

freedomCAR & vehicle technologies program

U.S. Department of Energy • Office of Energy Efficiency and Renewable Energy

Just the Basics

Electric Vehicles

Electric vehicles are the least polluting mode of transportation available today. They also can operate very economically while using little or no petroleum fuel.

Do Battery-operated Electric Vehicles Pollute?

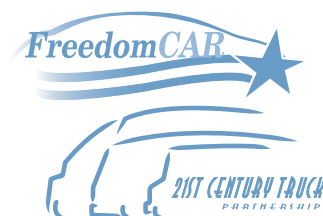
There are two kinds of electric vehicles currently in use: battery-operated electrics and hybrid electric vehicles, or HEVs. Battery-operated electrics run on electricity stored in batteries, electricity that ultimately comes from generating plants that also provide our homes with electrical power. With HEVs, most electricity is produced by small onboard generating plants driven by internal combustion engines. HEVs can be designed to run on gasoline, diesel, or alternative fuels.

Battery-operated electric vehicles are sometimes referred to as “zero emission vehicles” because they do not directly pollute through tailpipe emissions, fuel evaporation, fuel refining, or fuel transport to service stations. A certain amount of pollution, however, is associated with the use of these vehicles. This comes from power plant emissions. Pollution levels from battery-operated electric vehicles remain extremely low even when these emissions are taken into account.

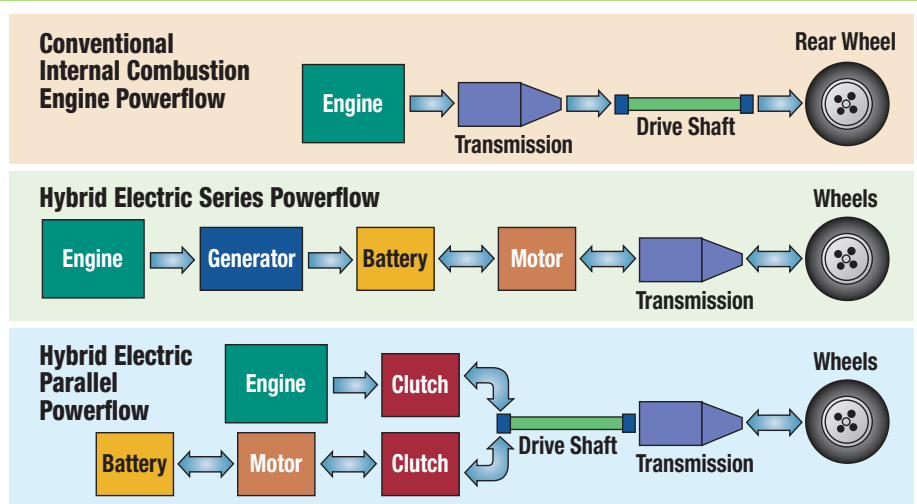
One reason this is true is that the generators and motors used in electric vehicles are much more efficient than the powertrains of internal combustion engines. The difference is such as to make it more efficient to burn

an amount of fuel in a power plant to generate electricity for an electric vehicle than to burn it directly in a vehicle's internal combustion engine. Adding to the efficiency of electric vehicles is the technique of regenerative braking. This involves slowing and stopping a vehicle by absorbing its energy and converting it to electricity that may be returned to the vehicle's onboard battery. In a conventional vehicle, this energy is simply wasted as heat.

Of course, burning less fuel in going a certain distance does not necessarily make for less pollution. That depends on the efficiency of and emissions from the power plant providing the electricity. Over 95% of the fuel used to generate electrical power comes from within the U.S. in the form of coal, natural gas, nuclear power, hydropower, and renewable energy sources.



Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle



The two most common types of hybrid vehicle (series and parallel) powertrains compared to the conventional gasoline engine powertrain

vehicle systems

Electric vehicles turn out to be more than 90% cleaner than the cleanest conventional gasoline-powered vehicle when the electricity running them comes from clean energy sources such as natural gas, nuclear power, hydropower, or renewable fuels.

Electric vehicles remain cleaner than comparable gasoline-powered vehicles even when the electricity they use derives from polluting fuels like coal. The reasons are their high-efficiency electric powertrains and the fact that modern coal-burning generating plants produce electricity more efficiently and with fewer emissions than they did in the past.

The environmental benefits from using battery-operated electric vehicles promise to increase with time. That's because electric generation continues getting cleaner as older, dirtier generating plants are taken out of service and replaced with newer, less polluting ones, and as pollution-free solar or wind generators come on-line.

How Clean Are HEVs?

Much development work has gone into HEVs, which provide the efficiency advantages of electric drive-trains without burdening vehicles with the large, heavy battery packs found in battery-operated electrics. HEVs basically consist of an internal combustion engine, a generator to turn the energy developed by the engine into electricity, and an electric motor to propel the vehicle. Hybrids also include a relatively small battery pack to store energy recovered through regenerative braking and to provide extra power beyond what the generator can produce on its own when the vehicle must accelerate quickly.

Current HEVs produce very low emissions because of their electric powertrains and their highly efficient internal combustion engines. The engines in conventional vehicles are

relatively inefficient under average driving conditions because they are designed for peak demand situations, which occur when a vehicle is accelerating or climbing a steep hill. By contrast, the fuel-burning engines that run generators in HEVs are tailored to efficiently meet the average power requirements of the vehicles, since onboard batteries handle surge power requirements.

Do Electric Vehicles Operate Differently?

Driving an electric vehicle is very similar to driving a gasoline-fueled vehicle. Well-designed electrics can travel at the same speeds as conventional vehicles and provide similar performance capabilities. However, the engines of some HEVs are designed to shut off automatically when the vehicle is braking or stopped at a red light, which can be a little disconcerting to drivers at first. The driving ranges of battery-operated electric vehicles typically vary from 50 to 130 miles, depending on a vehicle's weight, its design features, and the type of battery it uses. By contrast, some HEVs being produced today have driving ranges that approximately double the 300-mile range of conventional vehicles.

What battery-operated vehicles give up in range, they return in refueling convenience. Drivers can refuel a battery-operated vehicle by simply plugging it into a special recharging outlet at home. The recharging time depends on the voltage of the recharging station, the ambient air temperature, the size and type of the battery pack, and the remaining electrical energy in storage. Typically, the process takes several hours, but batteries are being developed that can be recharged more quickly. The cost of fully recharging a battery pack varies with the rates charged by local utility

companies, but generally is considerably less than the cost of an equivalent amount of gasoline.

Electric vehicles are significantly more expensive to purchase than comparable conventional vehicles. An additional expense with battery-operated vehicles involves replacing the vehicles' batteries every few years.

More routine maintenance costs are less with battery-operated vehicles than their conventional counterparts, since the vehicles have fewer moving parts to service and replace. The long-term maintenance characteristics of commercially available HEVs have not yet been established, since the vehicles only recently reached the marketplace.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



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