EV Charging: Speeds, Ports & Specifications

EV charging is categorized by delivery of electricity as direct current (DC) or alternating current (AC):

- **DC**: The batteries in battery electric vehicles (BEVs) store and deliver power as DC. DC fast charging (DCFC) equipment supplies DC power directly from the utility to the vehicle batteries, bypassing the on-board charger (OBC).
- **AC**: The power delivered by utility equipment through transformers is AC. AC power, common for moderate-powered charging, must be converted to DC using the vehicle's OBC, also known as a rectifier.

The information provided below addresses:

Charging speeds & power levels

The charging speed describes how fast energy is transferred from the electrical supply to the vehicle's battery. This speed varies within each charging level, depending on factors such as the ambient temperature, electrical supply, the car's OBC size, the battery capacity and state of charge (charge rates taper as the battery nears a full charge), and battery temperature.

- **Level 1 (L1)**: 110 V or 120 V, such as a common indoor or outdoor wall outlet. Safe L1 charging requires a dedicated circuit, typically 20 A, and is the slowest charging option.
- **Level 2 (L2)**: 208 V to 240 V. These charging staions use a 40 A circuit often found in residential, workplace, and public locations.
- **DC Fast Charge (DCFC)**: 480 V or higher. DCFC uses commercial three-phase power and can deliver power at various speeds. Modern EVs can recharge from 10% to 80% in 20 to 30 minutes with DCFC. Depending on the vehicle's battery size and efficiency, some EVs will accept power levels from 250-350 kW. This means that an EV with a 75 kWh battery can replenish its state of charge to 80% in less than 20 minutes with a 350 kW charger, but a 150 kW charger would take twice as long.
- **Extreme Fast Charging (EFX)**: Very high-power charging designed for fast-charging medium- and heavy-duty trucks, including semi-trucks. Such vehicles may demand power levels ranging from several hundred kW to more than 1 MW per vehicle. EFX charging allows operators to quickly recharge large battery packs with capacities above 500 kWh.

Charging Taper

Charging to 80% instead of 100% is standard practice when fast charging because charging slows as a battery pack nears its storage capacity. The charging taper or overall charging speed might also be impacted by extreme ambient temperatures (below -40 °F or over 110 °F). Each original equipment manufacturer (OEM) has a different charging taper charging as battery capacity nears full. Generally, larger batteries at a low state of charge allow for a faster charge rate, which might be a factor when choosing one electric pickup over another.

The approximate time required to charge an EV battery from 20% to 80% state of charge (SOC) based on charging types and battery sizes is shown below. Actual charging times may vary according to exact vehicle type and specifications.

Charging Level	Power Output per Charging Session	Small EV (40 kWh battery)	Medium EV (65 kWh battery)	Large EV (90 kWh battery)
Level 1	2.3 kW	11 hr 36 min	18 hr 50 min	26 hr 5 min
Level 2	7.4 kW	3 hr 36 min	5 hr 51 min	8 hr 6 min
Level 2	11 kW	2 hr 25 min	3 hr 56 min	5 hr 27 min
Level 2	22 kW	1 hr 8 min	1 hr 45 min	2 hr 27 min
DCFC	50 kW	32 min	52 min	1 hr 12 min
DCFC	100 kW	16 min	26 min	36 min
DCFC	150 kW	-	17 min	24 min
DCFC	240 kW	-	11 min	15 min
DCFC	300 kW	-	8 min	11 min

Charging Ports

Common charging ports currently in use in North America are:

- **CCS Combo**: Combined charging system, also known as Combo. This charging plug supports AC (i.e., J1772 as part of the configuration) and DC charging power levels up to 350 kW. In practice, the charging ranges from 50 kWh to 150 kWh.
- **CHAdeMO**: Charging plug used in DCFC systems. This is currently available in fewer models and is the only DC standard that offers vehicle-to-grid (V2G) connectivity.
- **J1772**: Plug/port style used for L2 (AC) charging. Part of the CCS configuration. (This is not the same as L2 for Tesla for destination charging.)
- **Tesla Superchargers**: Proprietary charging system and port (250 kWh to 400 kWh) that can only be used for Tesla vehicles, although several OEMs announced in mid-2023 that they are adopting the Tesla standard for their vehicles. The port also includes the AC L2 plug-in.
- **SAE**: Society of Automotive Engineers, the governing body that sets vehicle charging standards for the connectors AC-J1772, DC-CCS/Combo, and CHAdeMO.

Each of the main charging methods—L1, L2, and DCFC—provide different options and charging speeds. The most common types of charging methods and the types of ports used to connect charging equipment to vehicles are shown below.

Level 1	Level 2	DC Fast Charging
 J1772	 J1772  Tesla	 CHAdeMO  CCS Combo  Tesla Supercharger
SAE J1772	SAE J1772 Tesla or North American Charging Standard (NACS)	CHAdeMO – CCS Combo Tesla or North American Charging Standard (NACS)
120 V	240 V	480 V
1.9 kW max	Up to 19.2 kW power	CHAdeMO – typically 50 kW power
		CCS Combo – up to 350 kW power
		Tesla – up to 400 kW power

Charging Specifications

EV charging equipment should meet the following requirements specified in NEC Article 625. This article covers the electrical conductors and equipment external to an EV that connect an EV to an electric supply, and installation of equipment and devices related to EV charging.

EV charging equipment hardware specifications:

- Certified to operate outdoors and in extreme weather conditions.
- Meets SAE J1772 standard for charging plug connector and operational requirements. For DCFC, hardware must include dual-protocol charging, compatible with both CHAdeMO and CCS1 Combo charging ports.
- Commercially available in Washington.
- Minimum lifespan of five years.
- Minimum three-year warranty. Minimum five-year manufacturer's warranty.
- Must be certified through a nationally recognized testing laboratory (Underwriters Laboratories, NRTL, ETL, or an equivalent certification program) to demonstrate compliance with appropriate product safety standards.
- Certified with EPA ENERGY STAR.
- Compliant with the Open Charge Point Protocol (OCPP) 1.6.

EV charging equipment network requirements (if applicable):

- Maintain appropriate hardware and software that allows remote diagnostics, remote start of the charging equipment, and collects and reports usage data.
- Ensure EVS charging station data fields are made available, free of charge, to third-party software developers via an interface that includes location, operator and network name, access type, port information, and pricing structure.
- Effective January 1, 2024, follow WSDA Weights and Measures rules for Electric Vehicle Supply Equipment (*link not available*), including equipment registration.

Networked EV charging equipment must be able to accurately record and report the following data:

- Number of unique charging events by month.
- Average or duration of each charging event by month.
- Kilowatt hours delivered by each charger at each site.
- Downtime at each charger at each site by month when monitored.

EV charging equipment location requirements:

- Sites must have dedicated paved parking spaces available for charging services. These spaces must be adequately lit and safe from traffic circulation, and be maintained and repaired according to an operations and maintenance plan.

EV charging equipment user interface should:

- Be legible in both day and nighttime conditions.
- Be certified to operate outdoors and in extreme weather conditions.
- Include adequate cord length, protection, and storage.
- Include signage per RCW 46.08.185.

WSDA Specifications for Public Charging

Effective January 1, 2024, new WSDA rules for EV supply equipment (*link not available*) will include:

- WAC 16-662-200 (payment methods and fee disclosures)
- WAC 16-662-215 (language requirements)
- WAC 16-662-220 (interoperability)

For any public charging with payment required, support multiple point-of-sale methods, such as pay per use and subscription methods. Payment options must:

- Include the ability to accept credit, debit, and pre-paid cards (chip and tap readers) without incurring any additional fees or delays versus other payment or access control methods.
- Be offered without restriction based on network membership or subscription.
- Display clear, simple, and real-time pricing and fee information on device or payment screen.
- Be accessible to people with disabilities.
- Be compliant with appropriate Payment Card Industry Data Security Standards for the processing, transmission, and storage of cardholder data.
- Provide customer support service that is accessible 24/7 via a toll-free telephone number clearly posted near the charging equipment that is available to EV drivers accessing the charging equipment. This customer support must include a mechanism to report outages, malfunctions, or other issues with charging infrastructure.
- Be operational and publicly accessible 24/7.
- Include a signage plan that conforms to industry standards, including the WSDA.
- Effectively communicate to EV drivers when using and searching for a charging station if a station is not working (e.g., through a mobile app, text alerts, or similar technology).
- Ensure each port has an average annual uptime greater than 97%, achieving this level of performance in an operations and maintenance plan. A charging port is considered "up" when its hardware and software are both online and available for driver use and the charging port successfully dispenses electricity in accordance with the minimum power level requirements.