

# What to Consider When Buying and Installing a Home Electric Vehicle Charging Station



Tom Konrad sifts through all the decisions a homeowner needs to make when installing an EV charger—including features, brands and performance.

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January 30, 2017*

Most plug-in vehicles (both pure electric and plug-in hybrids) come with a Level 1 charging station which allows the vehicle to be charged from a standard household outlet. If your vehicle is a plug-in hybrid with limited electric range, or you don't drive much, this is likely all you will need. Otherwise, you will want a Level 2 charging station.

If you are a do-it-yourselfer and like to get into the nitty-gritty, you should read the whole article. If you just want some quick advice about the best charging station for you, skip to the last section, "Putting It All Together."

## What a home charging station does

Technically, a home charging station (also known as "electric vehicle supply equipment" or EVSE) does not charge your car. Your car has an on-board charger which converts household alternating current to the direct current which is stored in its batteries.

I just installed a charging station for my wife's new Prius Prime plug-in hybrid, and concurrently applied for a grant from New York state on behalf of the Town of Marbletown to install a commercial charging station at my town's community center. This article is based on that experience. The responses come from a poll of 20 charging-station owners I contacted through Facebook groups and PlugShare, an app that allows users to find and review charging stations, as well as connect with other plug-in owners.

## Before you begin

Here is the information you'll need to make your decision.

1. Make/model of the plug-in vehicle you want to charge.
2. Location of the closest electric panel to your parking spot.
3. Your vehicle's electric range (PHEVs) or the longest distance you expect to drive between charges on a regular basis (EVs).

The make and model of the plug-in let you know the capacity of the vehicle's on-board charger and the size of its battery pack. You will need a charger powerful enough to fully recharge the battery between trips, and you will need an outlet or the charging station installed near the parking space that has the capacity to service that rate of charging.

## How fast a charger do you need?

If you will only need to charge your car up overnight, you have a plug-in hybrid with limited electric range, or you will not drive very far between charges, you probably don't need a very fast charger. Quick charging may only be something you need on long trips, when you can take advantage of the higher charging speeds available at most public charging stations.

Most plug-in hybrids (with the notable exception of the Volt) have limited electric range, meaning they can charge completely in less than 5 hours using the included Level 1 (120 V) charger plugged in to a standard household outlet. Most owners of these vehicles will not need a Level 2 charging station.

My wife's Prius Prime is a borderline example. It has 25 miles of electric range, and can be charged completely in 5 to 6 hours with a Level 1 charger. I elected to install a Level 2 charger for the convenience of being able to leave the factory Level 1 charger stowed in the car at all times, and because there are times when we take the car out more than once in a day. In this case, a quick charge between trips can make the difference between using gasoline and staying all-electric. Plus, I like gadgets.

The table below shows approximately how much electric range a typical EV that gets 3 to 4 miles per kilowatt-hour can recover for charging stations with different capacities (**miles can be 10% - 20% higher than shown on chart below**). The number followed by the A is the rated current in amps, the number followed by V is the voltage. Level 1 charging stations use 120 V, while Level 2 charging stations use 240 V.

<b>Charging Current</b>	<b>1 hour</b>	<b>2 hours</b>	<b>4 hours</b>	<b>6 hours</b>	<b>10 hours</b>
Level 1 (12A 120V)	4-5 miles	9 miles	18 miles	27 miles	45 miles
Level 2 (16A 240V)	10 miles	20 miles	40 miles	60 miles	100 miles
Level 2 (30A 240V)	20 miles	40 miles	80 miles	120 miles	200 miles
Level 2 (40A 240V)	30 miles	60 miles	120 miles	180 miles	300 miles

The rate at which a plug-in can charge is also limited by its on-board charger. This charger's capacity is rated in kilowatts (kW). The vehicle's battery pack is rated in kilowatt-hours (kWh). A vehicle's electric range is its efficiency (usually 3 to 4 miles/kWh times the size of its battery pack.) So a 2016 Nissan Leaf's 30 kilowatt-hour battery pack and approximate efficiency of 3.5 miles per kilowatt-hour give it a range of about 105 miles. The Leaf has a 6.6-kilowatt-hour on-board charger, giving it a maximum rate of charge of about 10 miles of range per hour, for a complete charge in 4 to 5 hours using a 30A, 240V Level 2 charging station.

Most plug-in hybrids have smaller on-board chargers to match their smaller battery packs, as do some pure electric vehicles with smaller battery packs and lower electric range. Much of the information available online says that the Leaf has a 3.3 kW on-board charger, but all eight Leaf owners who responded to my survey reported charging times that could only be achieved with a faster on-board charger.

Below is the charger capacity for most plug-ins on the market today, along with the size of the charger needed to take full advantage of this capacity. Additional charging capacity is available as an option on some models.

**Table 2: Charging Capacity of Various Plug-in Vehicle Models**

<b>Fastest EVSE</b>	<b>Min. circuit</b>	<b>On-board charger</b>	<b>Vehicles</b>
40A -- Level 2	50A 240V	10 kW	Tesla Model S, Tesla Model X, Mercedes B-Class Electric
32A -- Level 2	40A 240V	7.4 kW	BMW i3
30A -- Level 2	40A 240V	6.6 - 7.2 kW	Nissan Leaf, Chevy Bolt, Ford Focus Electric, VW e-Golf, Fiat 500e, Kia Soul EV, Hyundai Ion iq, Chrysler Pacifica Hybrid
16A -- Level 2	20A 240V	3.0 - 3.7 kW	Chevy Volt, Audi A3 e-tron, BMW X5 xdrive40e, Chevrolet Spark EV, Ford C-Max & Fusion Energi, Hyundai Sonata Plug-in Hybrid, Mercedes C350, S550, GLE550e Plug-in Hybrids, Mitsubishi i-MiEV, Porsche Cayenne & Panamera SE-Hybrid, Prius Prime, Smart Electric, Volvo XC90 T8, Porsche 918 Spyder, Nissan Leaf (early models).
10A -- Level 2	15A 240V	2 kW	Prius Plugin

## Circuit size

The final factor which may limit the size of the charging station you need is the capacity of the electrical circuit you will be using. If you try to charge a car at a rate equal to or greater than the capacity of your wiring, you will flip the circuit breaker. Unless the circuit is rated for continuous use, you should limit the charging rate to 80 percent of the circuit's capacity.

A second reason for charging at slower rates is efficiency. The electricity lost (called line loss) is proportional to the square of the current (the amps number in the charging rate) and inversely proportional to the capacity of the wiring. Line losses also increase with temperature, and the lost energy becomes heat in the wiring, further reducing efficiency. Line losses become more significant the longer the wiring between your main electrical panel and your charging station. With properly sized wiring, these losses will usually be less than 2 percent of the electricity used. But 2 percent can add up given the large electricity consumption of EVs. Thirty-five miles of driving a day in a typical EV uses 3,650 kilowatt-hours over a year. Two percent of that is 73 kilowatt-hours, or two to three days' worth of a typical household's electricity usage.

Most charging stations can be set to limit charging speed to less than their maximum capacity. Many plug-in vehicles also have the capacity to limit their charging rates and charging times. This feature can be used both to keep actual charging rates within the capacity of the circuit, as well as to reduce charging rates further in order to reduce line losses. Choosing specific charging times (either with your vehicle or some charging stations) can also save you money because of preferential rates from your utility.

If you have to install a new 240V circuit to service your charging station, I recommend installing at least a 50A, 240V circuit, or even a 100A, 240V subpanel for your garage if you can. Reasonably affordable EVs with large battery packs and powerful on-board chargers such as Tesla Model 3 are likely to be widely available in the next few years. You'll want the charging capacity to accommodate your new long-range EV. If you have a two-car household, you may also want the ability to charge two cars at the same time.

Higher capacity wiring will cost you more today, but the extra cost will be a fraction of the cost of the electrical work. Upgrading your wiring at a later date would involve doing everything over again. Even if you never need a more powerful charging station, the reduced line losses will help defray the extra cost over time.

# Should you oversize your charging station?

You may find a charging station with the features you want but a higher capacity than you need. If the rated power of your charging station exceeds 80 percent of the capacity of your circuit, make sure that you are buying one that has the ability to limit the charging current.

One good reason to oversize your charging station is durability, which my poll respondents felt was the single most important feature. Since no brands have a long history, it's hard to judge which brands are likely to be the most durable. However, it is a good bet that a charging station rated to supply 40 amps of current is likely to last a long time if it is only used to charge cars at 15 amps.

## Features

I included a question about features in my poll. Here are the ones my respondents found most important.

Durability, a long charging cord, charging speed, cost, and being outdoor rated were among the most valued features. One I neglected to ask about was the charging station having a plug as opposed to being hard-wired. Charging stations with plugs don't cost much more than those without, but even if they are too large to be truly portable, it makes them easier to take with you if you move.

Some features may have gotten lower ratings in my poll because they are only useful to some users, even if they are essential to the users who want them.

- An outdoor rating will be essential if your parking space is outdoors, but it will be irrelevant if you park in a garage.
- The ability to control charging times will be important if your car does not have this feature itself -- but only if your electrical utility gives rewards or preferential rates for avoiding charging during peak demand. That said, utility rates for plug-ins are changing, and you may need this feature tomorrow even if it is superfluous today.

## Brands

While few people have more than a couple years experience using charging stations, my poll respondents had this to say about the following brands.

### Top recommended brands

- Clipper Creek: Recommended by more respondents than any other brand
- JuiceBox: Probably the best options in terms of power and features for the price
- ChargePoint Home
- Bosch
- Tesla
- Siemens/Versicharge
- GE Durastation
- [Other EVSEs listed @ SacEVA.org](#)

### Mixed reviews

- Aerovironment (some rebranded by Nissan): Expensive, but a good warranty. One (of four) had it break right before the warranty expired. Respondent was unimpressed with their customer service, but said he thought service had gotten better in recent years.
- Audi: Expensive to install, but easy to use

## My top picks

- Duosida 16A: [\\$289 on Amazon](#), a basic portable charging station with a long cord and a great price. Not designed for wall mounting.
- Clipper Creek 16A: [\\$402 on Amazon](#), a well-rated charging station with a long cord and a reputable brand.
- GE DuraStation 30A: [\\$397 on HomeDepot.com](#), a powerful, no-frills charging station from a recognized brand. Maximum current can be adjusted to 30A, 24A, 16A, or 12A using a jumper.
- JuiceBox 40A: [\\$499 at eMotorWerks](#), the least expensive 40A charging station available. Maximum current can be set by adjusting trim-pots inside the enclosure.
- JuiceBox Pro 40A and Pro 75A: [\\$599 and \\$899 at eMotorWerks](#), full-featured, high-power charging stations at a low price. Wi-Fi enabled. Can be adjusted with a smartphone app to charge at any lower current required. I have not listed any other full-featured charging stations because the JuiceBox Pro beats the other options on price, and provides enough current for any vehicle.

*(Prices noted above include shipping)*

I had personal experience with eMotorWerks (JuiceBox) support through eBay, where I bought a refurbished JuiceBox Pro 40. I found them very slow to respond, and the problem had not been resolved after a week. But given that mine was a cut-price refurbished unit (and their prices are amazing to begin with), I still give the brand my highest recommendation.

I contacted eMotorWerks and asked them to respond to the previous paragraph. Here is their response:

"We appreciate the endorsement of our products, and are working diligently to fully staff and train our support team. Our sales have nearly doubled at the end of 2016 due to accelerated growth in EV sales (record 25,000 EVs sold in December, nearly twice the previous year) and successful programs we recently launched with our utility and community-choice aggregation partners. We're working to further grow our support team and deliver top-notch service to all our customers."

If you want top-notch service, [Clipper Creek](#) and [ChargePoint Home](#) have good reputations according to my poll respondents. I do not know if growth is straining their customer service departments. You will pay \$100 to \$300 extra for similar models from these vendors compared to eMotorWerks.

## Putting it all together

Although this is a rather technical article, choosing a home charging station does not have to be complex. Here are the essential steps:

1. If you do not drive much or your vehicle's electric range is less than 20 miles, a Level 2 charging station is probably not worth the cost. Try using just the factory Level 1 charger for a while.
2. Otherwise, use Table 2 above to determine the charging station capacity your vehicle can use.
3. If you are doing your own electrical work, go back and read the whole article.
4. Otherwise, purchase a charging station from my top picks (above) with a rated capacity at least as high as given in Table 2.
5. Have an electrician or three give you quotes to install a "240 volt(V) 50 amp(A)" circuit to your parking space and install your charging station. You can also ask them for a quote to install the minimum recommended circuit for your vehicle from Table 2, but the savings are not likely to be significant. You will probably be better off with a 240V, 50A circuit in the long run.
6. Have your electrician install the charging station, and adjust the charging station's maximum current to not overload the circuit. The adjustment should not be needed unless you opted for the cheaper electrical circuit.
7. Charge your car quickly at home.

The prices and specific models mentioned in this article are based on what was available at the start of 2017, and that will certainly change over time. The advice about charging station and circuit sizing should be more durable.

## **Giving back**

After you install your charger, I encourage you to let the occasional plug-in driver charge at your home. You can do this with [PlugShare.com](https://www.plugshare.com) and the PlugShare app ([Android](#), [iTunes](#)), which is a great resource for finding both public charging stations and plug-in owners like yourself who want to make electric driving as worry-free as possible by extending the network of public stations.

My own charger is available on PlugShare, and I'm looking forward to meeting the first plug-in driver I can help with a charge.