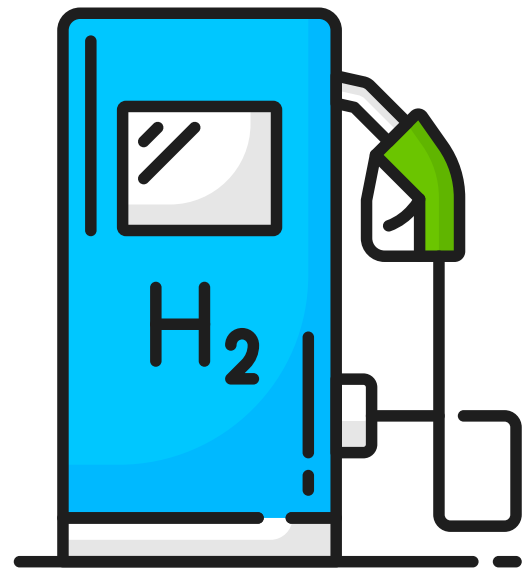


Fuel Cell Electric Vehicles

What Is It?

Fuel Cell Electric Vehicles (FCEV) are a form of electric vehicle (EV) that use **hydrogen fuel cells** to generate electricity. The electricity powers the motor, leaving only water vapor exhaust.



How Clean Is It?

FCEV have no direct emissions, with only water vapor and warm air as exhaust. The manufacturing process and the source of hydrogen does increase emissions, with most hydrogen today produced from natural gas that releases CO₂.



What Does It Cost?

FCEVs are generally priced higher than traditional gasoline vehicles and many battery electric vehicles. The current cost to fill up a fuel cell with hydrogen in the US is significantly more expensive than gasoline vehicles and battery-electric vehicles.



How Does It Work?

1. The FCEV stores hydrogen gas in high-pressure tanks. These tanks are designed to be lightweight yet durable, ensuring the hydrogen remains safely contained under high pressure until it is needed.
2. When the vehicle is started, hydrogen flows from the storage tanks into the fuel cell stack. The stack is made up of many fuel cells, each of which generates electricity through a chemical reaction.
3. The fuel cell stack also takes in oxygen from the air outside. This oxygen is essential for the chemical reaction that will take place within each cell of the fuel cell stack.
4. Inside each fuel cell, hydrogen molecules are split into protons and electrons at the anode. The electrons flow through an external circuit, generating electricity that powers the motor, while the protons move through a membrane to combine with oxygen at the cathode, creating water vapor that is released through the tailpipe.
5. The electricity generated by the flow of electrons powers the electric motor, which drives the wheels of the FCEV, propelling the vehicle forward.

Space



Modern FCEVs have a range of 300-400 miles on a single tank, comparable to traditional gas vehicles and better than most battery EVs. There are more than 50 open retail hydrogen stations in the U.S., about the size of a traditional gas station.

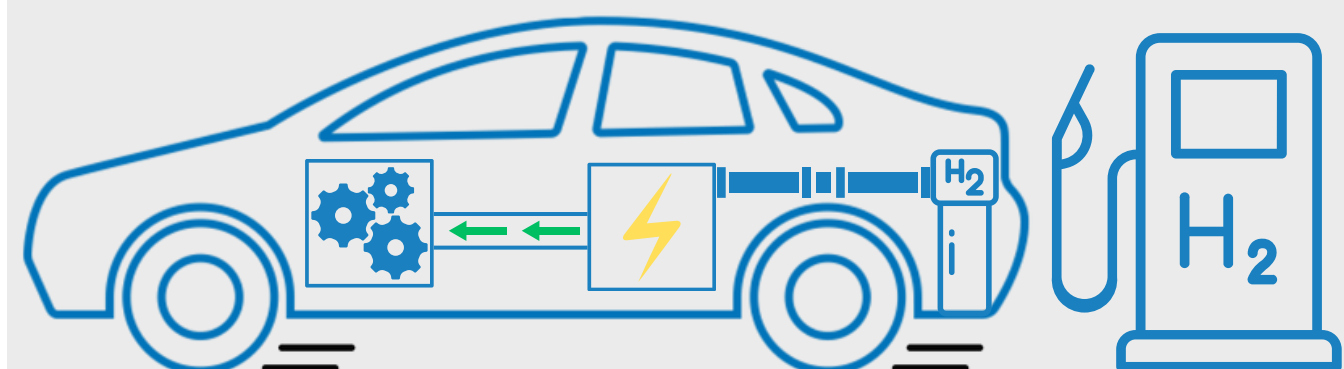


Point

- FCEVs emit only water vapor, minimizing their environmentally impact.
- Many FCEVs offer ranges comparable to gasoline vehicles, typically around 300-400 miles.
- Hydrogen refueling takes about 3-5 minutes, similar to gasoline vehicles.
- Hydrogen tanks are lighter than large battery packs, an advantage for larger vehicles like trucks and buses.
- Unlike some battery EVs, FCEVs generally maintain range and efficiency in cold temperatures.

Counterpoint

- ◁ ▷ • Most hydrogen is currently produced from natural gas, which emits CO₂ during production.
- ◁ ▷ • The lack of hydrogen infrastructure limits the range of FCEVs to specific regions.
- ◁ ▷ • Hydrogen fuel is currently quite expensive, making it more costly to fuel an FCEV compared to a gasoline or battery electric vehicle.
- ◁ ▷ • FCEVs are generally more expensive to produce than traditional vehicles and battery EVs, due to the cost of fuel cell technology.
- ◁ ▷ • Hydrogen is highly flammable and requires careful handling and storage with robust safety measures.



Did You Know?

Virtually all FCEVs in the U.S. are located in California, which contains the overwhelming majority of fuel stations.

What's Next?

Innovative methods of producing hydrogen, such as distributed methane pyrolysis can generate hydrogen on-site and on-demand but without CO₂ emissions, rather than requiring centralized production facilities and new hydrogen transportation and storage solutions. This may make hydrogen fueling stations more viable, requiring only a natural gas connection and modular unit to convert the methane gas into hydrogen.