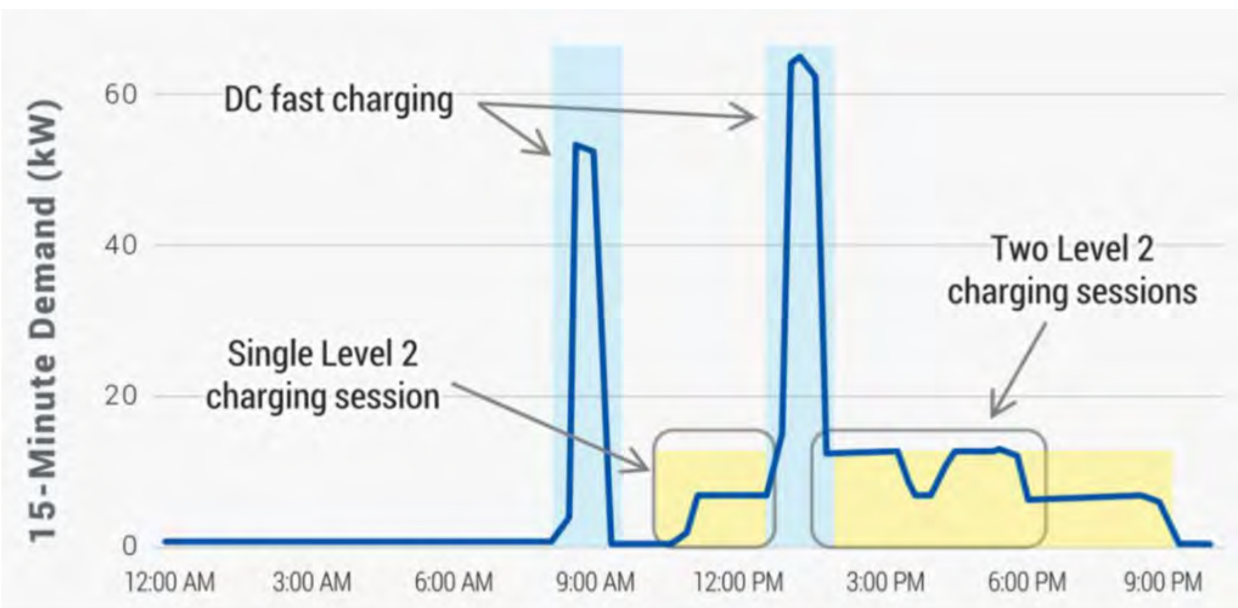
The load profile of a DC charger is different from those of appliances or electronics. An L2 charger can be similar to a refrigerator or an air conditioner, coming on and running for hours, occasionally cycling on and off, because it uses low power over a long period of time. But DC charging draws very high power for a relatively short period of time, resulting in spikes of demand, which can impact generation resources, as well as transmission and distribution.

The figure below presents load curves for DC fast charging and AC L2 chargers, illustrating their very different charging profiles.

Example Load Curves for AC L2 and DCFC Charging sessions

Below is a snapshot of the load curve for a charging station in San Diego that has both DCFC and L2 chargers. It illustrates how DCFC causes a high spike in load demand, but for a shorter time than the L2 demand, which is lower and lasts longer. It also demonstrates how the chargers impact the rate of energy the utility must supply.

SDG&E Parks Pilot December 14, 2021 Load Curve



Source: Standard Review Projects and AB1082/1083 Pilots: Evaluation Year 2021 (Year 1). p. 248 [Online]: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/sb-350-te/sb-350-standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

The unpredictable nature of these spikes puts more intense demand on the electric infrastructure. To account for this, there are two components to electricity pricing that can impact costs for high-power charging scenarios: the amount of total electricity used and the highest power requirements (demand charge element). Therefore, mitigating spikes can be important for managing costs.

There are options for mitigating the high-power spikes for charging. Approaches include distributed energy resources (DERs), which can generate or store electricity, such as photovoltaic solar panels, wind turbines, and onsite battery storage. Other approaches include lowering prices to encourage charging when there is excess capacity on the grid and raising them when loads are high or reservation systems that use communication between vehicles and the grid to arrange charging times. Modelling studies that combine approaches while utilizing utility feeder and load data have shown the potential to reduce peak power demand by more than 25%.

Even when taking these measures, however, it is still crucial to work with the utility so it can be aware of requirements at the charging site when conducting future grid capacity studies. Failure to do so can lead to overvoltage, undervoltage, overloaded transformers and lines, frequency violations, and multiple other violations that can be costly and detrimental to service for the charger and for other customers as well.

Other site considerations

Charger reliability is an issue that can be easy to overlook. It doesn't matter that the power to charge a vehicle is available if the charger can't deliver the electricity to the battery. When a malfunction prevents a vehicle from charging, the issue is not always related to charger components. Often the problem could be one of interoperability or interfacing. Problems with internet connections can prevent payment authorization, or the system may fail to reboot following a power outage. Customers, however, won't see any of these details, only that the charger didn't work.

DC charging will be an essential element of the electrified future of transportation. Understanding the advantages and disadvantages, as well as the impacts of this higher level of charging capacity can both smooth and hasten the transition to electrification.