Frequently Asked Questions about EVs and Charging Infrastructure

What are the different charging levels?

EV Charging comes in three primary forms:

- Level 1 charging uses a 120 V outlet, like the standard household outlet (although it requires a Ground Fault Circuit Interrupter). It can restore about 3-5 miles of range per hour of charging. While this is too slow to conveniently charge an EV from "empty" to "full," it is well-suited to replenishing typical daily driving distances over the course of a workday. As such, it can be a good fit for charging at workplaces or other locations where vehicles are parked for 8 hours or more. Public Level 1 charging stations are not common, but have viable use cases.
- Level 2 charging uses a 208 V or 240 V outlet. It can deliver far more power than Level 1 charging, and can restore 10-25 miles of range per hour of charging. It is suitable for locations where vehicles are parked for a few hours. It can also be used at workplaces, but will may require vehicles to be moved when fully charged. There are many suppliers for public Level 2 stations.
- Direct Current Fast Charging (DCFC) generally uses three-phase power at 480 V or higher. These can charge an EV rapidly, restoring a vehicle from nearly empty to full in an hour or less. Some newer DCFC systems can charge some newer EVs from 20% to 80% in 15 minutes; however, not all EVs can accept this charge rate. And not all DCFC systems can provide it. DCFC systems are considerably more expensive, may face high demand charges from utilities, and provide a reduced incentive for site hosts (since EV drivers do not stay as long at the location). But, it is the closest to the current paradigm of vehicle "refueling."

What kind of charging should we install?

The "dwell time" – how long you expect driver to stay at a location – most often determines the appropriate charging speed. If charging speed is too fast, drivers will need to move fully-charged vehicles. A DCFC would not be suitable at a cinema, for example, since patrons would not wish to leave the cinema after half an hour to move a fully-charged vehicle.

Public level 2 charging is suitable for many municipal applications, such as municipal parking lots, parks and playgrounds, beaches, shopping centers, concert venues, or stadiums. These are locations where a driver might stay for a few hours.

Public level 1 charging is suitable for long dwell time locations such as commuter rail lots or airports.

Aren't there different charging standards? What type should we install?

There is a single standard Level 1 and Level 2 charging connector that all EVs can use; this is the J 1772 connector. (Tesla vehicles come with an adapter for this connector.)

Tesla vehicles use a proprietary connector for DCFC, and the company does not expect public investment to support fast charging of its vehicles; accordingly, public investment in fast charging should be focused on the other primary standard, the Combined Charging System (CCS). There is a third standard for DCFC, CHAdeMO, which was used for some EVs such as the Nissan LEAF. Newer Nissan vehicles will use the CCS connector.

Municipalities installing level 2 charging do not need to worry about charging standards, as there is only one (J1772). Those installing DCFC should focus on CCS, but also include some CHAdeMO connectors for older LEAF vehicles.

What are the maintenance needs of public charging stations?

The U.S. Department of Energy's Alternative Fuels Data Center notes, "General maintenance for charging infrastructure includes storing charging cables securely, checking parts periodically, and keeping the equipment clean. Chargers may need intermittent repairs as well." Either the EVSE installer or the charging network operator (if one is used) may be able to provide a maintenance contract.

Additional features may require additional maintenance. For example, network capabilities or payment systems may offer significant benefits, but do introduce a potential point of system failure. A 2019 report from Avista Utilities found that networked Level 2 stations incurred about $600/year in operations and maintenance costs per charging port, compared to $185/year for non-networked Level 2 stations. The networked stations also had significantly lower uptime.

Common causes of charging station damage include collisions, vandalism (including for theft of materials), or component failure. Connectors can become obstructed by debris or dirt, especially if left on the ground. Some systems only end a charging session (and stop billing the customer) when the nozzle is returned to its holster; others have retractable cords to ensure that cords do not remain on the ground.

Do electric vehicles have all-wheel drive?

Some electric vehicles do have all-wheel drive, either standard or as an option. These generally have a somewhat higher energy consumption, and therefore slightly reduced range. As well, they tend to cost somewhat more. For example, the Tesla Model 3 offers AWD only in its longer-range versions. Many of the crossover SUV EVs offer all-wheel drive, such as the Audi E-Tron, Ford Mustang Mach-E, and Tesla Model Y.

Should we install networked or non-networked chargers?

There are costs and benefits to installing networked charging stations. They cost more initially, at about $6000 per level 2 charger (of which about $3000 is hardware cost and $3000 is installation). The hardware cost of non-networked level 2 chargers is about $1000. These values are drawn from an ICCT report from August 2019. The installation cost of a non-networked level 2 station is likely somewhat less due to the lack of need to establish a network connection. As well, networked stations have ongoing network fees of around $200-250/yr for each charger (see this RMI report), and they may require additional maintenance since there is another potential point of failure. The advantages of networked stations are that they can process payments, can report real-time operational status, can limit access to specific vehicles (such as for a fleet), can enable queuing of vehicles, and can manage load to avoid adding to a facility's peak demand.

Level 1 chargers are not normally networked, and do not need to be. For level 2 chargers, it depends on the specific balance of costs and benefits in each case.

Should we seek vehicle-to-grid capabilities in our EVs?

Electric vehicles can serve as distributed energy resources for the grid. At their most basic level, they can use the scheduled charging features common to all EVs to start charging during off-peak periods. This places downward pressure on rates for all ratepayers, and may save money if the site host is on a time-of-use rate from the utility.

More advanced smart charging approaches involve using the chargers for demand response during times of high electricity demand, or modulating power demand to provide grid services such as frequency regulation. The market for these grid services saturates fairly quickly, so the more EVs are on the grid, the less value each one will get.

The best near-term value proposition for vehicle-to-grid capabilities is probably to provide backup power during outages. Because this approach does not provide power to the *grid*, it is sometimes called "Vehicle-to-Home (V2H)" or "Vehicle-to-Building (V2B)" (although V2G is also used as a catch-all term). For municipal or business needs, a large vehicle with a sizeable battery could provide power for essential systems such as refrigerators, lights, and computers during a power outage. Electric school buses are a good option for this capability, as schools are often used as emergency shelters. Cummins has developed such systems for Bluebird electric school buses, and in a March 2021 press release notes that by mid-2021 all of these electric school buses will have V2G hardware and software. Lion Electric has been running a pilot with similar systems in partnership with Con Ed in New York.