

HOW TO SELECT AND INSTALL A

Home Electric Vehicle Charger

Useful Information and Tips from Efficiency Maine



This “**how to**” manual provides easy-to-use, practical information about selecting and installing **electric vehicle (EV)** charging equipment for your home, including

- ⚡ **the advantages of home charging;**
- ⚡ **details on the equipment you need;**
- ⚡ **the considerations and implications of each option;**
- ⚡ **where you can buy an EV charger;**
- ⚡ **criteria for choosing an optimum site;**
- ⚡ **safety considerations;**
- ⚡ **what to expect in terms of costs, including potential upgrades to your electrical panel and circuits, and**
- ⚡ **tips on finding equipment vendors and installers.**



To learn more about electric vehicle technology visit the Efficiency Maine website at efficiencymaine.com/ev or call **866-376-2463**.



Types of Electric Vehicles

Electric vehicles can be solely powered by an electric motor with a battery (a Battery Electric Vehicle or **BEV**, also known as an All-Electric Vehicle) or by a combination of both an electric motor and a gasoline engine (a Plug-in Hybrid Electric Vehicle or **PHEV**).

Most BEV models can travel farther on electricity alone than PHEVs because they have larger batteries. However, BEVs do not have a backup gas engine like PHEVs do, so when the battery is exhausted, the only way to continue driving is to recharge the battery.

PHEVs have a longer total driving range because they can be powered by the gasoline engine after their battery is exhausted, but PHEVs have a shorter range on electricity alone.



 Electricity	FUEL TYPE	 Electricity  Gasoline
100 - 380 miles	RANGE	20 - 50 all-electric miles 400 - 600 combined miles
No oil changes and fewer repairs	MAINTENANCE	Similar to internal combustion engine (ICE) cars
Approximately ½ of typical cost of fueling an ICE car	FUEL COSTS*	Between ½ and ⅔ the cost of fueling an ICE car
No tailpipe emissions	EMISSIONS	No tailpipe emissions in all-electric mode

Estimated Charge Times From Empty to Full Battery

Actual charging times vary and depend on specific vehicle battery capacity and charger level.

Why Charge Your EV at Home?

Charging at home is convenient and inexpensive. For those reasons, most EV drivers do more than **80%** of their charging at home using either a Level 1 charger cable or a faster-charging Level 2 charger.* (The levels of chargers are defined in the diagram on page 11.)

If you have an all-electric car, a Level 2 charger allows you to charge five to seven times faster compared to a Level 1 charger. If you have a plug-in hybrid, recharging with a Level 2 charger is about three times faster than it is with a Level 1. A Level 2 charger takes about five hours to fully charge a 30-kWh-battery car, which allows you to get on your way sooner. Some of the newer model BEVs have larger capacity batteries – 62 kWh to 90 kWh – which can typically take 4 – 10 hours to charge.

Home charging is typically done in the evenings and overnight. This avoids straining the grid during periods of “peak” demand. In Maine, the peak demand period ends on weekdays at 7:00 p.m. in the winter and 5:00 p.m. in the summer.** You should check with your electric utility to see if they offer rates that would lower your charging costs if you charge during “off-peak” hours. And you also might want to consider consulting your car’s owner’s manual to set the default charging to off-peak.

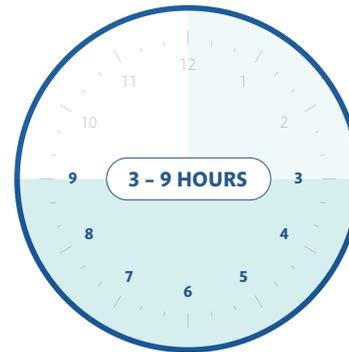
For most households and businesses, an EV’s range is more than enough for their travel needs. For instance, the average round-trip commute to work for Mainers is 24 miles, and **50%** of Mainers commute less than 10 miles a day.*** Since most new EVs have a range of 150 – 300 miles, when you charge up overnight you can go several days before recharging and never need to stop at a public charger.



BEV - LEVEL 1*



BEV - LEVEL 2**



PHEV - LEVEL 1*



PHEV - LEVEL 2**

* According to the US Department of Energy’s Office of Energy Efficiency and Renewable Energy

** Efficiency Maine – Residential TRM v2021.3, efficiencymaine.com/docs/EMT-TRM_Retail_Residential_v2021_3.pdf

*** Source: <https://onthemap.ces.census.gov/>, U.S. Census Bureau

* Source: Clipper Creek clippercreek.com/charging-times-chart

** Range of charging times based on the Efficiency Maine list of eligible BEVs and PHEVs as of April 2021; source: fuel-economy.gov

What kind of charger should I buy?

The Environmental Protection Agency (EPA) awards ENERGY STAR® certification to EV chargers that meet specific efficiency standards. The ENERGY STAR® mark on EV chargers indicates that a charger conserves energy in standby mode (between charges), which can help lower your electric bill.

Before you decide which charger to buy, it might help to outline your present-day needs, as well as think about what your future needs might be. Ideally you should purchase a charging station that fits your budget and lifestyle, today and in the future.

Be sure to choose a reputable manufacturer. Most highly regarded brands offer a three-year warranty, and some offer 24/7 customer support.

Seven key issues you should consider when deciding what kind of charger to buy

- 1 **Charger Level**
- 2 **Electrical Panel**
- 3 **Cost**
- 4 **Charging Speed (Amperage)**
- 5 **Wall Connection Options**
- 6 **Charger Location and Length of Charging Cable**
- 7 **Locking System**

1. Charger Level

There are **two types** of home charging: Level 1 charging and Level 2 charging. See the Table to the right for details.

Level 1 chargers are typically included with the purchase of a new car. One end plugs into any standard 120 volt (V) outlet and the other end plugs directly into the car. Level 1 chargers are the least expensive and also the slowest way to charge your EV. It can take more than 12 hours* to fully charge your car. If you routinely drive long distances, you may want to consider a Level 2 charger, which will charge your car faster.

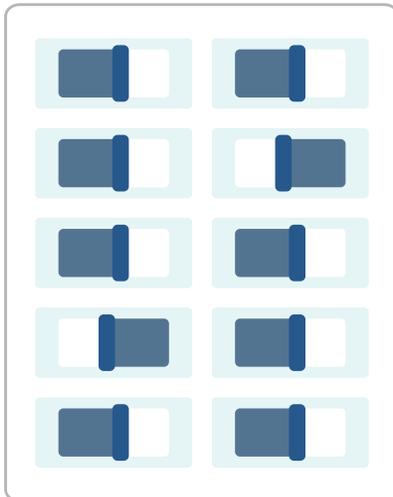
Level 2 chargers typically are sold separately from the car, although they're often purchased at the same time. These chargers plug into a 240V outlet or may be hardwired to a 240V line, and have a universal SAE J1772 connector. This connector is compatible with all BEVs and PHEVs in the North American market. Tesla chargers and cars have a modified version of the SAE J1772 connector. Every Tesla car comes with a SAE J1772-to-Tesla adaptor, enabling the driver to charge at most charging stations.

LEVEL 1		LEVEL 2
Typically the charger included with an EV purchase or lease	DESCRIPTION	Most home and public chargers are Level 2
Residential, workplace	SUITED FOR	Residential, workplace, multifamily dwellings
120V <i>(standard home outlet)</i>	POWER SUPPLY	240V <i>(similar to an electric dryer outlet)</i>
3 - 12+ hours	APPROXIMATE CHARGING TIME*	2 - 10 hours
\$0 - \$200 equipment \$0 installation	TYPICAL COSTS**	\$500 - \$900 equipment \$500 - \$1,500 installation <i>(networking often increases cost)</i>

2. Electrical Panel

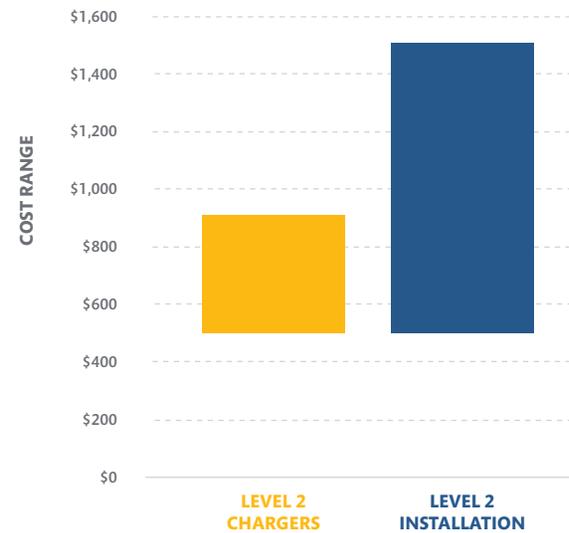
Determine whether your electrical panel can accommodate the electric load of the charger. This will tell you what capacity of charger your existing panel can handle or whether you'll need to upgrade it. An electrical upgrade will increase installation costs, so you may want to consult an electrician to help make this assessment.

For more tips on finding an electrician, see page 26.



3. Cost

A good Level 2 charger will cost between **\$500 to \$900*** depending on the type you buy. Installation costs will add another **\$500 to \$1,500**, depending on the complexity of the installation. A Level 1 charger may not cost anything to install, as these chargers typically come with the vehicle and most houses are already equipped with 120V outlets. Installation costs vary widely based on labor, wiring, and additional features specific to your site.



4. Charging Speed (Amperage)

Level 2 home charging stations operate at a voltage of 220V-240V. The fastest charging you can get out of your equipment depends on two factors:

- The amperage (A or “amps”) of the charger
- The car’s acceptance rate in kilowatts (kW)

You may want to consider buying a charger that can handle **at least 30 amps**. Even if you don’t need it for your first EV, having the additional capacity will avoid the need to upgrade in the future and will not damage the car. Note that a 30-amp charger will need a circuit breaker rated for at least 40 amps.

*Here’s a quick guide to how much amperage you need for different charging speeds.**

CHARGER AMPERAGE	REQUIRED CIRCUIT / BREAKER RATING	ESTIMATED DRIVING RANGE ADDED PER HOUR OF CHARGING
16A	20A	12mi (19km) 
24A	30A	18mi (29km) 
32A	40A	25mi (40km) 
40A	50A	30mi (48km) 
48A	60A	36mi (58km) 
50A	70A/80A	37mi (60km) 

5. Wall Connection Options

There are two ways to connect a Level 2 charging station at your home: permanently installed (hardwired to your electrical panel and not portable) or plugged into an electrical outlet.

Two types of plugs are commonly used with EV chargers: the NEMA 6-50P (welder plug) and the NEMA 14-50P (looks like a stove plug) so if you choose a portable charger, the outlet you install must match these plug types. You may already have an outlet that can accommodate these plugs somewhere close to your garage or parking space, which could reduce the cost of installation.



NEMA 6-50



NEMA 14-50



6. Charger Location and Length of Charging Cable

Before you buy a charger, think about where you'll park your electric vehicle at home. Where would be the most convenient location for a charger? If you have a garage, a great option is to put the charger on the wall inside the garage. Other good options are to place it on an exterior wall of the home or garage, or on a post. Not all chargers can be installed outdoors, but if you need to place it outdoors check to see if it will require a NEMA 4 enclosure, which protects the equipment in rain, sleet and snow, and from splashing or hose-directed water. If you decide to place the charger on an outside wall or post, be sure to choose a location that will not interfere, or be interfered with, when clearing snow in the winter. Just remember that the longer the distance of new wiring that needs to be added, the more the project will cost.

When selecting the length of your charger cable, make sure the cable can easily reach where you'll park your car and think about whether you want to accommodate the potential for a second plug-in car in your driveway or garage. Cables usually run from approximately 12 to 25 feet. Extension cords or adapters should not be used to reach the power supply. Measure the distance between where the charger will hang on your wall and where you are mostly likely to park, and take into account where the charging port is on your car.



7. Locking System

If you live in a densely populated area and you're planning to install your charger outside using a NEMA 6-50P or NEMA 14-50P plug, we recommend you choose a charging station with a locking mechanism to prevent theft. It's a simple step that can save you a lot of inconvenience.



Where can I buy an EV charger?

When you are ready to get your home charger, you have several choices. You can ask a local electrician to purchase a charger for you, or you can purchase one yourself and ask the electrician to install it. Most manufacturers of charging equipment offer their products online and some retailers in Maine also offer the equipment.



Efficiency Maine maintains a list of such vendors at efficiencymaine.com/docs/EV-Charging-Equipment-Suppliers.pdf *



You can find a list of EV charging equipment suppliers on the Efficiency Maine website at efficiencymaine.com/docs/EV-Charger-Installers.pdf *

What should I do to make my charger safe?

First, choose a charger that has been tested and certified for safety and quality by a Nationally Recognized Testing Laboratory (NRTL), such as Electrical Testing Laboratories (ETL) or Underwriters Laboratory (UL).

Other safety considerations:

Ensure your electrical system/panel is ready for the installation by consulting an electrician. Depending on the requirements of the installation, your electrician will contact your utility company, if needed.



Make sure you have a way to safely store the charging cable and connector when not in use. A dangling cable left on the floor or ground is prone to being damaged, risking malfunction, and poses a tripping hazard.

Do I need to hire an electrician to install my EV charger?

While the most common solution is to hire a licensed electrician, if you're handy and feel you can do the job safely, it's possible to install the wiring and the charger yourself.

However, if you're not sure whether you'll need to upgrade the existing electrical panel you should consult an experienced and licensed electrician who will assess the situation and determine if that work should involve your utility company. Your electrician can also help you secure any electrical permit you might need for the project.

Finally, if your charger is not installed by a licensed electrician, check to make sure this will not void the warranty on the device.



Here are **7 tips** on how to pick an experienced, licensed electrician.

1. Find a Qualified Electrician



Search for an electrician licensed by the State of Maine.
www.pfr.maine.gov/almsonline/almquery/SearchIndividual.aspx?board=4220



Licensure means an electrician is required to follow the requirements of the National Electrical Code (NEC), which is the nationally recognized electrical-safety standard. You can also search the Maine Contractor Directory
mainecontractordirectory.com/maine-contractors/electricians-electrical-contractors



Check the Efficiency Maine list of Qualified Partners. (where the form asks "What services do you need?," select "Electric Vehicle Chargers.")
efficiencymaine.com/at-work/qualified-partners

2. Ask About Experience

Ask if the electrician has experience installing EV chargers.

3. Check References

Ask the electrician for references and ask the references about their experience with the electrician.

4. Verify Place of Business

Verify that the electrician has an official place of business. All the estimates and contracts should have a company name, address and phone number.

5. Ask About a Warranty

Ask the electrician if they "warranty" their work, and if so, ask them what the warranty covers and for how long.

6. Request an Estimate

Get the estimate in writing. Most reputable electricians will provide a free price quote on the cost of installing your EV charger. And find out whether the electrician is offering to complete the project for a fixed price or will charge you on an hourly basis. Ideally, an electrician should come to your home to personally review the electrical panel and the planned EV charger location before providing a quote.

7. Make a Final Decision

Get quotes from several electricians before making a final decision.

What laws or regulations apply to my home EV charger?

If you use an electrician for your EV charger installation, they should check with your town to determine if a permit is needed before your project's electrical alterations are performed. A permit is usually required, and will likely cost less than \$50 and can typically be applied for and submitted online, sent by postal mail or email, or hand-delivered to the town offices.

Your electrician can find the proper standards for installing EV chargers in the National Electrical Code (NEC) in Article 625. The provisions of the NEC are published by the National Fire Protection Association.

What are the costs of installation?

As noted in the graph on page 13, the total capital cost of installing a home charger varies depending on the type of charger (Level 1 or Level 2), quality of the hardware, housing type, and the complexity of the electrical work needed to service your charger. Equipment and installation costs will continue to decrease over time as EV charging equipment becomes more prevalent.

Installation costs are composed of labor, materials, taxes, utility upgrades, and permitting (where applicable). Most homes are equipped to accommodate a Level 1 charger, so it may not cost anything to install if there is already a 120V outlet conveniently located to suit your EV. In most situations, home Level 2 chargers require some degree of an electrical upgrade. Higher costs for home charging installations generally correspond to the number of wall and floor penetrations, total circuit distance, or service upgrades.



About This How-To Guide

Maine has established aggressive requirements to reduce carbon emissions. It also is a Zero Emission Vehicle (ZEV)* state, creating an expectation that in the next several years Maine consumers will be purchasing and driving tens of thousands of battery electric vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs), collectively known as “EVs.”

At Efficiency Maine, we are committed to helping the state reach its long-range targets to reduce greenhouse gases while lowering energy costs for Maine drivers and helping transform the marketplace toward lower-cost, lower-carbon vehicles.

To that end, Efficiency Maine administers programs to expand availability of EV charging infrastructure and the adoption of electric vehicles in Maine. Its programs provide instant rebates for eligible vehicles (BEVs and PHEVs) at participating car dealers in Maine and grants to fund the installation of EV charging infrastructure in public areas, workplaces, and multi-unit dwellings in Maine.

Efficiency Maine received funding for this “how to” manual through a grant from the Maine Public Utilities Commission pursuant to An Act to Support Electrification of Certain Technologies for the Benefit of Maine Consumers and Utility Systems and the Environment. This manual is part of Efficiency Maine’s initiative to develop and distribute a comprehensive suite of educational materials about EVs, including “how to” manuals and videos, as well as a list of eligible vehicles, available rebates, charging station locator and vehicle cost calculator that can be found at efficiencymaine.com/ev.

For an online version of this “how to” manual, visit the Efficiency Maine website at efficiencymaine.com/docs/Home-EV-Charger-Guide.pdf or call 866-376-2463.**

* The aim of the Zero Emission Vehicle (ZEV) program is to help states achieve their emissions goals by requiring that a certain percentage of vehicles use the cleanest available technologies, including battery electric and plug-in hybrid electric vehicles. ZEV has been a major contributor to the successful commercialization of hybrid-electric vehicles and ultra-low-emission technologies. To date, 12 states have adopted the ZEV Program (California, Colorado, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, Vermont and Washington).

** Public Law, Chapter 365, LD 1464, 129th Maine State Legislature

Glossary of Terms

EV (Electric Vehicle): A broad category that includes all vehicles that are fully powered by electricity or an electric motor.

BEV (Battery Electric vehicle): Also known as an “All-electric” vehicle, BEVs utilize energy that is stored in rechargeable battery packs. BEVs sustain their power through the batteries and therefore must be plugged into an external electricity source in order to recharge.

PHEV (Plug-in Hybrid Electric Vehicles): PHEVs contain a battery that can be charged with an external electric power source. PHEV’s are a combination of all electric vehicles and ICE’s.

ICE (Internal Combustion Engine): An ICE is powered by combustible fuels, such as gasoline or diesel fuel, liquids derived from fossil fuels.

Level 1 Charger: Charges your EV using a common household outlet up to 120v. Level 1 is the slowest method of charging and can take up to 24 hours or more to fully charge your EV. A Level 1 charging cord typically comes with the purchase of a new EV.

Level 2 Charger: Charges your EV at 240v using an installed outlet or hardwired to a 240v power supply. Level 2 chargers are the most commonly recommended chargers for EV owners. Depending on your EV model and charger, a Level 2 plug can charge a vehicle five times more quickly than a Level 1 plug.

Level 3 Charger: Also known as a DC Fast charger, a Level 3 plug is the fastest method of charging for compatible EVs. It can charge a BEV battery to 80% in about half an hour. Most PHEVs are not equipped for DC Fast charging.

AC (Alternating Current): A charge of electricity that regularly changes direction, which is the kind of power that comes from a power plant to homes and businesses.

DC (Direct Current): A charge of electricity that flows in one direction and is the type of power that comes from a battery.



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