



Fact Sheet

Plug-in Electric Vehicles

June 2014

Plug-in electric vehicles (PEVs) use electricity from the energy grid to charge large battery packs, then use the batteries to power an electric motor. Because they are primarily powered by electricity instead of liquid fuels, these vehicles produce no tailpipe emissions. Plug-in vehicles can also generate power from a regenerative braking system, which converts kinetic energy from the vehicle’s brakes into electricity and stores it in the battery pack. Because plug-in vehicles rely on rechargeable batteries for power, each vehicle has an **electric range** – the maximum number of miles it can travel on battery power before it needs to recharge. Applications for these vehicles go beyond just passenger cars (though U.S. consumer passenger PEVs are the focus of this fact sheet), as there are currently plug-in electric commuter buses, utility trucks, high-performance vehicles, and motorcycles.

There are two main types of plug-in electric vehicles:

- **All-electric vehicles (EVs)** only use electric power from the grid; they do not have an internal combustion engine and do not use any type of liquid fuel. Because they have an electric motor instead of a combustion engine, they require less maintenance than most conventional cars. They do not need radiator fluid, timing belts, fuel filters, oil or oil changes. EVs use large battery packs to give the vehicle a long electric range – a typical EV will have a range of 70 to 100 miles, though some can travel up to 265 miles on a single charge.
- **Plug-in hybrid electric vehicles (PHEVs)** are powered by a combination of grid electricity and liquid fuel. A PHEV runs on battery power until the battery charge is exhausted, and then it switches over to its internal combustion engine. If a trip is within the vehicle’s electric range, a PHEV will run entirely on its battery pack.

Because plug-in vehicles consume electricity instead of liquid fuel, the U.S. Environmental Protection Agency (EPA) rates them on their **miles per gallon equivalent (MPGe)**, or how efficient the vehicle is with the electricity it consumes. The EPA’s MPGe equates 33.7 kilowatt hours (kWh) of electricity to one gallon of gasoline.² The EPA’s MPGe methodology has come under criticism, because it assumes that power plants producing the electricity are 100 percent efficient. When accounting for the real-world efficiencies of electricity production, plug-in vehicles’ MPGe may be lower than the EPA-rated MPGe. A PHEV receives an MPGe rating for the battery-electric motor and a separate MPG rating for the combustion engine. It is important to note that while plug-in vehicles produce no tailpipe emissions, generating the electricity a plug-in uses may produce pollution (depending on the energy source). Nevertheless, a 2012 study found that

Make/Model	Type	Pre-2012	2012	2013	2014 Jan-May	Total
Nissan LEAF	EV	9,674	9,819	22,610	10,389	52,492
Toyota Prius Plug-in	PHEV	--	12,750	12,088	7,729	32,567
Chevrolet Volt	PHEV	7,671	23,461	23,094	6,838	61,064
Tesla Model S (est.)	EV	--	2,650	17,650	5,600	25,900
Ford Fusion Energi	PHEV	--	--	6,089	4,296	10,385
Ford C-MAX Energi	PHEV	--	2,374	7,154	2,940	12,468
Fiat 500e (est.)	EV	--	--	2,310	850	3,160
smart electric drive	EV	--	--	923	814	1,737
Ford Focus Electric	EV	--	685	1,738	699	3,122
Chevrolet Spark	EV	--	--	539	551	1,090
Toyota RAV4	EV	--	192	1,096	455	1,743
Porsche Panamera S-E	PHEV	--	--	86	370	456
BMW i3	EV	--	--	--	336	336
Cadillac ELR	PHEV	--	--	6	293	299
Honda Fit EV	EV	--	93	569	183	845
Honda Accord PHV	PHEV	--	--	526	152	678
Mitsubishi i-MiEV	EV	80	588	1,029	75	1,772
Total		17,425	52,612	97,507	42,570	210,114

even plug-in vehicles running on electricity from the ‘dirtiest’ coal-powered electric grids in the United States produce less greenhouse gas emissions than the average gasoline powered vehicle.³

The U.S. market for plug-in vehicles is currently dominated by four models that have accounted for 81 percent of plug-in vehicle sales: the Nissan LEAF (EV), the Chevrolet Volt (PHEV), the Toyota Prius Plug-in (PHEV), and the Tesla Model S (EV). To date, approximately 50,000 LEAFs, 60,000 Volts, 30,000 Prius Plug-ins, and 26,000 Tesla Model S units have been sold (see Table 1). Currently, there are 17 all-electric and plug-in hybrid electric models for sale, with the Kia Soul EV, Tesla Model X, Mercedes-Benz B Class EV, Volkswagen eGolf, and others scheduled to hit the U.S. market later this year.⁴ Plug-in vehicle sales currently account for less than one percent of all new vehicles, but it is the fastest-growing segment of the automobile market. Sales jumped 85 percent from 2012 to 2013. Through May 2014, sales were 31 percent higher than over the same period in 2013.⁵

POPULAR MODELS

Vehicle Model	Price	Electric Range	Vehicle Efficiency
Nissan LEAF (EV)	\$28,980	84 miles	114 MPGe
The Nissan LEAF is the top-selling EV in the United States today. This four-door hatchback was first sold in the United States and Japan in December 2010. The lithium ion battery pack sits under the back seat and there is a small accessory battery under the hood that charges the radio and air conditioning unit. The LEAF features a solar cell on the rear spoiler that recharges the accessory battery. This year, Nissan launched its “No Charge to Charge” promotion to include no-cost public charging for two years with the purchase or lease of a new LEAF. Nissan plans to expand “No Charge to Charge” from 10 cities nationwide in 2014 to 25 cities in 2015.			
Chevrolet Volt (PHEV)	\$34,185	38 miles (EV mode)	98 MPGe/37 MPG gas
The Chevrolet Volt is a four-door compact car that was introduced nationwide in December 2010. After its initial electric range, the Volt can switch over to its combustion engine to travel a total of 380 miles on a full charge and a full tank of gas. It also uses a regenerative braking system. The Volt can run on gasoline power or on electric power alone. It has a pressurized gasoline tank to keep unused gasoline fresh for up to a year, at which time the combustion engine will automatically run to use up older gasoline. The Volt can charge its battery in 10-16 hours using a standard outlet, or in four hours using a 240V charging station.			
Toyota Prius Plug-in (PHEV)	\$29,990	11 miles (EV mode)	95 MPGe/50 MPG gas
The Toyota Prius Plug-in was first made available nationwide in 2012. It is the first Prius hybrid that can travel on electric power alone, though only for a short distance. The Prius Plug-in can travel 540 miles total by switching to its electric/combustion hybrid engine. The battery pack can be charged in three hours using a standard outlet, or in 1.5 hours using the special power outlet.			
Tesla Model S (EV) 60/85 kWh	\$69,900 / \$79,900	208 miles / 265 miles	95 MPGe / 89 MPGe
Unlike most plug-in cars, the Tesla Model S was designed as a high performance vehicle – it has a top speed of 125 miles per hour and can accelerate from 0 to 60 mph in 5.4 seconds. Consumers can opt for either the 60 kWh or 85 kWh battery pack, with the pricier 85 kWh battery providing additional range. With either battery, the Model S has by far the longest range of any EV. It can be charged at a rate of 29 miles of range per hour using a 240V outlet. It can achieve a 50 percent charge in 20 minutes with the Tesla Supercharger.			
Ford Fusion Energi (PHEV)	\$34,700	21 miles (EV mode)	100 MPGe/43 MPG gas
The Ford Fusion Energi is the plug-in hybrid electric version of the popular Fusion model and was first sold in early 2013. The four-door mid-size sedan provides the option of driving in three modes: electric only, gasoline only, or hybrid power. Fully charged, the Fusion Energi can travel up to 620 miles with a full tank of gas. Its battery can be charged overnight using a standard outlet, or in 2.5 hours with a 240V charging station.			
Ford C-MAX Energi (PHEV)	\$32,920	21 miles (EV mode)	100 MPGe/43 MPG gas
The Ford C-MAX Energi is the plug-in hybrid electric version of the Ford C-MAX. This four-door mid-size hatchback was first sold in October 2012. Its power train system is identical to the Ford Fusion Energi.			

smart electric drive (EV)	\$25,000	68 miles	107 MPGe
The smart electric drive is an all-electric two seat hatchback available as a standard coupe or as a convertible. The lithium ion battery is located under the drivers' seat and can be fully charged in six hours using a 240V charging station, or from 20 percent to 80 percent in only 3.5 hours. The vehicle features a sound generator to alert pedestrians of its presence.			

All vehicle information is for Model Year 2014.⁶ All prices are base manufacturer's suggested retail price (MSRP), before any tax incentives are applied.

PLUGGING IN TO THE GRID

As the number of plug-in vehicles on the road increases, there is a greater need for electric vehicle infrastructure. There are currently 8,000 public charging stations in the United States, compared with 150,000 gasoline stations.⁷ Public charging stations are vital, as they can help extend the electric range of plug-in vehicles and make them more viable for long-range trips. Proponents of electric vehicles say that the infrastructure for routine daily driving already exists, as plug-in vehicles can connect to almost any wall outlet and charge overnight.

Plug-in vehicles can be recharged at home in about 8-14 hours using a standard 110 volt wall outlet. However, some plug-in owners choose to install a dedicated 220 volt charger in their home, which can recharge their vehicle in 1.5 to eight hours, depending on the size of the battery pack. A 220 volt outlet is the same as those used by household washers and dryers. Some plug-in vehicles are also equipped to receive charges from a 400 volt direct current (DC) charger, which can fully charge most electric vehicles in an hour. DC chargers are presently available in only a few locations, but they may become the standard method for recharging plug-in vehicles in the future. However, multiple 220 and 400 volt chargers can create a serious strain on a local electric grid, and utilities and their customers may need to coordinate with smart grid technology to ensure that rapid charging does not lead to overloads and blackouts.

Because electricity is a cheaper power source than liquid fuel, ownership of a plug-in vehicle can result in large savings over the life of the vehicle. The amount saved, however, depends on oil and electricity prices and on the number of miles driven by the vehicle. So while the initial price of a plug-in vehicle may be more expensive than a conventional car, the **total cost of ownership** – the initial cost, plus the cost of fuel and maintenance over the life of the vehicle – of a plug-in vehicle may be substantially less.

BATTERY OUTLOOK

The single biggest expense in any plug-in vehicle is the battery pack. The Nissan LEAF's lithium ion battery initially accounted for one-third the cost of the entire vehicle. But the battery industry is changing rapidly. By late 2013, large-format battery packs cost an estimated \$500 per kWh, half the 2009 price per kWh.^{8,9} One 2012 study suggested that prices could fall to \$200 per kWh in 2020 and \$160 per kWh in 2025.¹⁰ Cheaper battery packs could bring down the price of plug-in vehicles dramatically, making them more commercially viable and competitive with conventional cars. For example, the average 24 kWh battery pack for a plug-in vehicle costs roughly \$12,000 today, but battery prices of \$125 per kWh could result in a battery pack price of \$3,000 per vehicle.

In partnership with battery manufacturers, Tesla Motors is planning to build a "Gigafactory" in order to reduce production costs and increase manufacturing capacity. By the end of the first year of production, Tesla expects to have reduced the per kWh cost of battery packs by 30 percent. The Gigafactory is designed to produce "more lithium ion batteries annually than were produced worldwide in 2013."¹¹

PEV INCENTIVES

As part of the 2009 *American Clean Energy and Security Act*, the federal government grants tax credits of \$2,500 for new qualified plug-in vehicles plus an additional \$417 for each kWh of battery capacity over four kWh, with a

maximum credit of \$7,500. Because they typically have very large battery packs, most EVs are eligible for the full \$7,500 credit. PHEVs have a wider range of battery sizes – the plug-in Toyota Prius has a small battery and is only eligible for a \$2,500 credit, while the Chevrolet Volt has a larger battery pack and is eligible for the full \$7,500 credit. The full federal tax credit is available for the first 200,000 eligible plug-in electric vehicles produced by each automaker. The tax credit will be gradually phased out as individual automakers pass this threshold.¹²

Many states also offer incentives for electric vehicles. For example, California offers rebates of up to \$2,500 for plug-in vehicles and gives them free access to the state's high occupancy vehicle (HOV) lanes. In Washington, plug-in vehicles are exempt from the state's sales tax and motor vehicle tax. Colorado offers a tax credit of up to \$6,000, plus a 20 percent rebate for an electric vehicle charger installation at home. Georgia offers an income tax credit of 20 percent of a new EV's purchase cost (up to \$5,000) and HOV lane access, which has helped propel Atlanta to become the second-largest U.S. metropolitan market for EVs, behind San Francisco.¹³ The U.S. Department of Energy maintains [a full list of state incentives and laws](#) for alternative fuels and advanced vehicles.

The federal tax credit for individual and commercial charging stations (30 percent of equipment costs, maximum \$1,000 for individuals and \$30,000 for commercial stations) expired at the end of 2013.¹⁴ The credit's potential renewal is tied up as part of the federal tax extender package, which is currently under consideration by Congress.

For more information see:

[Fuel Economy Guide to All-Electric Vehicles](#) - U.S. Environmental Protection Agency and U.S. Department of Energy

[Fuel Economy Guide to Plug-in Hybrids](#) - U.S. Environmental Protection Agency and U.S. Department of Energy

[Plug-in Electric Vehicle Deployment](#) – Environmental and Energy Study Institute

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¹ ["Monthly Plug-In Sales Scorecard."](#) *Inside EVs*. June 2014. (Accessed June 4, 2014)

² [Fact Sheet: New Fuel Economy and Environment Labels for a New Generation of Vehicles.](#) U.S. Environmental Protection Agency. May 2011. (Accessed June 4, 2014)

³ Anair, Don., Mahmassani, Amine. 2012. [State of Charge: Electric Vehicles' Global Warming Emissions and Fuel Savings across the United States.](#) Union of Concerned Scientists. April 2012. (Accessed June 4, 2014)

⁴ [New & Upcoming All-Electric Vehicles.](#) Fuel Economy.gov. June 2014. (Accessed June 4, 2014)

⁵ ["Monthly Plug-In Sales Scorecard."](#) *Inside EVs*. June 2014. (Accessed June 4, 2014)

⁶ [Model Year 2014 Fuel Economy Guide.](#) U.S. Department of Energy and U.S. Environmental Protection Agency. May 2014. (Accessed June 4, 2014)

⁷ Alternative Fuels Data Center. [Electric Vehicle Charging Station Locations.](#) U.S. Department of Energy. June 2014. (Accessed June 4, 2014)

⁸ Jaffe, Sam. ["The Lithium Ion Inflection Point."](#) *Battery Power Magazine*. October 2013. (Accessed June 4, 2014)

⁹ McCrone, Angus. 2012. ["Electric vehicle battery prices down 14 percent year on year."](#) *Bloomberg New Energy Finance*. April 2012. (Accessed June 4, 2014)

¹⁰ Seetharaman, Deepa. 2012. ["Electric-vehicle batteries' cost may drop 70 pct. 2025-study."](#) *Reuters*, July 2012. (Accessed June 4, 2014)

¹¹ Tesla Motors. 2014. ["Gigafactory."](#) *Tesla Motors Blog*. February 26, 2014. (Accessed June 3, 2014)

¹² [Federal Tax Credits for Electric Vehicles.](#) Fuel Economy.gov. June 2014. (Accessed June 3, 2014)

¹³ Ramsey, Mike. ["Atlanta's Incentives Lift Electric Car Sales."](#) *Wall Street Journal*. June 4, 2014. (Accessed June 4, 2014)

¹⁴ Berman, Brad. ["Federal and Local Incentives for Plug-in Hybrids and Electric Cars."](#) *PluginCars.com*. May 29, 2014. (Accessed June 4, 2014)