



The lightest and  
most abundant  
chemical element  
in the universe.

# Paving the Way for Hydrogen-Powered Transportation

**AIR**  
**PRODUCTS** 

Air Products has taken a leadership position in the development of hydrogen technologies that provide reliable and resilient power, reduce greenhouse gas emissions, and increase America's energy security.



Air Products' steam methane reformer in Sarnia, Ontario (Canada) produces hydrogen for a wide range of uses, including hydrogen fuel cell vehicles.

With more than 60 years of hydrogen experience, Air Products is the leading global supplier of hydrogen to refineries and operates the largest hydrogen pipeline network in the world. It is this experience that helped propel us to the forefront of hydrogen energy technology development.

Air Products makes hydrogen primarily through a process called steam methane reforming, where we react natural gas (methane) with steam (water). We can also produce hydrogen by biomass conversion or electrolysis, including electrolysis driven by renewable energy sources such as solar and wind.

## Hydrogen for Fueling

Hydrogen is no more or less safe than other fuels, it's just different. By designing cars and hydrogen fueling stations around the element's unique properties, hydrogen fueling can be done safely.

### Fast Facts

- Hydrogen is a great carrier of energy and can be produced from many renewable resources with a low impact on our environment. It is carbon-free, nontoxic and produces no tailpipe emissions when used in a fuel cell vehicle.
- One kilogram of hydrogen = approximately one gallon of gasoline on an energy equivalent basis.
- The price of hydrogen depends on how it is produced, stored and delivered. The price of hydrogen is expected to be competitive with gasoline when used in large quantities at a fueling station, especially on a \$-per-mile-traveled basis.
- Hydrogen is dispensed into a fuel cell car as a gas, eliminating messy "spills" on the ground that sometimes happen with gasoline.
- On a well-to-wheels basis (a comparison of the entire supply chain), greenhouse gas emissions are approximately 50% lower for fuel cell cars that run on hydrogen produced at our large production plants as compared to gasoline-powered cars.
- Cars, trucks, vans, buses, scooters, forklifts, locomotives, planes, cell towers, material handling equipment, and even submarines have been fueled using Air Products' SmartFuel® technologies.

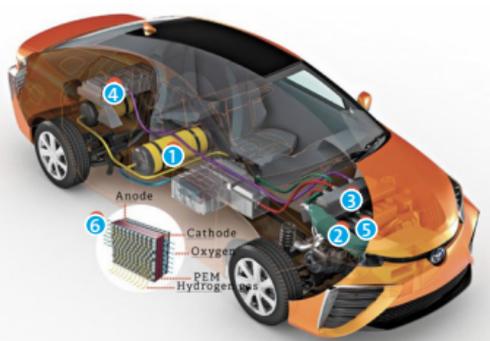
Many major automobile manufacturers have begun commercializing fuel cell electric vehicles (FCEV), like the Toyota® Mirai pictured here.

## Fuel Cell Cars

Driving a fuel cell car is like driving a regular (combustion) engine car, except a fuel cell car is so quiet you don't even know it's running! Performance is also comparable, although a fuel cell car has greater energy efficiency and zero pollution.

### Fast Facts

- Fuel cell cars are electric cars. The electricity is generated under the hood. The car converts hydrogen and oxygen (from the air) into electricity to power the vehicle.
- A fuel cell is an electric generator. Silent, efficient and compact, a fuel cell can produce electricity, water and heat as long as hydrogen and oxygen (air) are supplied.
- Hydrogen fuel cell cars are emissions-free; the only thing that comes out of the tailpipe is water.
- Hydrogen fuel cells are about two-to-three times more efficient than an internal combustion engine.
- Fuel cell cars have a range of 300 miles or more on a full tank of hydrogen and can be refueled in about five minutes.
- Fuel cell cars have fewer moving parts than an internal combustion engine car; they do not have a transmission or an engine.
- In the U.S., California is the first market where fuel cell cars are available to consumers. Toyota, Honda and Hyundai all sell or lease fuel cell cars commercially.



- 1 Hydrogen Tank
- 2 Airflow
- 3 Power Control Unit
- 4 Battery (Ni-metal Hydride)
- 5 Electric Motor
- 6 Fuel Cell

## Hydrogen Fueling Stations

Hydrogen dispensers operate very much like gasoline dispensers. If you can fuel your current vehicle, you can fuel a hydrogen car.

### Fast Facts

- Air Products deployed its first hydrogen fueling station in 1993 and has developed an extensive patent portfolio related to hydrogen supply and dispensing technology.
- Hydrogen fueling stations dispense hydrogen into fuel cell vehicles at 10,000 psi (700 bar). The station is designed to compress, store and dispense hydrogen safely and quickly—in about five minutes!
- Infrastructure is being built to support the first commercial fuel cell cars primarily in Japan, U.S., U.K. and Germany.
- Hydrogen fueling stations are being built at retail gas stations in California to support the introduction of fuel cell cars into the market. Thirty-five stations are operating today, and another 29 stations are under development.
- Air Products has been involved in over 200 hydrogen fueling projects in the U.S. and 20 countries worldwide.



Use of Air Products' fueling technology is increasing and accounts for over 1,500,000 hydrogen fills per year.

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