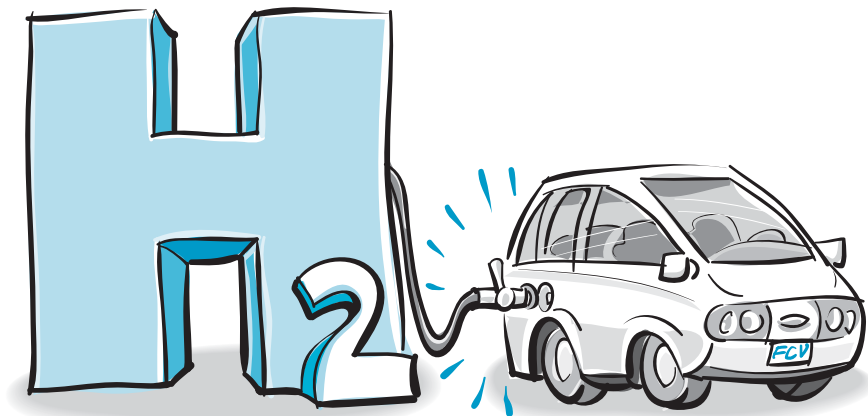


For more information visit  
[www.cafcv.org](http://www.cafcv.org)



Frequently Asked  
Questions

## BENEFITS OF FUEL CELL ELECTRIC VEHICLES

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

- FCVs are zero-emission vehicles with 300-500 mile range, refill in minutes and have the power and performance people want in a vehicles.
- Fuel cell vehicles and hydrogen fuel will be cost competitive with other options.
- Hydrogen is a clean, efficient fuel that can be made from renewable sources of energy with almost no environmental impact. Every country and region of the world can produce hydrogen from a variety of sources using multiple methods.

Fuel cell vehicles are part of the advanced transportation family that includes batteries, biofuels and improved combustion engines. All vehicles are necessary to improve our environment and our world.

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The California Fuel Cell Partnership is a unique collaborative of auto manufacturers, energy companies, fuel cell technology companies and government agencies.

By 2050, most vehicles on the road must use electric drive, including FCVs, PHEVs and BEVs. It takes about 20 years to turn over the entire vehicle population, so by 2030 automakers must have a wide variety of vehicles on the market: sports cars, sedans, vans, SUVs, and pick-up trucks. They must be family vehicles, police cars, taxi cabs, rental cars and delivery trucks. By 2020, automakers must be in full production of cost-effective, reliable vehicles. Right now, many automakers are working toward production design vehicles that meets consumer demands so they can start establishing the supplier chain for components, building the sales and service network and build customer acceptance.

## INTRODUCTION

Fuel cell vehicles are real and ready for the commercial market. Hundreds are on the road now, and new hydrogen stations are preparing for the thousands of passenger vehicles and dozens of buses coming as soon as 2015. FCVs combine the performance and emissions-free driving of an electric vehicle with the range and convenience of a traditional vehicle. FCVs powered by hydrogen help reduce pollution, greenhouse gases, energy use and dependence on imported oil.

## FREQUENTLY ASKED QUESTIONS

1. How is a fuel cell different than a battery?
2. How efficient is a fuel cell?
3. Is the H<sub>2</sub> a liquid or gas?
4. Why not make the H<sub>2</sub> onboard the vehicle?
5. Where are the stations?
6. What happens when the fuel cell wears out?
7. How does a fuel cell vehicle perform?
8. How can I get one?
9. Are the vehicles safe?
10. What does CaFCP do?
11. Why make the investment now?

## QUICK ANSWER

It's the only way to reach our future goals.

## LONG ANSWER

California has a goal of reducing greenhouse gas emissions to 80 percent below 1990 levels by 2050. Vehicles account for almost 40% of GHG emissions. To reach the goal, we have to reduce the number of miles we drive and the GHGs created when producing and using fuel in our vehicles. Electric-drive vehicles—fuel cell and plug-in battery—significantly lower GHG emissions from transportation.



#11

QUESTION:  
Why make the  
investment now?

set some standards and regulations. CaFCP members provided the Department of Measurement Standards with joint input about hydrogen quality regulations, instead of the agency receiving individual and conflicting input. DMS was able to create the regulation in months instead of years.

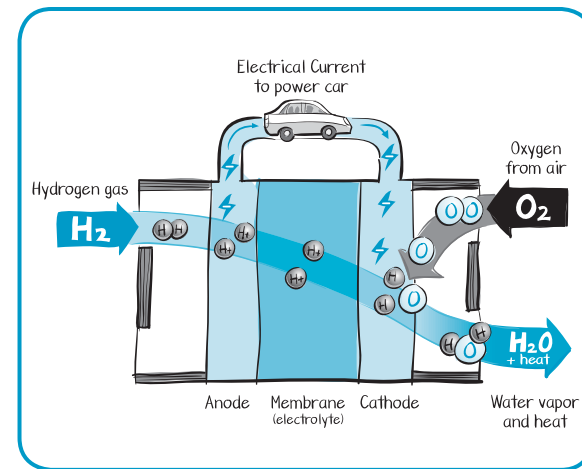
Some projects, like public outreach and firefighter education, are ongoing. Other projects arise around one issue, like fueling protocols or messaging. When the issue has been resolved, the project team disbands. People from our member organizations are all engaged on a day-to-day basis to move fuel cell vehicles closer to the market.

### QUICK ANSWER

A battery stores electrical energy and a fuel cell converts hydrogen into electrical energy.

### LONG ANSWER

A fuel cell has an anode, a cathode and a membrane coated with a catalyst. The membrane is the electrolyte. The reactants (hydrogen and oxygen) are stored externally. Hydrogen enters the anode side of the fuel cell and oxygen enters from the cathode side.



#1

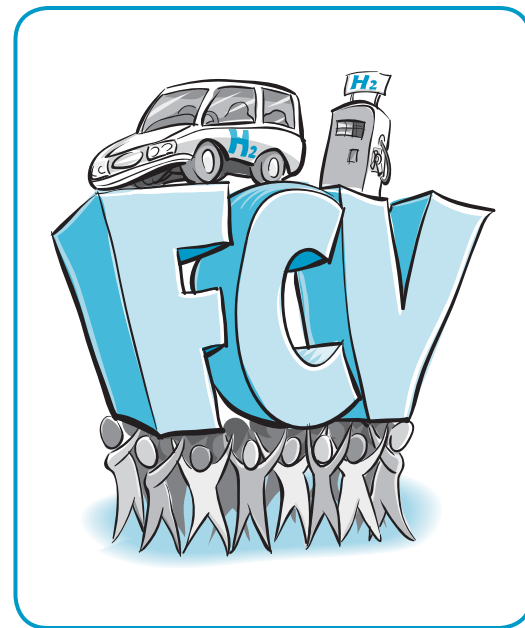
QUESTION:  
How is a fuel cell  
different than a battery?

When the hydrogen molecules come into contact with the catalyst, a chemical reaction converts the energy stored in the hydrogen into an electric current. A fuel cell will create a current as long as it has fuel. When the fuel supply is shut off, the reaction stops and therefore, so does the current.

A battery has an anode, a cathode and an electrolyte that allows a chemical reaction to occur. The reactants are inside the battery. When the battery operates, a chemical reaction releases electrons through an external circuit, providing a current. Some types of batteries can be recharged, which reverses the chemical reaction and allows energy to be stored again in the battery.

#### INTERESTING FACT

- PEM fuel cells in vehicles use hydrogen as fuel. Other types of fuel cells that power small devices (like phone chargers) or provide power to buildings use other fuels, such as methanol, natural gas and biogas.



#### QUICK ANSWER

CaFCP works together to promote the commercialization of fuel cell vehicles.

#### LONG ANSWER

CaFCP members collaborate on the issues that move the vehicles to market. For example, California was the first state to designate hydrogen as a transportation fuel. With that designation came a need to immediately

#10

QUESTION:  
What does CaFCP do?

Sensors, valves and other safety features are specifically designed around hydrogen's lighter-than-air property. The on-board hydrogen storage tanks are extremely strong, carbon-fiber wrapped tanks. Similar to CNG tanks, hydrogen tanks are put through a series of extreme tests, including bonfire, impact, burst and gunfire tests. The tanks must meet strict manufacturer guidelines and applicable DOT criteria to be on public roads.

#### INTERESTING FACTS

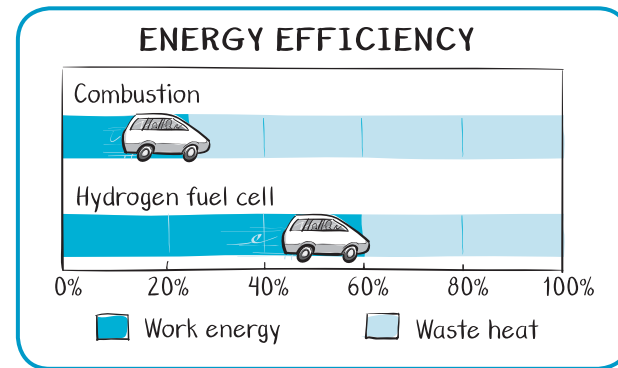
- The number of miles driven has doubled in the last decade.
- The average adult spends 75-83 minutes a day in a vehicle.
- 85% of personal travel is in a passenger vehicle, as opposed to public transit.

#### QUICK ANSWER

Fuel cell vehicles are 2-3 times more efficient than conventional combustion engine vehicles.

#### LONG ANSWER

As energy transfers from one system to another, some energy becomes "work" and some becomes "waste." In a vehicle, work energy provides power and waste energy becomes heat. Efficiency is a measure of the amount of work energy from the fuel. A fuel cell is about 60% efficient. The vehicle's electric motor is also very efficient in converting the energy from the fuel cell into work.



#2

QUESTION:  
How efficient is a fuel cell?

A combustion engine is about 25% efficient when using gasoline. (The efficiency is slightly greater with diesel.) An engine uses energy created by burning fuel. Quite a bit of the energy is waste heat from combustion and friction from moving engine parts creates even more waste heat.

#### INTERESTING FACT

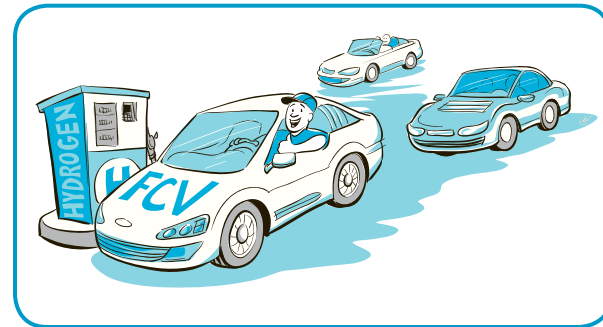
- The Department of Energy's target for fuel cell efficiency is 60%. DOE reports that efficiency is currently 56-59%.

#### QUICK ANSWER

Yes. They are as safe as the vehicles we drive today.

#### LONG ANSWER

CaFCP automaker members subject fuel cell vehicle models to extensive safety testing prior to releasing them on public roads, including destructive and non-destructive evaluations at the component, system and vehicle level. Hydrogen is as safe as other transportation fuels, but has different characteristics.



customers, primarily in the Los Angeles and Orange County areas. Several automakers have stated plans to put FCVs in early market areas in 2014-2015. The early market vehicles will be available in major metro areas in Northern and Southern California.

By 2018, automakers expect that they will have placed about 50,000 FCVs in customer hands—80 percent of those in Southern California. Vehicles and stations will be deployed together, making sure that customers have multiple places to fuel near the places they live, work and play.

#### INTERESTING FACTS

- More fuel cell passenger vehicles and buses are on California's roads than any other region of the world. California also has the most hydrogen fueling stations.
- AC Transit in Oakland operates the largest fuel cell bus fleet in the U.S.
- Germany, Japan, Korea and Canada all have programs to bring FCVs and FCBs to the commercial market.

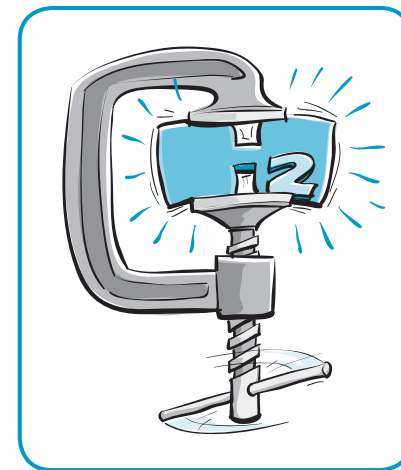
#### QUICK ANSWER

Fuel cell vehicles use gaseous hydrogen.

#### LONG ANSWER

Fuel cell vehicles carry their hydrogen in a gaseous state. At normal temperatures, hydrogen is a gas. A kilogram of gaseous hydrogen fills more space than a kilogram of liquid hydrogen.

One way to extend the range of a vehicle is to increase the amount of fuel it holds. So why don't FCVs use liquid hydrogen? To be a liquid, hydrogen must be stored at  $-423^{\circ}\text{F}$  ( $-253^{\circ}\text{C}$ ). If the hydrogen



#3

QUESTION:  
Is the  $\text{H}_2$  a liquid or gas?

warms up even a little, it begins to evaporate. Tanks to hold hydrogen at a cryogenic temperature would have to be thicker and heavier than tanks that hold gaseous hydrogen. At the station, fueling equipment would have to be well insulated, too, making it bulky and heavy.

#### INTERESTING FACTS

- Hydrogen dispensers list fuel pressure as H35 and H70. The numbers refer to pressure in megapascal (MPa) instead of psi or bar.
- Longer term, storing hydrogen in a solid may be an option. A hydride stores molecules of hydrogen between the molecules of metal, like a sponge stores water in its pores.

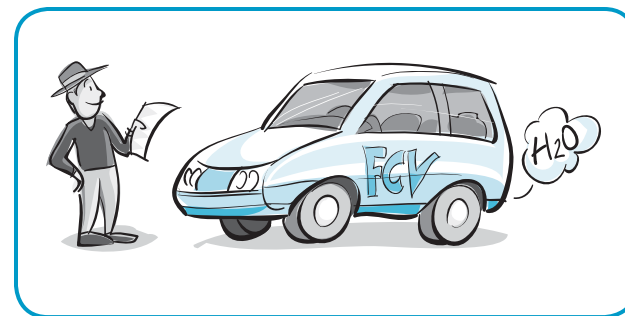
#### QUICK ANSWER

Transit buses are available now. Look for passenger vehicles around 2015.

#### LONG ANSWER

Transit agencies are already buying fuel cell buses. Look for them on the road in the San Francisco Bay Area, Burbank and Palm Springs. More transit agencies in California will be adding fuel cell buses in the coming years.

Fuel cell vehicles are currently not for sale, although each of the automakers has FCVs on the road. Some are leasing vehicles to



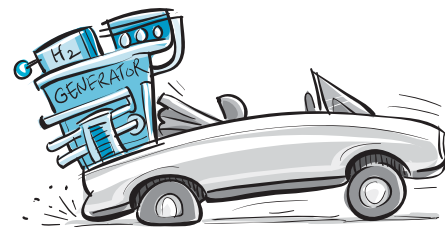
#8

QUESTION:  
How can I get one?

Driving or riding in an FCV, you do notice a few differences. First, you won't feel the vehicle change gears when accelerating or climbing hills. FCVs have electric motors and no transmission, so it's smooth driving all the way. Second, it's very quiet. Fuel cell vehicles have no combustion engine or moving parts, so they make very little noise. You especially notice the quietness when riding in a fuel cell bus or driving a passenger vehicle on the highway with the windows down.

#### INTERESTING FACT

- Street traffic is the largest contributor to noise pollution. An average automobile operates at 67-75 decibels, diesel buses operate at 100 dB. Fuel cell passenger vehicles and transit buses operate at 50-60 decibels, about the same level as a refrigerator, a gentle breeze or an ordinary spoken voice.



#### QUICK ANSWER

It's possible, but not practical.

#### LONG ANSWER

Early in CaFCP's history, some automakers looked at reforming gasoline

or methanol into hydrogen onboard the vehicles. Both processes worked, but added weight, complexity and cost to the vehicle. It's easier and more cost effective to produce the fuel at a central location and dispense it at stations.

Filling a tank is a quick and simple process. A hydrogen dispenser nozzle looks similar to a nozzle on a natural gas or propane

#4

QUESTION:  
Why not make the  
H<sub>2</sub> onboard the vehicle?

dispenser. The driver locks the nozzle onto a valve on the vehicle. When the seal is tight, fuel flows into the tank. When the tank is full, the dispenser turns off. It typically takes three to five minutes to fill the tank at new stations.

#### INTERESTING FACTS

- The world produces hydrogen equivalent to 56 billion gallons of gasoline, enough to fuel 180 million fuel cell vehicles.
- 53% of the hydrogen produced in North America is already dedicated to transportation, enough to fuel 21 million FCVs. It's used to make gasoline cleaner by removing sulfur from petroleum at refineries.
- A large hydrogen production site exists today near almost every major U.S. and European city.



#### QUICK ANSWER

Great!

#### LONG ANSWER

In most respects, a fuel cell vehicle drives like a conventional vehicle. It has power and performance—great pick-up and easily cruises at freeway speeds. Inside the vehicle, it has all the space and comfort you'd expect. The dashboard gauges are different, displaying percentage of fuel remaining, kilowatts instead of RPM, and power management.

#7

QUESTION:  
How does a fuel cell  
vehicle perform?

some people choose to replace the fuel cell, just as some people choose to replace the engine in a conventional car.

At the end of its lifespan the fuel cell will be disassembled and the materials recycled, similar to what happens with vehicle components today.

#### INTERESTING FACTS

- A fuel cell stack is about the size of a roll-aboard suitcase.
- Fuel cell durability is very close to the Department of Energy goal of 5,000 operating hours (150,000 miles). The fuel cell in an AC Transit bus has more than 10,000 hours of durability in real-world operation.
- The target cost for a fuel cell stack is \$35/kW by 2015. DOE shows that 2009 cost was \$61/kW, a 35% decrease in just two years.

#### QUICK ANSWER

Primarily in Los Angeles and Orange County

#### LONG ANSWER

Early on, hydrogen stations were small, industrial-looking stations that were designed to fill automakers' test vehicles. As vehicles are coming into customer hands, the stations are changing. Most of the new stations are dispensers in existing gas stations.

CaFCP's members work closely together to identify areas where vehicles are coming to market first and where drivers need the first



#5

QUESTION:  
Where are the stations?

stations. The goal is to place stations so that every driver is just a few minutes from a station in their normal commute pattern and that every station serves many drivers. It's a two-prong plan for customer convenience and station utilization.

Visit CaFCP's website to see pictures of some of California's hydrogen stations and our interactive map showing the locations of the stations already open and those in planning and construction.

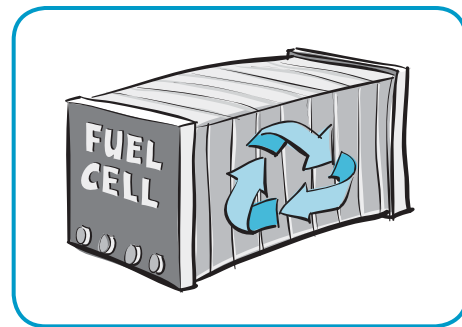
### QUICK ANSWER

They won't wear out during the life of the vehicle.

### LONG ANSWER

The fuel cells are being designed to last the lifetime of the vehicle, about 150,000-200,000 miles.

Demonstration fuel cell vehicles have already accumulated 100,000 and more in real-world driving. Automakers assume that, like today, when the vehicle reaches 150,000 miles most people will trade in their fuel cell vehicle for a newer model. It may be that



#6

QUESTION:  
What happens when the fuel cell wears out?