Take Charge

What electric vehicle owners need to know about safely installing and operating a Level 2 charger at home

BY CHARLES BICKFORD

The Edison Electric Institute (eei.org) predicts that by the year 2030, about one-third of cars (and trucks) in the United States will be battery powered. Environmentally, it's an overall win that will help to reduce carbon emissions. Add in fuel cost savings and various federal and state rebates, and electric vehicles (EVs) start to look better and better to most folks. Given that charging a car at home is the least expensive and most convenient way to charge an EV battery, most drivers will want a home EV charger. For homeowners and renters with grid-tied solar, having an EV is a no-brainer. Often the low cost of electricity makes it possible to power the car very inexpensively or for free if the electric customer has a regular surplus of PV-generated power.

EV chargers, also referred to as electric vehicle supply equipment (EVSE), are classified by the amount of amperage they can supply to your car. The more amperage, the faster the charge. Your car battery's size is measured in amps or kilowatts (kw), and also has a limit of how much charge it can take over a period of time, known as its acceptance rate. Level 1 and 2 chargers supply household AC power to an EV, where an onboard device converts the AC power to DC before it's stored in the battery. Level 3 chargers supply DC power directly to the battery, making a faster charge time possible.

Not all chargers connect to all cars

At this time in North America, there are two different connectors that link the charger cable to the car's charger port. (EV manufacturers in Europe and Asia use different connectors.) Tesla, the world's largest EV manufacturer, uses one type, the NACS, while most others use another, the J1772 plug. Beginning in 2022, Tesla gave permission to other manufacturers to use their NACS connector. In response, multiple auto companies announced that, starting in 2025, their EV's will be equipped with the NACS charging port. Many of the companies that manufacture chargers (including Tesla) offer buyers the choice between connectors; some even offer dual-connector chargers with both types of plugs.

For those whose choice are limited (if, for example, you already have a charger with a J1772 connector and a new car with an NACS

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3 LEVELS OF EV CHARGERS

FASTER CHARGING RATES COST MORE

▲ **LEVEL 1** Typically included as part of the equipment package with new EVs, Level 1 chargers plug in to a 120v GFCI-protected receptacle outlet and have a range of output between 1kw and 1.8kw, which translates to 2 to 5 miles of range per hour of charging. While this might work for occasional-use vehicles, Level 1 charging is often too slow to power the typical commute.

◀ **LEVEL 2** Depending on the model, these chargers can be hardwired or plugged in to a 240v circuit of typically 40 amps to 60 amps, and output 7kw to 19kw for a faster charging rate of 10 to 20 miles of range per charging hour. Most chargers have the ability to adjust their power to match that of the car's battery; the output amperage on Level 2 chargers can typically be adjusted from 6 amps to 48 amps. A higher amperage requires a larger-capacity circuit. (The designated circuit must have 25% more amp capacity than the charger, per the National Electrical Code.) For the majority of EV owners, Level 2 chargers make the most sense—they afford the most charge on a household circuit. Charger costs range from about $150 for a low-amp plug-in model to about $1300 for the Ford 80-amp bidirectional charger (p. 61, bottom right). Most cost between $300 and $700.

◀ **LEVEL 3** Typically used for public charging stations, these chargers are powered by a three-phase, 300-amp, 480v current that gives the charger an output of up to 140kw. The higher amperage gives Level 3 chargers the fastest charging rate of 180 to 240 miles of range per charging hour. However, their power requirements exceed the capacities of residential areas, which typically do not have access to such commercial/industrial service (unless you plan to install a substation in your backyard). Level 3 equipment can cost between $10,000 and $50,000.

port), there are adapters that allow the connection, and costs typically range from $70 to $170.

What to look for in a Level 2 charger

Most EV owners will want a Level 2 charger for home charging, given their faster charging rate when compared to Level 1 chargers. If you only drive short distances, say 40 miles a day, you may be able to charge your car adequately with a Level 1 charger and you won't need to install a new 240v circuit and Level 2 charger in your garage. If you do drive more than the Level 1 charger can produce, install a Level 2 unit and keep the Level 1 for road trips. The marketplace is overflowing with Level 2 chargers, so here are a few tips to keep in mind.

First and foremost, be sure that the charger has a UL certification or the equivalent, and that it has at least a three-year warranty—many do not. Another thing to look for is rebates for a particular model. For instance, in the state of Connecticut, the utility Eversource offers rebates for ChargePoint and JuiceBox chargers.

The charger's connecting cable should be at least 20 ft. long, so that you can reasonably reach your car's port no matter where the charger is installed. The charger should have a weatherproof housing that protects the charger (and therefore, you) from the elements. Also, look for controls that allow you to monitor and change the charging cycle. Phone apps are often used to control or monitor the performance of a charger. On-board programs may also auto-detect the amperage of the circuit and schedule charging during off-peak times, when the electric rates are lower.

Potential EV owners should also think about their driving needs when they buy a charger. If you have two EVs, consider dual chargers that can split a 40-amp output between the two cars at a rate of approximately 15 miles per hr.

What's on the horizon?

The first electric vehicle was invented in 1891; obviously, there have been massive developments in EV and EV-charging technology since then. We may expect the next generation of Level 2 chargers to be more powerful, capable of producing 19.2kw of power at 80 amp, and charging at a much faster rate than the contemporary 40-amp to 50-amp chargers. These higher-powered residential chargers may also take the pressure off the larger problem of establishing a nationwide Level 3 charging infrastructure, which has lagged in the more remote regions of the country.

The method of charging may also change. Companies such as WiTricity, Plugless Power,

A BUYER'S GUIDE TO EV CHARGERS

7 FEATURES TO CONSIDER FOR LEVEL 2 CHARGING

OUTDOOR-RATED
The Canadian-made Grizzl-E Avalanche Edition is meant for all-weather outdoor installations, according to the manufacturer. Outdoor chargers should be hardwired with an outdoor disconnect.

Grizzl-E Avalanche Edition

$350

Adjustable from 16-amp to 40-amp output

REMOTE MONITORING
Many chargers have smartphone apps to keep you informed of your vehicle's battery level and the charging rate. Most can also help you find commercial fast-charging stations when you're traveling.

ChargePoint Home Flex

$550

Adjustable from 16-amp to 50-amp output

CORD MANAGEMENT The cable that connects the charger to the EV is long and heavy and can make connecting and disconnecting a twice-daily struggle. Enphase's HCS series is arranged like a hose rack for easy cable storage.

Enphase HCS series Starting at $730

Four models ranging from 32-amp to 64-amp output

SIDE HOLSTER Legrande's Level 2 chargers have a holster separate from the charger housing. The arrangement allows you to hang the charging cable closer to the connection on the car, so there's less cable dragging when connecting and disconnecting.

Legrande L2EVSE48AC $650

Adjustable from 16-amp to 48-amp output

PART OF THE DECOR Tesla's Wall Connector is suitable for both indoor and outdoor installations and can be equipped with the NACS (Tesla) or J1772 connector. Tesla also offers four colors of their Wall Connector faceplates ($100) to match your charger with your garage or vehicle.

Tesla Wall Connector $475

Adjustable from 12-amp to 48-amp output

TWO FOR ONE The Grizzl-E Duo can charge two electric vehicles at the same time. It has a pair of 24-ft. cables and load-sharing technology that charges one or both vehicles depending on their state of charge.

Grizzl-E Duo $800

Adjustable from 16-amp to 40-amp output

MAXIMUM POWER Larger vehicles benefit from the faster charging times of hardwired chargers. Ford's largest, 80-amp home charger requires a 100-amp circuit. It can bring the F-150 Lightning's extended-range battery from 15% to 100% power in about 8 hours.

Ford Charge Station Pro $1310

80-amp max output

Hevo, and others are manufacturing EV chargers that work just like those wireless phone chargers you may have seen. Known as inductive charging, a ground pad creates a magnetic field that transfers power to a receiving coil mounted underneath the car. Receivers are sized according to the height of the vehicle from the pad—the lower the car, the smaller the receiver. A car doesn't have to be perfectly centered over the pad to receive the charge. Both the level of charge (up to 11kw) and costs on inductive chargers are similar to a Level 2 hardwired charger.

In addition to their contribution to cleaner air, EVs can become part of the larger power grid. A specialized bidirectional charger can transfer AC power to the EV battery, and then convert the DC power from the car back to AC power. At the time of writing, Ford, Hyundai, Nissan, Kia, Volkswagen, and Mitsubishi EVs are equipped with bidirectional chargers that allow them to power small appliances, laptops, and more via on-board receptacles. Builder Josh Salinger uses his company's Ford's F-150 Lightning, which has ten 120v standard receptacles and one 240v receptacle, to power job-site tools (see "A truck that powers the job," *FHB* #317).

An EVs battery can also be used as backup household power, known as vehicle-to-home (V2H) technology. The Ford Lightning's bidirectional system, when paired with its Home Integration System, can power an average home during a blackout for up to three days. GM and Volkswagen have similar V2H integration systems ready to launch in 2024, with other manufacturers sure to follow.

As the infrastructure for EVs develops further, bidirectional chargers will also be enlisted to help beef up the grid during brownouts or periods of high demand. Vehicle-to-grid (V2G) technology allows an individual or fleet of EVs to charge during periods of low usage and contribute back to the grid during periods of high usage. In theory, contributors would be credited in a fashion similar to that of solar net-metering. One sign of the perceived importance of this new technology was the announcement in July of 2023 by the U.S. Department of Energy of its planned initiative to build an infrastructure between states, agencies, and manufacturers to create a more resilient, dependable power grid through the use of bidirectional chargers and the increasing numbers of electric vehicles. □

Charles Bickford is a former senior editor. *Fine Homebuilding* reader and EV enthusiast David Pickering provided assistance for this article. Photos by the manufacturers.

INSTALLING A LEVEL 2 CHARGER

CODE REQUIREMENTS, CLEARANCES, AND MORE

The National Electrical Code (NEC) requires home EV chargers be mounted at least 18 in. from the floor (24 in. if outside) and have 12 in. of clearance on both sides. The cable should reach the car's charging port without straining. Electrical contractor Joe Fratello likes to install chargers and their receptacle outlets on the wall separating two garage doors, provided the space is at least 3 ft. wide. This gives owners the option of easily charging two cars, indoors or outdoors by running the cord(s) under the garage door.

Both hardwired and plug-in Level 2 chargers require a 240v circuit, which code requires a permit and inspection to install. When it comes to Level 2 charging, it's best to hire a licensed electrical contractor to ensure the installation meets code. According to HomeAdvisor.com, the national average cost to install a Level 2 charger runs between $400 and $1700, minus a federal tax credit of up to 30% of the installation cost.

HARDWIRED VS. PLUG-IN CHARGERS

Hardwired chargers can support up to 80 amps and may be required for large vehicles or high-mileage commuting.

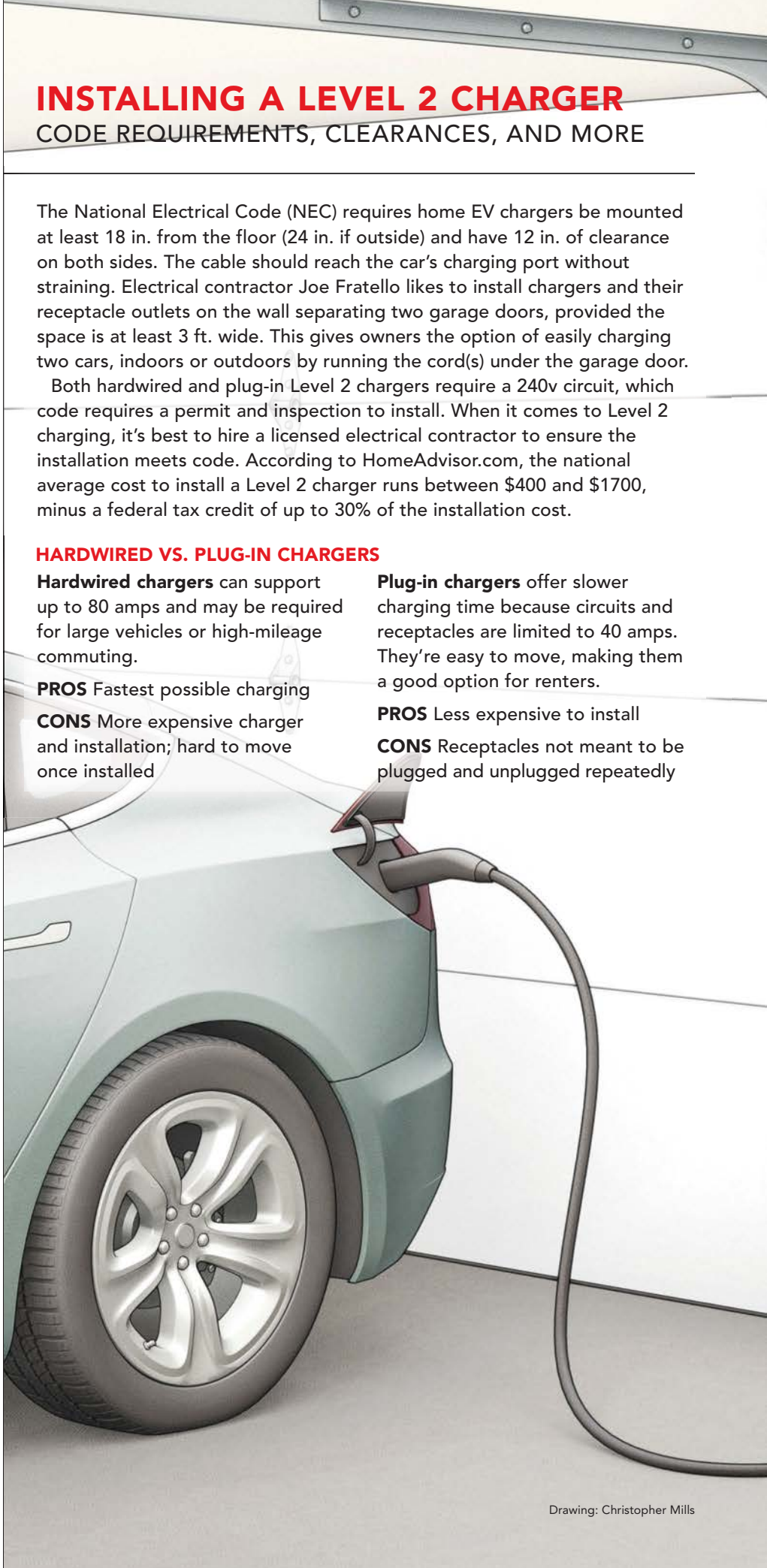
PROS Fastest possible charging

CONS More expensive charger and installation; hard to move once installed

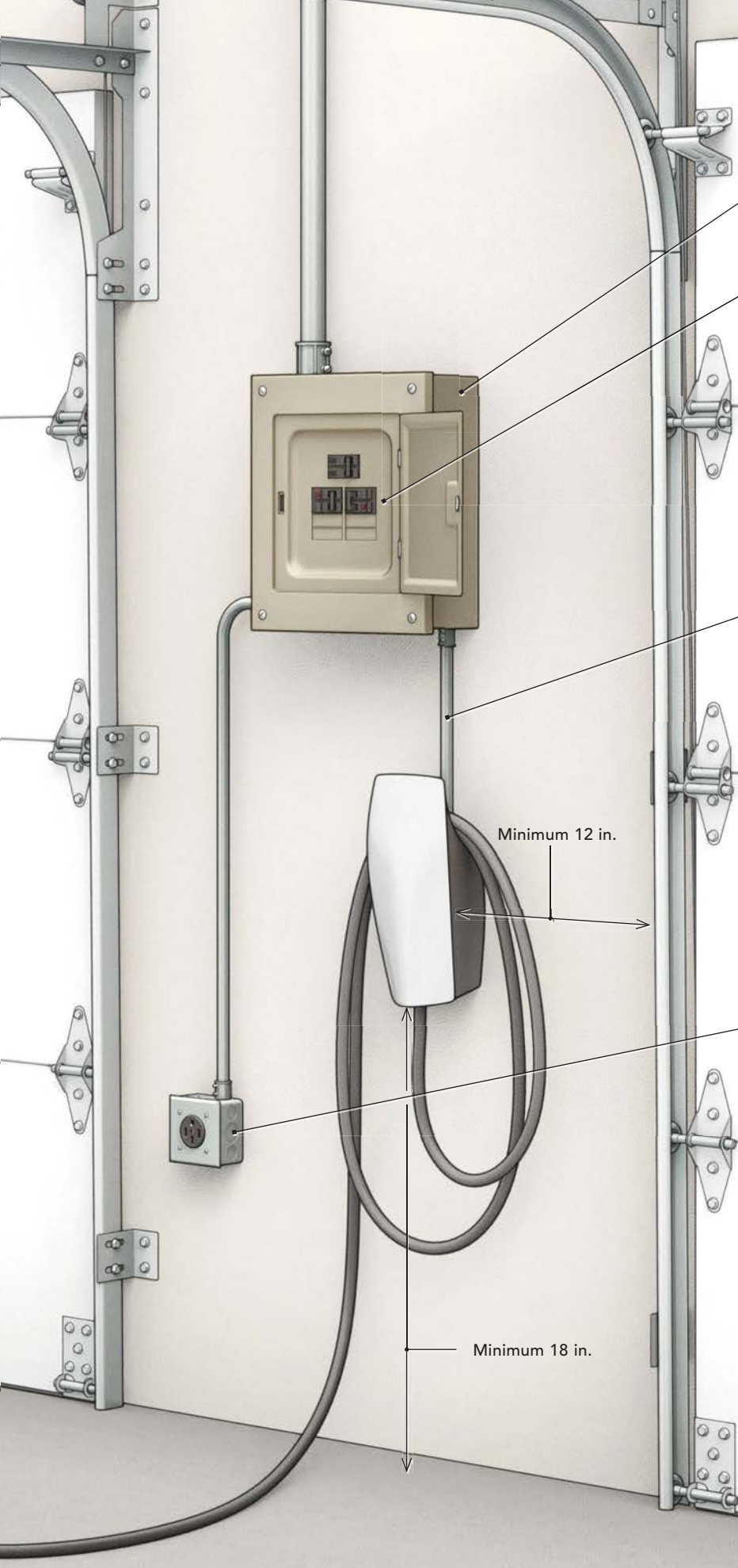
Plug-in chargers offer slower charging time because circuits and receptacles are limited to 40 amps. They're easy to move, making them a good option for renters.

PROS Less expensive to install

CONS Receptacles not meant to be plugged and unplugged repeatedly



Drawing: Christopher Mills



FUTURE-PROOF PANEL

EV chargers can be powered by a main panel or a subpanel circuit. Adding a subpanel adds cost, but can future-proof the installation should you decide to install a larger charger or a second EV.

APPROPRIATE AMPERAGE

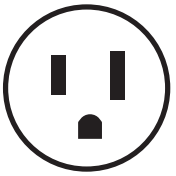
For fastest charging, your electrical panel must accommodate an additional 40-amp to 60-amp circuit. Many chargers can be set for a slower charging rate that uses less amperage if needed.

CORRECT CONDUCTORS

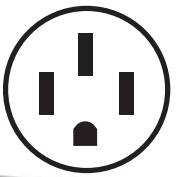
In most areas, the NEC requires that every 240v circuit is protected with a ground-fault circuit interrupter (GFCI) at the panel as a safety measure. Some chargers have internal GFCIs; beware that when you combine two GFCIs on the same circuit, it can lead to nuisance trips that turn off the charger when no fault exists. To supply the charger with electricity you need 8-ga. (100-amp), 6-ga. (55-amp), or 3-ga. (40-amp) conductors in a cable or conduit unless the vehicle charger is especially far from the electrical panel, in which case you may need to upsize the conductors.

OPTIMAL OUTLETS

Receptacle outlets or hardwired chargers should be mounted on a fire-rated wall that is covered with at least one layer of 5⁄8-in. drywall. The 240v receptacles for plug-in chargers must be UL-certified or the equivalent, and should be a commercial grade so that they resist heat generated by long charge times. EV expert Sandy Munro says commercial receptacles like those made by Hubell better withstand the heat of EV charging than cheaper options. Level 2 plug-in chargers use either a NEMA 14-50 or NEMA 6-50 receptacle. The more common 14-50 receptacle includes a neutral conductor. With one fewer conductor, the 6-50 receptacle is often less expensive to install. Some EV manufacturers offer both options, leaving the choice up to preference. NEMA 6-50 and 14-50 plugs and receptacles are not meant to be unplugged and plugged in repeatedly. The connections inside the receptacle can loosen, creating a fire hazard.



NEMA 6-50



NEMA 14-50