

Developing Infrastructure to Charge Plug-In Electric Vehicles

Consumers and fleets considering plug-in electric vehicles (PEVs)—which include plug-in hybrid electric vehicles (PHEVs) and all-electric vehicles (EVs)—need access to charging stations, also known as EVSE (electric vehicle supply equipment). For most drivers, this starts with [charging at home](#) ([electricity_charging_home.html](#)) or at fleet facilities. Charging stations at [workplaces](#) ([electricity_charging_workplace.html](#)) and [public destinations](#) ([electricity_charging_public.html](#)) may help bolster market acceptance. Community leaders can find out more about getting ready for PEVs from [Clean Cities Coalition Network PEV vehicle community readiness projects](#) (https://cleancities.energy.gov/partnerships/search?project_search=Electric+Vehicle+Community+Readiness) or through [PEV readiness planning](#) ([pev-readiness.html](#)). The [EVI-Pro Lite tool](#) ([evi-pro-lite](#)) is also available to estimate the quantity and type of charging infrastructure necessary to support regional adoption of PEVs by state or city/urban area.

The [Alternative Fueling Station Locator](#) ([/stations/#/find/nearest](#)) allows users to search for public and private charging stations. Suggest new charging stations for inclusion in the Station Locator using the [Submit New Station](#) ([/stations/#/station/new](#)) form. Suggest updates to existing charging stations by selecting “Report a change” on the station details page.



The SAE J1772 charge port (right) on a vehicle can be used to accept charge with Level 1 or 2 charging equipment. The DC fast charging receptacle (left) uses a different type of connector. In this photo, it is a CHAdeMO.

Charging Infrastructure Terminology

The charging infrastructure industry has aligned with a common protocol, the [Open Charge Point Interface](#) (<https://ocpi-protocol.org/>) (OCPI) protocol. Therefore, charging infrastructure counting logic in the [Station Locator](#) (<https://afdc.energy.gov/stations/#/find/nearest>) aligns with the hierarchy defined in OCPI: stations, ports (referred to as electric vehicle supply equipment, or EVSE), and connectors. The Alternative Fuels Data Center and the Station Locator use the following charging infrastructure definitions:

- **Station:** called a “location” in OCPI; a collection of one or more EVSE at an address. A station has one or more EVSEs at the same site. A parking garage or a mall parking lot might be considered a station.
- **EVSE:** the technology that controls the energy supply to a single PEV, also called a port. An EVSE cannot charge more than one vehicle at a time.
- **Connector:** the socket or cable available for a PEV to use. A single EVSE may have multiple connectors and connector types (such as CHAdeMO and CCS) but only one may be used at a time. See the DC Fast Charging section below for more information about connector types.

Charging Equipment

Charging equipment for PEVs is classified by the rate at which the batteries are charged. Charging times vary based on how depleted the battery is, how much energy it holds, the type of battery, and the type of charging equipment (e.g., charging level and power output). The charging time can range from less than 20 minutes to 20 hours or more, depending on these factors. Charging the growing number of PEVs in use requires a robust network of stations for both consumers and fleets.

For information on currently available charging infrastructure models, see the Electric Drive Transportation Association's [GoElectricDrive website](#) (<https://www.goelectricdrive.org/charging-ev/charging-equipment-showroom>) and [Plug In America's Get Equipped resource](#) (<https://pluginamerica.org/get-equipped/>), which include information on charging networks and service providers. When [choosing equipment](#) ([electricity_infrastructure_development.html](#)) for a specific application, many factors, such as networking, payment capabilities, and [operation and maintenance](#) ([electricity_infrastructure_maintenance_and_operation.html](#)), should be considered.

Level 1 Charging

2 to 5 miles of range per
1 hour of charging



J1772 charge port

[Alternating Current \(AC\) \(/glossary.html#AlternatingCurrent\)](#) Level 1 equipment (often referred to simply as Level 1) provides charging through a 120 volt (V) AC plug. Most, if not all, PEVs will come with a Level 1 cordset, so no additional charging equipment is required. On one end of the cord is a standard NEMA ([/glossary.html#CommonNEMAOutlets](#)) connector, (for example, a NEMA 5-15, which is a common three-prong household plug) and on the other end is an SAE J1772 standard connector (often referred to simply as J1772, shown in the above image). The J1772 connector plugs in to the car's J1772 charge port, and the NEMA connector plugs in to a standard NEMA ([/glossary.html#CommonNEMAOutlets](#)) wall outlet. Note that Tesla vehicles have a unique charge port and connector. All Tesla vehicles come with a J1772 adapter which allows them to use non-Tesla charging equipment.

Level 1 charging is typically used when there is only a 120 V outlet available, such as while charging at home, but can easily provide charging for all of a driver's needs. For example, 8 hours of charging at 120 V can replenish about 40 miles of electric range for a mid-size PEV. As of 2020, less than 5% of public charging outlets in the United States were Level 1 (https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=all).

Level 2 Charging

10 to 20 miles of range per
1 hour of charging



J1772 charge port

AC Level 2 equipment (often referred to simply as Level 2) offers charging through 240 V (typical in residential applications) or 208 V (typical in commercial applications) electrical service. Most homes have 240 V service available, and because Level 2 equipment can charge a typical PEV battery overnight, it is commonly installed at PEV owners' homes for [home charging \(/fuels/electricity_charging_home.html\)](#). Level 2 equipment is also commonly used for [public and workplace charging \(/fuels/electricity_charging_public.html\)](#). This charging option can operate at up to 80 amperes (Amp) and 19.2 kW. However, most residential Level 2 equipment operates at lower power. Many of these units operate at up to 30 Amps, delivering 7.2 kW of power. These units require a dedicated 40-Amp circuit. As of 2020, over 80% of public outlets in the United States were Level 2. (https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=all).

Level 2 charging equipment uses the same J1772 connector and charge port that Level 1 equipment uses. All commercially available PEVs have the ability to charge using Level 1 and Level 2 charging equipment. Although Tesla vehicles do not have a J1772 charge port, Tesla does sell an adapter.

Tesla vehicles have a unique charge port and connector that works for all their charging options, including their Level 2 Destination Chargers and chargers for home. All Tesla vehicles come with a J1772 adapter which allows them to use non-Tesla charging equipment.

DC Fast Charging

60 to 80 miles of range per
20 minutes of charging



CCS charge port



CHAdeMO charge port



Tesla charge port

Direct-current (DC) (</glossary.html#DirectCurrent>) fast charging equipment (typically 208/480 V AC three-phase input), enables rapid charging along heavy traffic corridors at installed stations. As of 2020, [over 15% of charging outlets in the United States were DC fast chargers.](https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=dc_fast) (https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=dc_fast) There are three types of DC fast charging systems, depending on the type of charge port on the vehicle: SAE Combined Charging System (CCS), CHAdeMO, or Tesla.

The **CCS** (also known as J1772 combo) connector is unique because a driver can use the same charge port when charging with Level 1, 2, or DC fast equipment. The only difference is that the DC fast charge connector has two additional bottom pins.

The **CHAdeMO** connector is the most common of the three connector types.

Tesla vehicles have a unique charge port and connector that works for all their charging levels including their fast charging option, called a Supercharger. Although Tesla vehicles do not have a CHAdeMO charge port and do not come with a CHAdeMO adapter, Tesla does sell an adapter.

[Charging Infrastructure Procurement and Installation \(electricity_infrastructure_development.html\)](#)

Increasing available public and private charging equipment requires infrastructure procurement. Learn about how to successfully plan for, procure, and install charging infrastructure.

[Charging Infrastructure Operation and Maintenance \(electricity_infrastructure_maintenance_and_operation.html\)](#)

Once charging infrastructure has been procured and installed, it must be properly operated and maintained. Learn about charging infrastructure operation and maintenance considerations.

Additional Charging Options

Another standard (SAE J3068) was developed in 2018 for higher rates of AC charging using three-phase power, which is common at commercial and industrial locations in the United States. Some components of the standard were adapted from the European three-phase charging standards and specified for North American AC grid voltages and requirements. In the United States, the common three-phase voltages are typically 208/120 V, 480/277 V. The standard targets power levels between 6 kW and 130 kW.

Extreme fast chargers (XFC), which are capable of power outputs of up to 350 kW and higher, are rapidly being deployed in the United States. While XFC are currently available from several charging manufacturers, the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy's Vehicle Technologies Office is pursuing research that will bridge the technology gaps.

associated with implementing XFC charging networks in the United States. A 2017 [report](https://energy.gov/sites/prod/files/2017/10/f38/XFC%20Technology%20Gap%20Assessment%20Report_FINAL_10202017.pdf) (https://energy.gov/sites/prod/files/2017/10/f38/XFC%20Technology%20Gap%20Assessment%20Report_FINAL_10202017.pdf) highlights technology gaps at the battery, vehicle, and infrastructure levels. In particular, most PEVs on the roads today are not capable of charging at rates higher than 50 kW. However, vehicle technology is advancing, and most new EV models will be able to charge at higher rates, enabling the use of XFC.

Inductive Charging

Inductive charging equipment, which uses an electromagnetic field to transfer electricity to a PEV without a cord, has been introduced commercially for installation as an aftermarket add-on. Some currently available wireless charging stations operate at power levels comparable to Level 2, though this technology is more common for transit or other fleet operations at higher power levels comparable to DC fast.



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