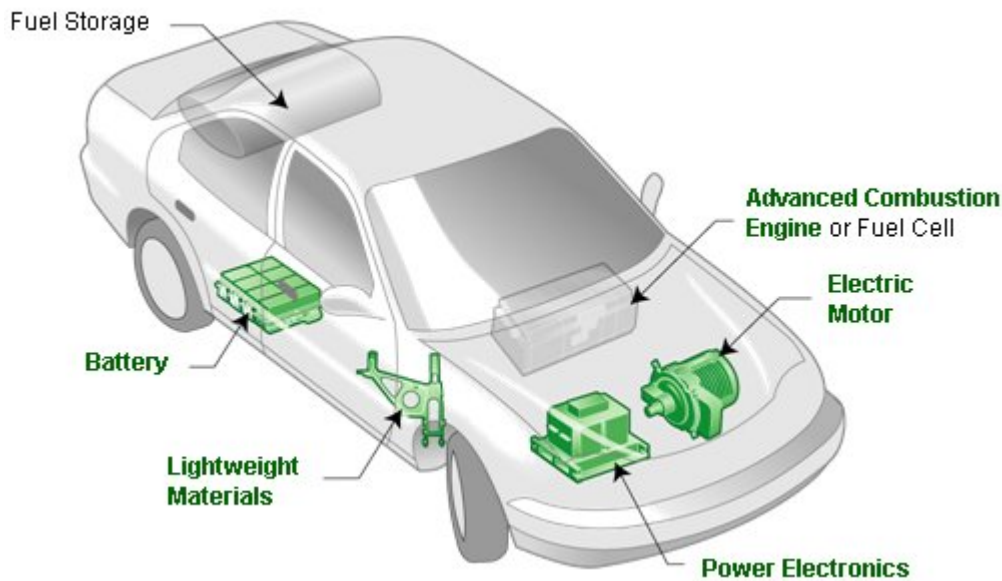


## U.S. Department of Energy - Energy Efficiency and Renewable Energy Vehicle Technologies Program

### Hybrid Electric Vehicles (HEVs)

#### What Are HEVs?



Hybrid electric vehicles (HEVs) combine the internal combustion engine of a conventional vehicle with the high-voltage battery and electric motor of an electric vehicle. As a result, HEVs can achieve twice the fuel economy of conventional vehicles. In combination, these attributes offer consumers the extended range and rapid refueling they expect from a conventional vehicle, as well as much of the energy and environmental benefits of an electric vehicle. HEVs are inherently flexible, so they can be used in a wide range of applications — from personal transportation to commercial hauling.

#### What Are the Advantages of HEVs?

Hybrid electric vehicles have several advantages over conventional vehicles:

- Greater operating efficiency because HEVs use regenerative braking, which helps to minimize energy loss and recover the energy used to slow down or stop a vehicle;
- Lighter engines because HEV engines can be sized to accommodate average load, not peak load, which reduces the engine's weight;
- Greater fuel efficiency because hybrids consume significantly less fuel than vehicles powered by gasoline alone;
- Cleaner operation because HEVs can run on alternative fuels (which have lower emissions), thereby decreasing our dependency on fossil fuels (which helps ensure our national security); and
- Lighter vehicle weight overall because special lightweight materials are used in their manufacture.

Hybrid electric vehicles are becoming cost-competitive with similar conventional vehicles, and most of the cost premium can be offset by overall fuel savings and tax incentives. Some states even offer incentives to consumers buying HEVs.

[Click to review hybrid tax incentives](#) (opens new window to [www.fueleconomy.gov](http://www.fueleconomy.gov), New Energy Tax Credits for Hybrids)

Auto manufacturers are making HEVs that match the performance and safety, and approach the cost of conventional vehicles because they know that these are the three most important attributes to consumers. And by combining gasoline with

electric power, HEVs have the same or greater range than vehicles powered by traditional combustion engines. An HEV is two times more efficient to operate than a conventional vehicle. Behind the wheel, drivers of HEVs will experience performance that is similar to, or better than, that of conventional vehicles. More important, HEV performance is available now, and so consumers can choose a cleaner-driving vehicle today.

### What Are the Key Components of HEVs?

Essentially, an HEV combines an energy storage system, a power unit, and a vehicle propulsion system. The primary options for energy storage include [batteries](#), [ultracapacitors](#), and [flywheels](#). Although batteries are by far the most common choice for energy storage, research is still being done in other energy storage areas. Hybrid power unit options are [spark ignition engines](#), [compression ignition engines](#), [gas turbines](#), and [fuel cells](#). Propulsion can come entirely from an electric [motor](#), such as in a [series configuration](#), or the engine might provide direct mechanical input to the vehicle propulsion system in a [parallel configuration](#) system.

### What's Next for HEVs?

Hybrid electric vehicles are a hot subject today — and they have entered the transportation mainstream across the United States. Several HEVs are now available to consumers, and more are expected to enter the marketplace during the next few years. The key to their widespread penetration into the automotive market is the economics of producing a complex hybrid power system, rather than the inherent capabilities of the technology itself. What will be the ultimate impact of HEVs in the market? Opinions vary because HEVs are complex and some of the best energy storage and conversion systems have yet to be fully developed.

Research and development sponsored by the U.S. Department of Energy, Vehicle Technologies Program, is leading to a comprehensive suite of new technologies, including advanced combustion systems, advanced fuels, and overall vehicle systems, as well as hybridized components such as electric motors, energy storage systems, power electronics, and lightweight materials. Many of these innovative technologies are already in vehicles or soon will be. Also, many of the technologies being developed today for HEVs will contribute to the development of hydrogen-powered fuel cell vehicles in the future.

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