

# ELECTRIC VEHICLES

TAKING CHARGE OF THE ROAD





## THE ELECTRIC OPTION

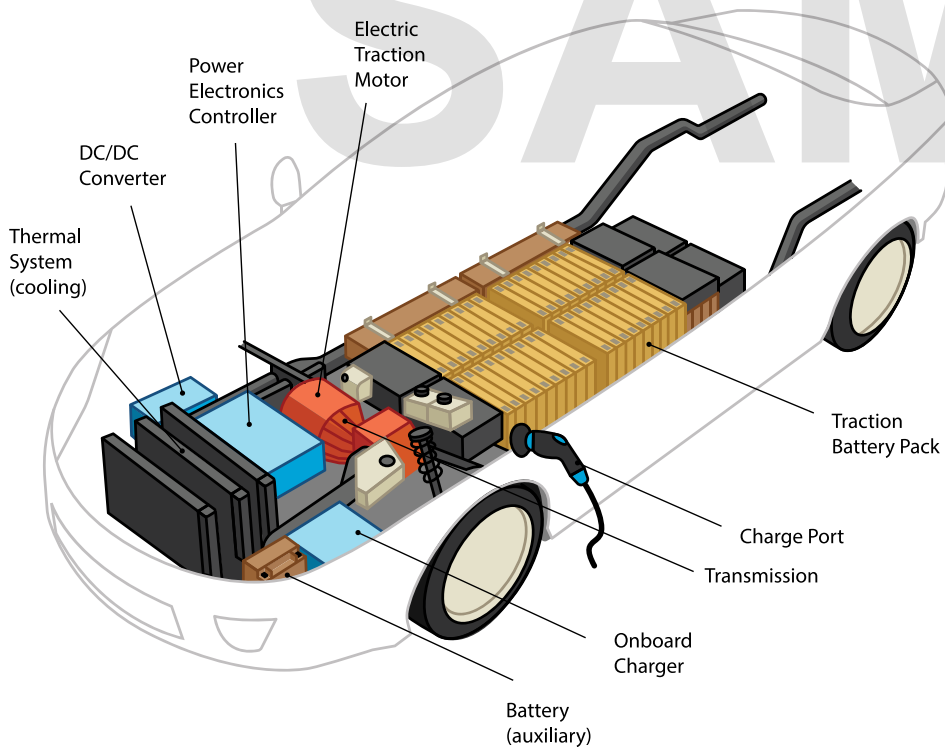
Evaluating what type of vehicle is right for you, based on your needs, should be the first step in deciding on a new car, whether gasoline powered, electric, or hybrid. The latest electric vehicles (EVs) offer many advantages for drivers compared to gasoline cars. EVs can be charged at home rather than taken to the gas station. EVs require less maintenance because they have fewer mechanical parts, and EVs reduce harmful emissions compared to a traditional vehicle. They can also be a lot of fun to drive, offering a driving experience that many prefer to that of gasoline-powered cars.

As with any vehicle—gas, hybrid or electric—to get the most out of an EV, you need to plan how to properly maintain and protect it. EVs require installation of a good charging system and awareness of charging habits to get the longest life possible out of your car's battery. This tip book goes over some of the basic considerations, but it's important that you research prospective vehicles and how to get the most out of your vehicle. And as with anything involving high-voltage electricity, ensure that your new charging station meets local ordinances and is safely installed by a licensed electrician.

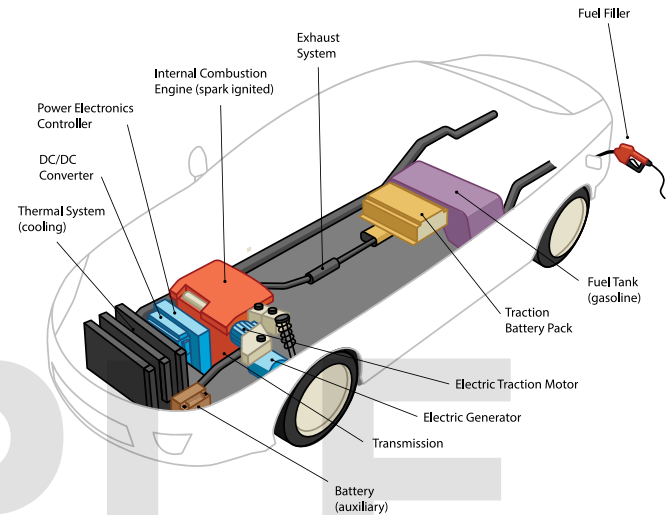
# HOW DO THEY WORK?

Electric vehicles replace the core components of a gasoline-powered car with batteries and a motor. While this book mostly covers battery EVs with no gasoline-powered components, it's worth evaluating all types of electricity-based vehicles on the market. There are three main types of EVs: fully electric vehicles that don't use gasoline at all, hybrid electric-gas vehicles, and plug-in hybrids that combine the benefits of both. Each works differently.

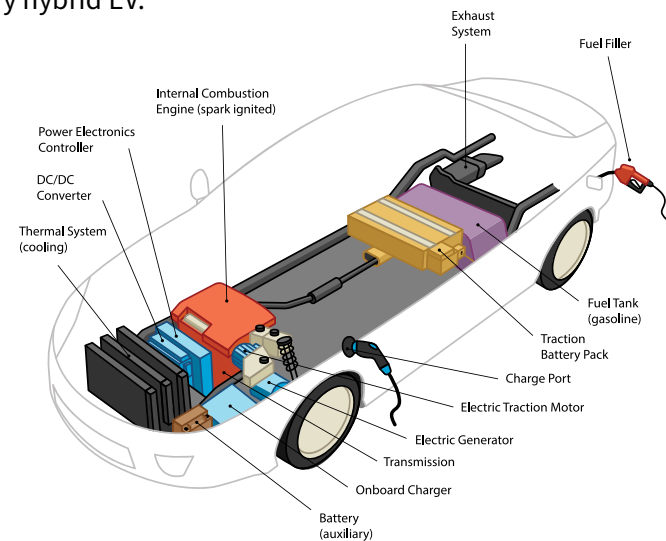
**Battery electric vehicles (BEVs):** Totally electric vehicles run on a bank of efficient batteries that are recharged with electricity. You can charge them with electric vehicle supply equipment (EVSE), commonly referred to as a charging station or dock. BEVs run on an electric motor that powers the wheels. Because it doesn't use fuel the way a gas or hybrid electric car does, there are no emissions from a tailpipe and no fuel line or tank is required.



**Hybrid EVs:** Hybrid vehicles have small gasoline engines that power the car and charge battery packs. They don't plug in the way a BEV does. These smart cars, SUVs, and trucks will go from electric power to engine power depending on what's most efficient. You can get more than 60 miles per gallon and spend less over a car's lifetime to maintain a hybrid vehicle as compared to a traditional gasoline-powered one.



**Plug-in hybrids** allow you to charge a battery at home and drive short distances—from 25 to 50 miles depending on the vehicle—solely on battery power. Then the engine kicks in, and the car works like an ordinary hybrid EV.



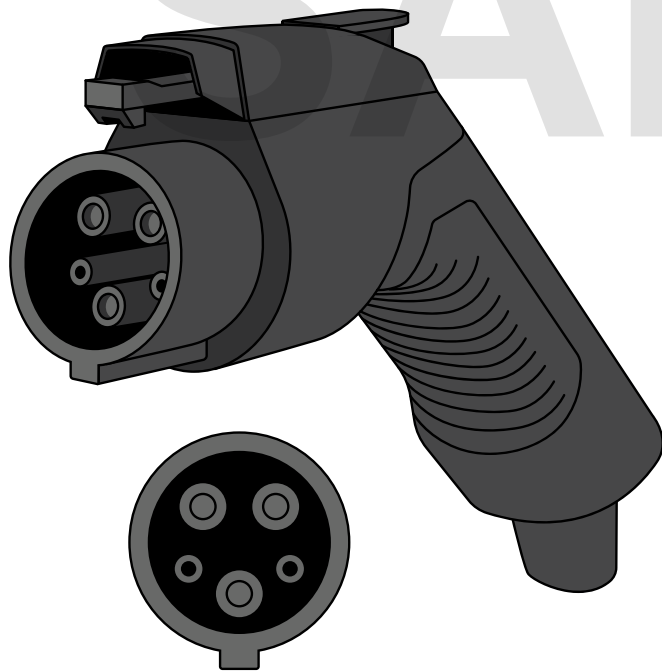


# CHARGING OPTIONS

The time it takes to charge your EV depends on the charging equipment, the size of the batteries, and the battery-charging capacity. Charging equipment is categorized as level 1, level 2, or level 3 direct current (DC) fast charging.

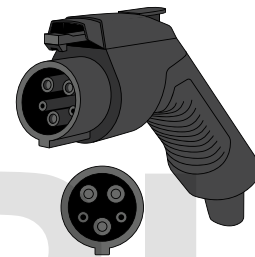
While it's commonly referred to as a charger, charging port, or charging station, the technical term for equipment that provides electricity to your EV is electric vehicle supply equipment (EVSE). That's because when you're using an alternating current (AC) charger, you're supplying an onboard system that converts the power and charges your battery.

**Level 1 chargers** are often included in a new car package. You can plug them in to a regular household 120V outlet, just like your toaster or desk lamp. Level 1 chargers will add 1–10 miles of range for every hour of charging. For plug-in hybrid vehicles with smaller batteries, level 1 might be sufficient. But for 15+ miles of daily driving and maintaining a healthy battery, a level 2 charger is recommended.

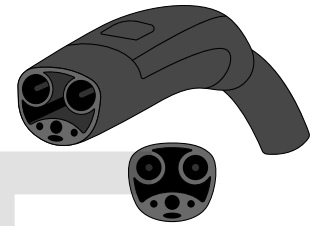


J1772 connector

**Level 2 chargers** will add 14–35 miles per hour of charging. They require the installation of a EVSE, which requires a 240V electrical connection, like those found on electric clothes dryers. This may require an electric panel upgrade. Consult a licensed electrician to evaluate what is needed for your home. The charger's control unit communicates with the EV through a charging port. This communication helps ensure that the EV and the charger are compatible and that the charging process is safe and efficient. Because EVs run on DC and your home runs on AC, the charging unit converts the electricity before delivering power to your car. Because of the higher levels of voltage and energy, you should always have a licensed electrician install this equipment.

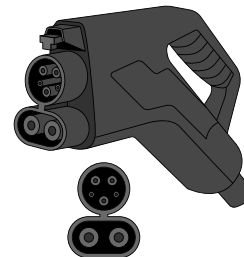


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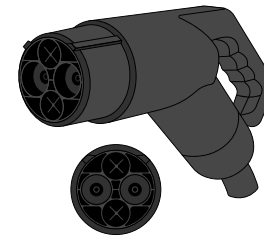


NACS connector

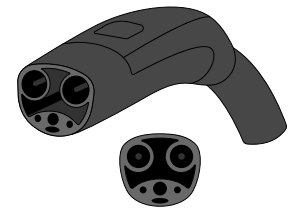
**Level 3 direct current chargers** require 480V connections, which are rarely found in homes. You'll find DC charging stations only in public spaces, such as parking lots in shopping centers. Unlike with level 2 chargers, no conversion of electricity from AC to DC is needed. They're called fast chargers for a reason: they add to your electric car's range by hundreds of miles per hour and can fully charge your vehicle in about 30 minutes. However, that rapid charge stresses the battery. Occasional use won't significantly affect battery health, but frequent use could reduce driving range.



CCS connector



CHAdeMO connector



NACS connector



## TAKING CARE OF YOUR BATTERY

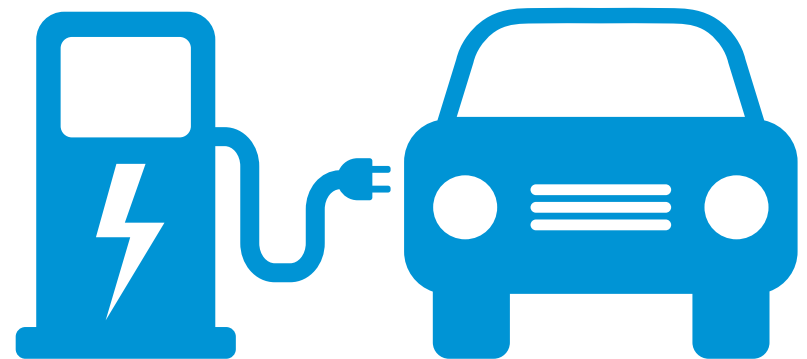
Just as properly maintaining an engine in a gasoline-powered car is critical to its longevity, caring for the battery in your EV is key to maintaining its lifetime and range. EVs and battery technology are rapidly advancing, and it's essential to follow manufacturers' guidelines to get the most out of your battery. Here are a few important things to consider:

**Don't overcharge or deplete your battery:** Being at either 100% or below 10% puts your battery under stress, reducing its longevity. Strive to keep your battery between 20% and 80% or within your manufacturer's recommended range. Luckily, many EVs have battery management systems to keep energy levels in this range.

**Avoid extreme temperatures:** EV batteries need to maintain moderate temperatures to hold or dispense a charge. Parked in extreme heat or cold, your EV will use its charge to cool or heat the battery, reducing your driving range. When possible, park in a garage or in shade.

**Keep track of battery health:** If your EV is showing a warning related to battery health, take it in for repair or maintenance. EV manufacturers design their systems to monitor battery health, so don't delay when the warning appears.

**Use DC fast chargers sparingly:** The occasional use of fast chargers won't significantly affect your battery's performance, but frequent use could reduce your battery's range over the lifetime of your car.



## CHARGING SAFETY

When you buy an EV or plug-in hybrid, your home becomes the nearest charging station and the one you'll probably use most. Charging an EV at home is generally safe, but it's important to take some precautions to ensure that charging is done correctly and safely. Here are a few safety measures you can take when charging your EV at home:

**Use dedicated electric vehicle supply equipment (EVSE):** It's recommended to use dedicated EVSE designed for home use to charge your EV. These stations are specifically designed to handle the high current and voltage required to charge an EV. Ensure that your EVSE is installed by a licensed electrician and on a circuit rated for the power requirements of the EVSE. Don't use an extension cord.

**Check the charging cable:** Inspect the charging cable for any signs of damage or wear before plugging it in. If you notice any damage, don't use the cable. Replace it as soon as possible.

**Don't overcharge:** Follow the manufacturer's recommendations for charging your EV and don't leave it on the charger longer than necessary.

**Keep the charging station clean:** Keep the charging station clean and free of debris, and don't allow water or other liquids to come into contact with the charging station or the charging cable.

**Turn off the power:** Always turn off the power to the charging station or stop the charging session before unplugging the charging cable from the vehicle.



## BATTERY SAFETY

Electric vehicles use efficient lithium-ion batteries that store chemical energy using lithium materials and release the energy in a controlled manner via electricity. The batteries operate with a much higher energy density compared to the traditional lead-acid batteries in gasoline vehicles. With proper care, these batteries are safe. But they may catch fire if improperly installed, physically damaged, or exposed to extreme temperatures. If you see any damage to the batteries, have a certified electric vehicle repair professional check it out immediately and replace the batteries if necessary.

**Proper maintenance:** Regularly maintain your EV's battery system as specified by the manufacturer. This includes checking for any leaks, corrosion, or damage to the battery, wiring, and connections.

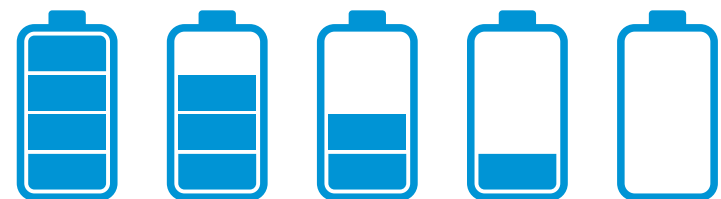
**Charge correctly:** Use only manufacturer-recommended charging equipment—avoid using aftermarket or unapproved charging equipment.

**Temperature control:** Avoid exposing the battery to extreme hot and cold temperatures. High temperatures can damage the battery, while extremely low temperatures can reduce its efficiency.

**Avoid water exposure:** Avoid getting the battery wet or exposing it to water or other liquids, as this can lead to a short circuit or other damage.

**Avoid physical damage:** Avoid dropping or hitting the battery, which can cause internal damage or a rupture.

**Fire safety:** If you notice any smoke, fumes, or burning smell while charging your EV, stop charging immediately and evacuate the area. Contact emergency services if necessary.





## DRIVE SAFELY

Just as it takes time to get used to driving gasoline-powered cars, EVs have a learning curve. There are a few differences that new EV drivers should familiarize themselves with:

Electric cars are silent! You need to exhibit the same caution and safe-driving skills as when operating any vehicle, but you also need to be extra cautious because people won't hear your car. Make sure you can see all around the car when accelerating from a stop sign. Some manufacturers are finding ways to make electric cars a little noisier with artificial sound-making devices.

Electric cars are much more responsive than gasoline cars. When a gasoline car accelerates, you step on a gas pedal that delivers fuel to an engine, setting off a complex process in your engine that sends power to the transmission, which in turn rotates the wheels. The farther you press on the gas pedal, the more fuel and air go into the engine and the faster you go. The multiple gears in the transmission help propel the car from a complete stop to higher speeds. By contrast, when you step on the pedal of an electric vehicle, you're sending a signal to an electric motor with one gear capable of all speeds. An EV doesn't require a transmission or many of the other mechanical components in gas-powered cars. Therefore, EVs can accelerate much more quickly than you might be used to, and drivers should be cautious while they're getting used to an EV.

Towing an EV is different than towing a gasoline-powered car. Because the spinning of an EV's wheels cause the electric motor to generate power, EV manufacturers recommend using a flatbed truck to transport an EV. Consult your EV's manual for specific instructions about how to safely tow your EV. If a tow truck driver insists on a method other than the one the manual suggests, tell them to stop and call a different tow truck company.

## BRAKING

Braking in an EV is different from doing so in a gasoline-powered car in several ways:

**Regenerative braking:** EVs use regenerative braking, which recovers energy lost during braking. This is done by using the electric motor as a generator to convert kinetic energy produced by the car's motion into electrical energy, which is stored in the battery. This process slows down the vehicle while simultaneously charging the battery.

**Single-pedal driving:** In many EVs, the accelerator pedal can also be used to control the amount of regenerative braking. Lifting your foot off the accelerator pedal activates regenerative braking, causing the vehicle to slow down more quickly than if it were coasting in neutral. This allows for a smoother and more efficient driving experience often referred to as "single-pedal driving" or "one-pedal driving."

**Less wear on brakes:** Since regenerative braking reduces the amount of mechanical braking needed, the brake pads and rotors experience less wear and tear than in a traditional gasoline-powered car. This can lead to longer-lasting brakes and reduced maintenance costs.

**Regenerative braking limits:** In some situations, such as emergency stops or when driving downhill, mechanical brakes may be needed to bring the vehicle to a complete stop.

Overall, regenerative braking in EVs offers a more efficient and smoother braking experience, while reducing wear and tear on the braking system.



118 mi  
RANGE

## WHAT OPTION IS BEST FOR YOU?

### Range

To choose the EV that's best for you, determine your average driving range: how far do you drive between opportunities to charge your vehicle? The ranges of electric cars vary. Choose the one that suits the way you drive. Battery range varies from 40–50 miles between charges on the low end to over 300 miles on the high end.

### Size

Picking a vehicle that's the right size for you and your family is essential for daily driving. A larger vehicle may take longer to charge, and it's important to factor that into your planning.

### Charging Needs

Can you charge at home or at work? Are you able to park near a spot where an electrician can install a level 2 charger? Ensure that you've planned for your charging needs while picking the right EV.

### Cost

You pay three prices when you purchase a vehicle: the upfront purchase price, the cost of fuel, and the cost of maintenance. A car that costs more upfront might be less expensive in the long run. Electric cars typically cost less to operate—both to fuel and to maintain. Electric cars have fewer parts that can break down and fewer fluids to change.



## PLANNING A TRIP IN AN EV

Planning a road trip with an EV is similar to a trip with a gasoline car but requires some additional preparation. Here are some tips to help you plan a successful EV road trip:

**Research your route:** Before you hit the road, research your route and identify EV charging stations along the way. Use an online tool or an app to help with this. Make sure you know how long it takes to charge it at each charging station, and factor in additional time to account for any delays or unexpected circumstances. Make the most of charging time by picking locations near restaurants for meal breaks or playgrounds when traveling with children.

**Check your EV's range:** Your EV's range is how far it can go on a single charge. Knowing your range will help you plan your trip and avoid running out of battery power.

**Drive efficiently:** Drive efficiently to conserve battery power. Avoid rapid acceleration and hard braking, and try to maintain a steady cruising speed. Use your EV's regenerative braking feature to recapture energy while driving.

**Be flexible:** Be flexible and prepared to adjust your plans if necessary. Unexpected delays or changes in your itinerary might require you to make adjustments in your charging stops or route.

**Understand your car's charging curve:** EV batteries pull power at different rates depending on how full they are. Typically EVs pull power more slowly when they are at low power (under 20%) and start to slow again as they pass an 80% charge. Each EV model is different, and knowing your EV's charging curve will optimize your charging time.

By following these tips, you can plan a successful road trip with your EV and enjoy the journey without worrying about running out of battery power.



# RESOURCES

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Visit these sites for additional information:

## U.S. DEPARTMENT OF ENERGY

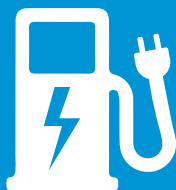
[www.energy.gov/vehicles](http://www.energy.gov/vehicles)

## JOINT OFFICE OF ENERGY AND TRANSPORTATION

[driveelectric.gov](http://driveelectric.gov)

## U.S. ENVIRONMENTAL PROTECTION AGENCY

[www.epa.gov/greenvehicles](http://www.epa.gov/greenvehicles)



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