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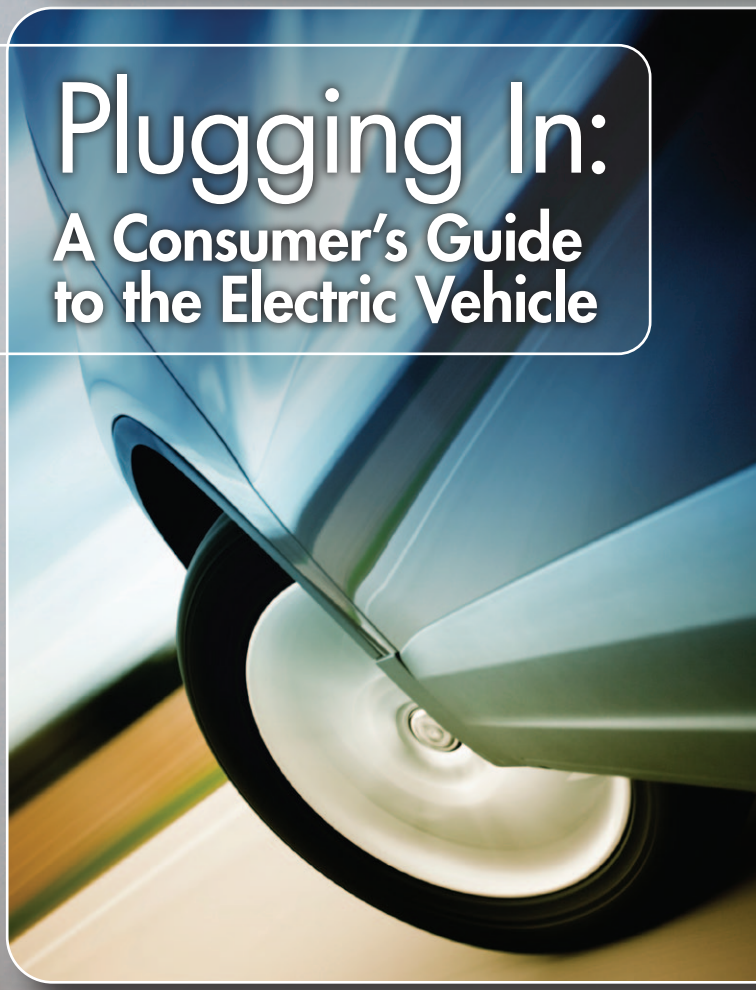
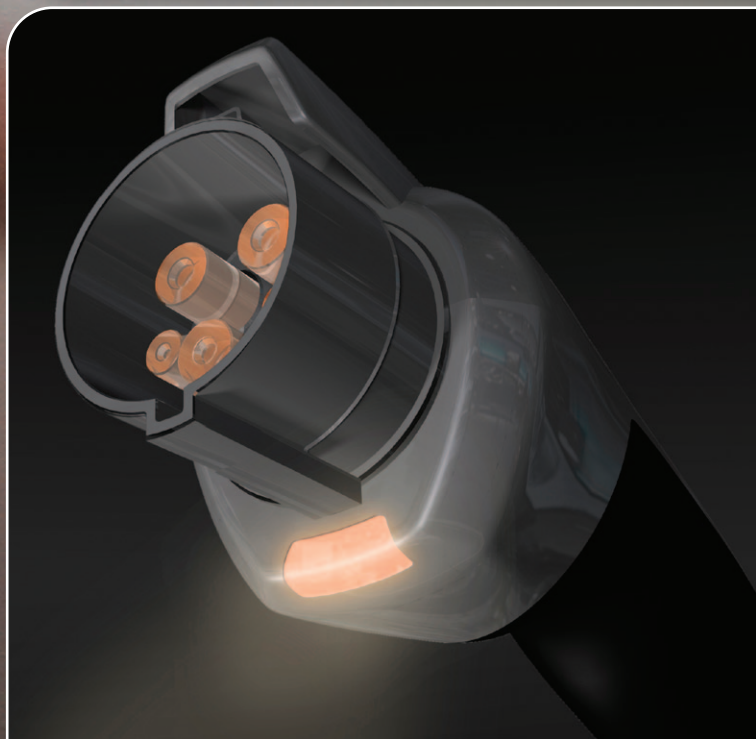
Plugging In:
A Consumer's Guide to the Electric Vehicle





Today's Choices in Cars

Late in 2010 the first mass-produced electric vehicles hit dealer showrooms, bringing car buyers a new, electric option. Electric cars offer performance, safety and versatility and can be charged from the electric grid, providing convenient, low- cost, at-home charging. At the U.S. national average price of 11.5 cents per kilowatt-hour, buying electricity is approximately equivalent to buying gasoline at $1 per gallon. Displacing gasoline with electricity also lowers emissions and decreases petroleum use. On a typical day half of all drivers log 25 miles or less, so electric vehicles – if widely adopted – could reduce petroleum fuel consumption by 70 to 90%.

One challenge for consumers is to understand their driving needs and how each vehicle option can meet their specific requirements.

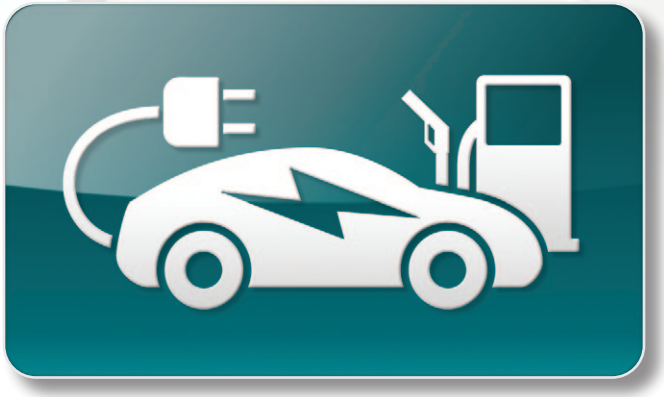
Here are the three options and some essential points for buyers to know about each:

Hybrid vehicles

Hybrid vehicles are powered by a gasoline engine and one or more electric motors.

The battery is charged as the vehicle drives, so the vehicle is powered ultimately by gasoline. Examples are the Toyota Prius and Ford Fusion Hybrid. Hybrid vehicles cannot be recharged from the grid. Hybrids operate like conventional vehicles and are fueled with gasoline. Generally they are more efficient than conventional vehicles since they use technologies that turn off the gasoline engine at a stop and capture braking energy for battery power instead of turning it into heat.

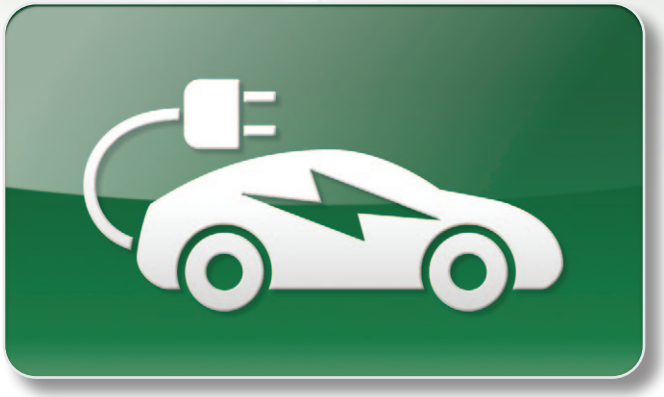
Plug-in hybrid electric vehicles



Plug-in hybrid electric vehicles are powered by a gasoline engine and electric motor, but they have a larger battery pack than a hybrid vehicle which can be recharged from the grid.

This combination allows the vehicle to use electricity, and enables the vehicle to continue driving indefinitely after the battery is discharged. The Chevrolet Volt is an example of a plug-in hybrid electric vehicle. Plug-in hybrids operate like hybrid vehicles but can be charged from the grid. Grid energy is used first, so a vehicle with a 40-mile range such as the Volt operates on electricity for most daily driving, using up to 70% less gasoline than a hybrid vehicle if it is plugged in each night. Plug-in hybrid electric vehicles do not have to be plugged in, but if they are not they will not save additional gasoline compared to a hybrid vehicle. Typical charge time for 40 miles of range is 8-10 hours with a conventional wall outlet.

Electric vehicles



Electric vehicles are powered by an electric motor and battery alone. Electric vehicles can travel farther on electricity than plug-in hybrids, but their range is more limited.

Electric vehicles never use gasoline and most models are designed to travel up to 100 miles between charges. This is greater than the distance driven by average Americans on over 90% of driving days, but it could be a limitation for some drivers who frequently drive long distances. The Nissan LEAF is an example of an electric vehicle. While the availability of public and workplace charging infrastructure is currently limited, many cities, states, and companies are working to provide locations for all plug-in vehicles to charge when they need it. In addition, manufacturers are developing "fast" charging technologies that can recharge properly equipped electric vehicles in 30 minutes or less.

Available Now

Photo courtesy Chevrolet

2011 Chevrolet Volt

The Volt is a type of plug-in hybrid that GM refers to as an "Extended Range Electric Vehicle". While it has an unlimited driving range with its gasoline engine, the Volt drives only on electricity as long as the battery is charged. With an EPA tested range of 35 miles on its battery. The Volt will recharge from "empty" in about 8-10 hours using a 120-volt portable charger or in 3 to 4 hours from a dedicated 240-volt charger.

Photo courtesy Nissan

2011 Nissan Leaf

The Leaf is a 100% battery electric vehicle with a EPA-rated range of 73 miles. While the Leaf can also use a portable 120-volt charger, most drivers will likely opt for a dedicated wall-mounted 240-volt charger that can completely recharge the battery from "empty" in less than 8 hours. The Leaf also has a navigational system that helps drivers locate the nearest public charging location.

Available Soon

Ford Focus Electric

Ford plans to release the battery electric version of the Ford Focus in late 2011. The Focus Electric is powered by a lithium ion battery that can recharge from either 120 or 240 volts. Using the wall-mounted 240-volt charger can completely recharge the battery in as little as 3 to 4 hours.

Toyota Prius Plug-In Hybrid

The plug-in hybrid version of the Toyota Prius, the top selling hybrid in the U.S., is due to be released in 2012. The Prius Plug-In Hybrid will use primarily battery power at low speeds and rely on its hybrid system and efficient gasoline engine at higher speeds. The Prius Plug-In Hybrid should recharge from a 120-volt outlet in 3 hours.

Ford C-Max Energi

The C-Max Energi is a plug-in hybrid electric vehicle that will be available in 2012. The C-Max Energi relies on its battery at lower speeds and stop-and-go driving. At higher speeds, the battery and gasoline engine work together to power the vehicle.

Mitsubishi "i"

The Mitsubishi "i" is a battery electric vehicle already commercially available in Japan. Mitsubishi plans to begin selling the "i" in North America in late 2011.

Answers to important ques

How far will these vehicles go on a charge?

Studies of electric vehicle drivers have shown that the limited range of the battery was less of a problem than they initially expected. Most days' drives were well within the vehicle's range, and days with more driving could be met by charging during the day or swapping cars between members of a household. Many drivers became comfortable enough with the vehicle's range to drive for a couple of days between charges.

For electric vehicles, the advertised range varies by model from about 100 miles (Nissan Leaf) to up to 245 miles (Tesla Roadster). Each driver's experience will be different, but should expect a range that is about 80% of advertised as a starting point. Actual range depends heavily on driving habits and environmental conditions.

For plug-in hybrid electric vehicles, the advertised range for different models is anywhere from 13-60 miles between charges, depending on battery size. If the vehicle is not plugged in, the expected driving range is about 300-400 miles. If the vehicle is plugged in every day, as recommended, it may be possible to drive 1000-2000 miles or more between fill-ups.

What environmental factors could affect the vehicle performance?

For driver and passengers, temperature influences heating and cooling needs, using energy otherwise available to power the vehicle. In cold weather, electricity is needed to heat the passenger cabin and defrost or defog the windows, plus the vehicle's battery is a little less efficient at low temperatures. In hot weather, significant electricity is needed for the air-conditioning system but still less than the power required to accelerate the vehicle and maintain highway speeds. These impacts are most significant during very hot or very cold weather and at longer driving times (for example, stuck in traffic).

Windshield wipers, headlights, and similar accessories do not have a significant impact on range and should always be used to ensure safe, alert driving.

What types of vehicles will be available?

Near-term, most electric vehicles and plug-in hybrid electric vehicles will be compact cars, but manufacturers plan to introduce mid-size models, including vans and SUVs. Today, hybrid vehicles are available in almost all classes. For example, Toyota sells hybrid vehicles in all classes except minivans, and Chevrolet's hybrid Tahoe SUV and hybrid Silverado pickup boast the most towing capacity for a hybrid.

What manufacturers are bringing electric and hybrid vehicles to market?

General Motors, Nissan, Ford, and Tesla are selling vehicles now. Most major manufacturers are introducing vehicles or have announced plans to bring various models to market by 2012.

Will all vehicles be available for purchase throughout the United States?

It is common for manufacturers to introduce new vehicle technology slowly and methodically. Given early production limitations and the need to train and equip dealers and service technicians, manufacturers will often roll out electric vehicles and plug-in hybrid electric vehicles in select markets. It is anticipated that by the end of 2011, electric vehicles will be sold in all 50 states. Limited numbers of electric vehicles in 2011 will make them hard to find in many markets but will be more widely available starting in 2012.

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How, when and where will I charge my vehicle?

Both electric vehicles and plug-in hybrid electric vehicles can be charged from a standard 120V outlet. Many owners will choose to install a dedicated 240V charger for faster charging. Drivers can charge the battery at any time they have access to a charger, and all vehicles will be equipped with standard plugs.

Electric vehicle drivers who experience a detour or other unexpected event may have to recharge to reach a destination. Initially, public charging stations will not be common, and drivers will need to consider this limitation if choosing vehicles that rely solely on electricity. It is expected that charging infrastructure will be built in pace with vehicle sales so this limitation will decrease over time, but the construction of infrastructure will be uneven so it may not meet a particular driver's needs. Many cities and regions have taken very active approaches to developing public infrastructure to support electric vehicles.

Dedicated, pole- or wall-mount 240V chargers produce a minimum of 3000 watts—about the same power draw as a clothes dryer or an air conditioning system—and can fully charge most vehicles in 3 to 8 hours, or about 8 to 12 miles per hour of charging.

Plug-in vehicles come equipped with a portable cordset that can be plugged into any standard 120-volt outlet to enable the vehicle to recharge in a variety of locations.

The SMART charging station at EPRI's research laboratory at Knoxville, Tenn. features a solar-voltaic charging array and a battery storage system.

What should I consider in making a purchase?

Consider driving needs and lifestyle. Plug-in hybrids and extended range vehicles, for example, provide a worry-free transition to electrically powered vehicles thanks to the "back-up" internal combustion engine. This eliminates concerns about running out of battery power. If you have a second place to charge during the day, typically at work, you can effectively double the electric range of your plug-in hybrid. If you have only one car, or often drive long distances, a plug-in hybrid would be a good choice.

Pure electric vehicles have much larger batteries than plug-in hybrids and can usually drive more "electric" miles per day. The limited range of the battery, on the other hand, requires EV drivers to carefully consider their driving habits. As the public charging infrastructure develops over the next few years, many areas will have sufficient locations for electric vehicles to charge when necessary, alleviating concerns about range. If you have a predictable commute, access to a second car for long trips, or if the idea of a completely gasoline-free driving experience appeals to you, 100% electric vehicles will be a good choice.

Consider environmental benefits. Grid-powered vehicles have lower emissions than gas-powered vehicles, even in areas where many of the power is generated by fossil-fueled plants, such as coal or natural gas. For more information, read EPRI publication "*Environmental Assessment of Plug-In Hybrid Electric Vehicles.*" (Product ID 1015325)

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