

# California

FUEL CELL  
PARTNERSHIP

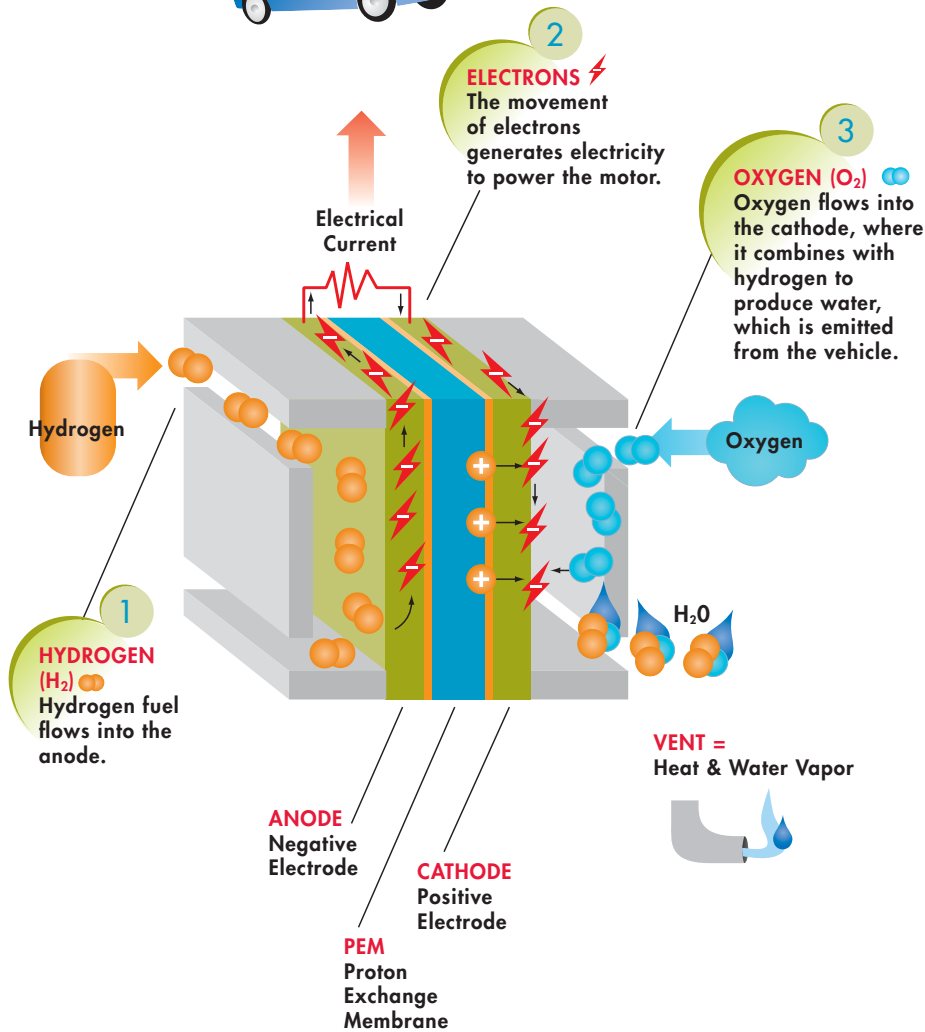


*DRIVING FOR THE FUTURE*

## HOW IT WORKS

[www.fuelcellpartnership.org](http://www.fuelcellpartnership.org)

## FUEL CELL ENERGY POWERS THE CAR!



Fuel cells also provide power to forklifts, airport tugs and even NASA's space shuttles. Large fuel cells can create electricity for houses and buildings. Tiny fuel cells can run laptop computers or digital cameras.

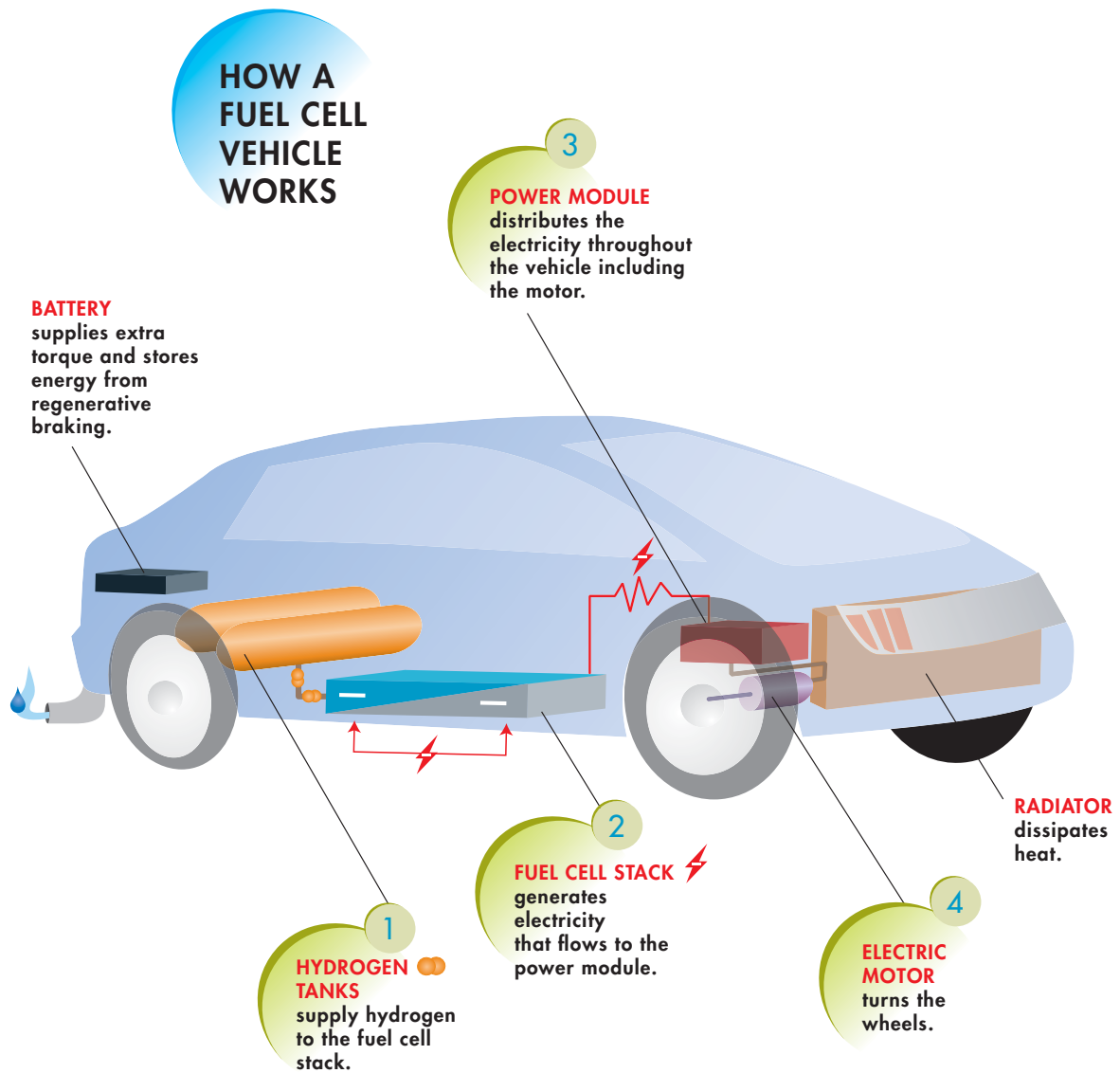
Automakers and bus builders use proton exchange membrane, or PEM, fuel cells to power the vehicles. A PEM fuel cell combines hydrogen fuel with oxygen from the air to generate electricity. In its simplest form, a PEM fuel cell is two electrodes—the anode and the cathode—separated by a catalyst-coated membrane. Fuel cells produce electricity as long as fuel is supplied.

A fuel cell stack is made up of many PEM fuel cells that are stacked together, like slices in a loaf of bread. The stack generates electricity that powers the vehicle.

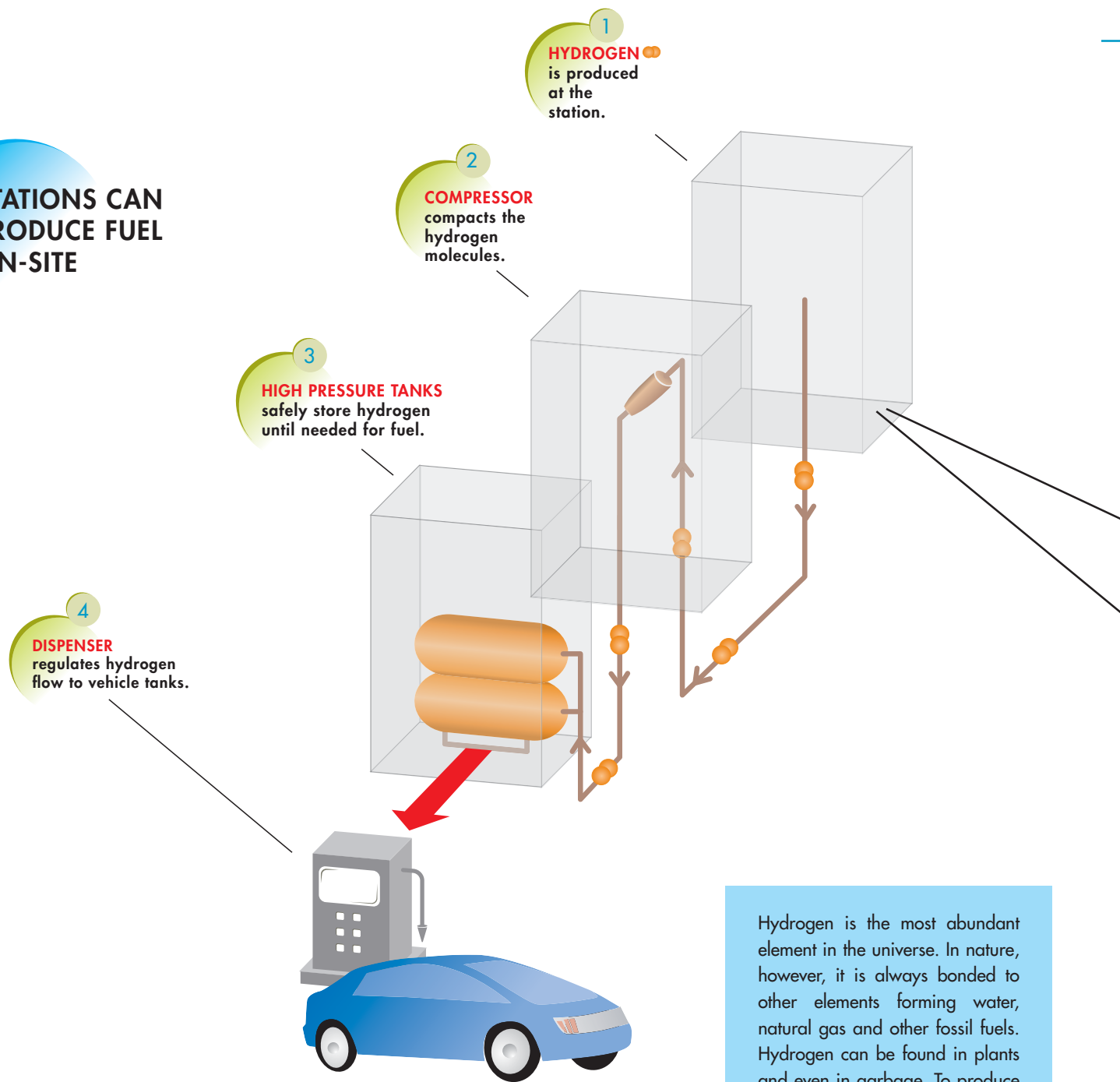
Fuel cell vehicles are electric vehicles that use a fuel cell stack to create electricity instead of requiring a battery that must be recharged.

The electricity from the fuel cell stack flows into a power module, which distributes the electricity to the electric motor that turns the wheels of the car. The power module also distributes electricity to the air conditioning, sound system and other on-board devices.

A high-voltage battery, similar to those in gasoline hybrids, provides extra torque when accelerating or climbing a hill, and helps improve fuel economy.



## STATIONS CAN PRODUCE FUEL ON-SITE



Hydrogen is the most abundant element in the universe. In nature, however, it is always bonded to other elements forming water, natural gas and other fossil fuels. Hydrogen can be found in plants and even in garbage. To produce hydrogen, we unlock the chemical bonds in the molecules.

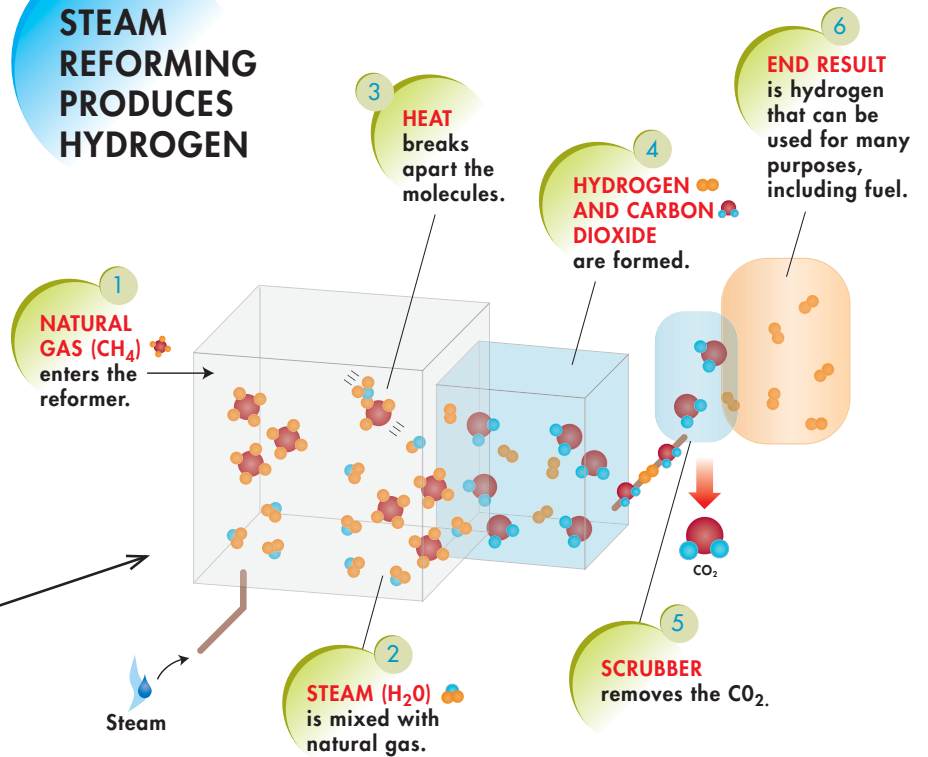
In California and around the world, fuel stations are producing hydrogen on-site. These stations produce fuel with either a reformer or an electrolyzer, resulting in gaseous hydrogen.

A compressor/pump pulls the hydrogen through a pipe, compresses it and then pushes it into storage tanks. The hydrogen remains compressed to more than 5,000psi in storage tubes until a vehicle needs it for refueling.

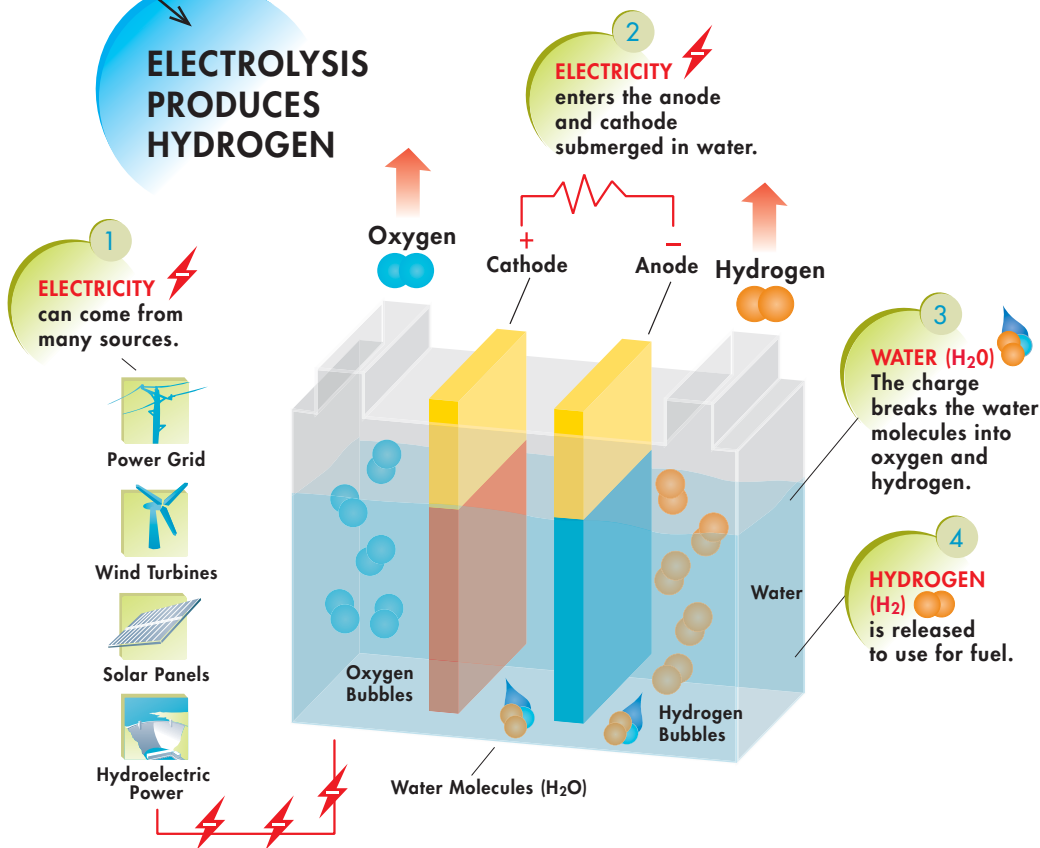
Currently, most hydrogen is produced by steam reforming natural gas. Steam reforming combines natural gas with superheated steam and a catalyst. The heat causes the molecules to collide, releasing the hydrogen from both the hydrocarbon and water molecules. Immediately, the loose oxygen and carbon combine into carbon dioxide, leaving the hydrogen molecules free.

Hydrogen can also be produced by reforming methanol, gasoline or ethanol through a similar process.

## STEAM REFORMING PRODUCES HYDROGEN



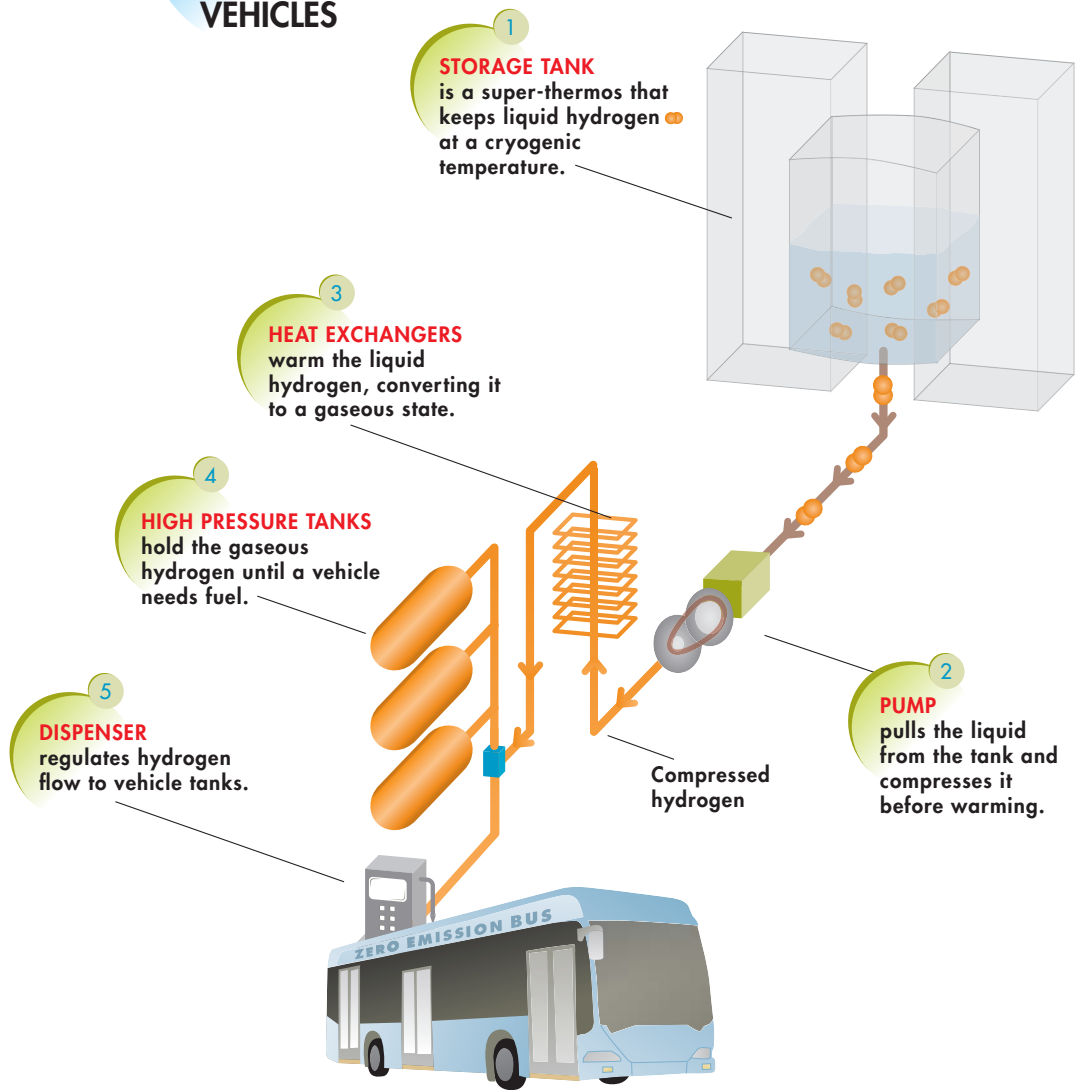
## ELECTROLYSIS PRODUCES HYDROGEN



Electrolysis uses electricity from many sources to pass a current through water, splitting the water molecules into hydrogen and oxygen. The electrolyzer contains a thin membrane coated with a catalyst to speed the reaction. The hydrogen is stored for fuel and the oxygen is released into the atmosphere.

When hydrogen is produced by renewable energy and used in a fuel cell vehicle, it is nearly pollution-free and has almost no impact on the environment. Researchers are exploring even more renewable sources of hydrogen, including biomass and algae.

## HYDROGEN STATIONS REFUEL THE VEHICLES



Hydrogen fueling stations can store hydrogen as a gas or liquid, and produce hydrogen on-site or have hydrogen delivered by a tanker or via a pipeline. The station in this illustration stores the hydrogen as a liquid at a cryogenic temperature of  $-423^{\circ}\text{F}$  ( $-253^{\circ}\text{C}$ ).

A reciprocating pump pulls the liquid hydrogen from the storage tank and compresses the liquid. As the hydrogen gets warmer, it converts to a gas—just like boiling converts water to steam. The gas remains compressed to more than 5,000 pounds per square inch (psi) in long storage tubes.

To fuel, the vehicle driver connects a dispenser nozzle to a receptacle on the vehicle. The dispenser pushes the hydrogen into the vehicle's tank, maintaining a 5,000psi compression. Filling the tank takes just a few minutes!

The California Fuel Cell Partnership is a collaboration of auto manufacturers, energy providers, government agencies, technology companies and transit agencies that work together to promote the commercialization of hydrogen fuel cell vehicles.

Today, CaFCP members operate fuel cell vehicles and hydrogen fueling stations in demonstration programs in California, and in other regions of the U.S. and countries around the world.

## THE BENEFITS

Fuel cell vehicles powered by hydrogen are a long-term solution to air quality, energy dependence and climate change issues.

- Fuel cell vehicles have great acceleration, are fuel efficient and virtually silent.
- Fuel cell vehicles only emit heat and water.
- Every country and region of the world can produce hydrogen from a variety of sources using multiple methods.
- Hydrogen can be made from renewable sources of energy with almost no environmental impact.
- Stations can produce hydrogen fuel on-site using several different methods.

## THE CHALLENGES

To bring these vehicles to market, automotive and energy companies must meet consumer expectations for convenience, ease of use and familiarity.

- Currently, most vehicles average 100-150 miles on a tank of hydrogen. American consumers expect cars to average 300 miles before refueling.
- Fuel cells must last the lifetime of a vehicle, about 150,000 miles.
- Hydrogen fueling stations must be convenient and plentiful, making it easy to fill a fuel cell vehicle near home, work or school.
- People need to learn about and understand this new technology.

Through collaborative work, the members of the California Fuel Cell Partnership address these challenges with a goal of bringing the first fuel cell vehicles to market.

California leads the world in hydrogen fuel cell vehicle demonstration programs.

More cars and buses are on California's roads than any other region of the world. California also has the most hydrogen refueling stations.

Please visit our website to learn more about the stations and the vehicles in California.

## PUBLIC TOUR

On the fourth Friday of every month, the California Fuel Cell Partnership welcomes guests to tour the facility and hydrogen station, and ride in a fuel cell vehicle.

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The members of the California Fuel Cell Partnership believe fuel cell vehicles powered by hydrogen have the potential to change the future of transportation.

For a complete list of members, please visit us at

**[www.cafcp.org](http://www.cafcp.org)**