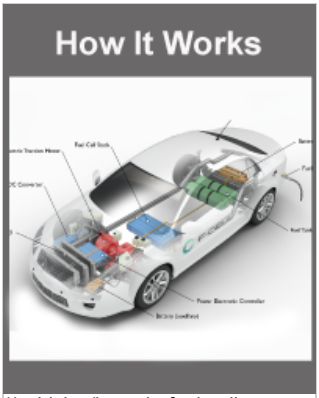
**U.S. Department of Energy - Energy Efficiency and Renewable Energy**
***Alternative Fuels Data Center***

# Fuel Cell Electric Vehicles

Fuel cell electric vehicles (FCEVs) are powered by hydrogen (/fuels/hydrogen_research.html). They are more efficient than conventional internal combustion engine vehicles and produce no tailpipe emissions—they only emit water vapor and warm air. FCEVs and the hydrogen infrastructure (/fuels/hydrogen_infrastructure.html) to fuel them are in the early stages of implementation. The U.S. Department of Energy leads research efforts (/fuels/hydrogen_research.html) to make hydrogen-powered vehicles an affordable, environmentally friendly, and safe transportation option. Hydrogen is considered an alternative fuel under the Energy Policy Act of 1992 (/laws/key_legislation#epact92) and qualifies for alternative fuel vehicle tax credits (/fuels/laws/3255).



(/vehicles/how-do-fuel-cell-electric-cars-work)

## What is a fuel cell electric vehicle?

FCEVs use a propulsion system similar to that of electric vehicles, where energy stored as hydrogen is converted to electricity by the fuel cell. Unlike conventional internal combustion engine vehicles, these vehicles produce no harmful tailpipe emissions (emissions_hydrogen.html). Other benefits (/fuels/hydrogen_benefits.html) include increasing U.S. energy security and strengthening the economy.

FCEVs are fueled with pure hydrogen gas stored in a tank on the vehicle. Similar to conventional internal combustion engine vehicles, they can fuel in less than 4 minutes (/fuels/hydrogen_basics.html#fueling-times) and have a driving range over 300 miles. FCEVs are equipped with other advanced technologies to increase efficiency, such as regenerative braking systems, which capture the energy lost during braking and store it in a battery. Major automobile manufacturers are offering a limited but growing number of production FCEVs (https://www.afdc.energy.gov/vehicles/search/results?view_mode=grid&search_field=vehicle&search_dir=desc&per_page=10&current=true&display_length=25&fuel_id=9,-1&all_categories=y&manufacturer_id=365,377,211,410,235,231,215,223,225,409,379,219,213,209,351,359,385,275,424,361,387,243,227,239,425,263,217,391,349,381,237,221,347,395,-1) to the public in certain markets, in sync with what the developing infrastructure can support.

**How Fuel Cells Work**

The most common type of fuel cell for vehicle applications is the polymer electrolyte membrane (PEM) fuel cell. In a PEM fuel cell, an electrolyte membrane is sandwiched between a positive electrode (cathode) and a negative electrode (anode). Hydrogen is introduced to the anode, and oxygen (from air) is introduced to the cathode. The hydrogen molecules break apart into protons and electrons due to an electrochemical reaction in the fuel cell catalyst. Protons then travel through the membrane to the cathode.

The electrons are forced to travel through an external circuit to perform work (providing power to the electric car) then recombine with the protons on the cathode side, where the protons, electrons, and oxygen molecules combine to form water. See the fuel cell animation (http://energy.gov/eere/fuelcells/fuel-cell-animation) or the Fuel Cell Electric Vehicle (FCEV) infographic (http://energy.gov/sites/prod/files/2015/07/f24/fcto_fcev_infographic_0.pdf) to learn more about the process.

## Related Information

- Availability
- Emissions
- Laws & Incentives