

# Hydrogen – The New Fuel of Choice

**H**ydrogen fuel promises a future of renewable, efficient, pollution-free energy. It also has the potential to keep much of the \$106 billion our nation pays for foreign oil a year at home instead.

Hydrogen is colorless, odorless, tasteless, and nontoxic, which makes it different from every other common fuel we use today. When used to power fuel cells, the only emissions are breathable oxygen, drinkable water, and some heat. Even when burned in an internal combustion engine, no pollution results.

## Sources of hydrogen fuel

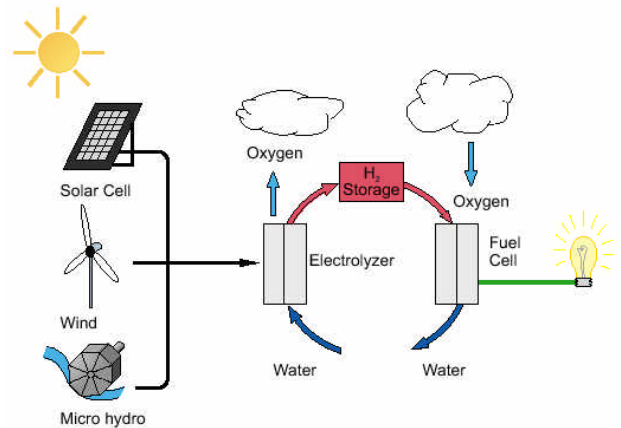
Hydrogen is the most abundant element in the universe. It's in water and all living things. It is also the simplest, lightest element, with only one proton and one electron.

Although hydrogen is all around us, it is rarely found in its free-floating or elemental form. It combines with other elements to make such things as water, sugars, and carbohydrates.

Most of today's hydrogen is produced from fossil fuels through coal gasification, or by "steam reforming" of natural gas or oil. These processes use non-renewable fossil fuels and also produce pollution. For sustainable, economic development and clean energy, a long-term goal is to produce hydrogen from renewable energy sources such as wind or solar power, biomass (plant material), and even water.

**Water:** In a process called "electrolysis," hydrogen is produced by passing an electric current through water. If the electricity is provided by wind or solar energy, the hydrogen is produced without creating pollution. Interestingly, the variable supply of wind and solar provides an advantage for producing hydrogen from water. Wind and solar energy are not constant. Very windy days or bright sunny days may provide more electricity than the available power grid can distribute.

Rather than shutting down a turbine or solar panel during periods of oversupply, the surplus electricity can be used to make hydrogen. The stored or transported hydrogen can then be used in a fuel cell to produce electricity when and where it is needed.



*Renewable energy sources can be used to produce hydrogen for use in fuel cells that can, in turn, generate electricity on demand.*

**Biomass:** Biomass (plant material) is another source of renewable hydrogen. Much of America has abundant biomass resources, including waste from sugar beet plants, canneries, ethanol and biodiesel facilities, and due to our sugar-rich diet, wastewater treatment plants. Demonstration projects are showing that organic methods (use of enzymes, catalysts, fermentation, and even algae) can produce renewable hydrogen. Sugar-rich wastes produce the most hydrogen. Production scale facilities are expected to be possible within five years.

## Why don't we use more hydrogen?

Given the many benefits, why isn't hydrogen our primary fuel? Both cost and capacity limit our use of hydrogen. We simply do not have the hydrogen production capacity or distribution system to match that of gasoline. It is possible to convert today's internal combustion engines to use hydrogen fuel as is commonly done for propane and natural gas powered vehicles. However, convenient access to hydrogen is a significant limiting factor. Blending



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hydrogen with fossil fuels is a likely next step because it does not require independent distribution systems, yet its presence increases performance and decrease pollution.

In terms of capacity, the amount of hydrogen we currently produce in the United States each year is only enough to power 1 million hydrogen vehicles for about three days. Clearly as the use of hydrogen increases, the production and distribution system will need to dramatically increase as well. Much of today's debate centers around how much of the hydrogen will be produced from renewable (wind, solar, hydro, or biomass) versus non-renewable (fossil or nuclear) sources of energy.

Cost is a significant factor limiting the use of renewable hydrogen. It now costs several times more to make hydrogen from renewable energy than by producing hydrogen from fossil fuel. The OEA is involved in several promising demonstration and research projects for renewable hydrogen, but it will be 5 to 10 years before these technologies approach the current price of obtaining hydrogen from fossil fuels.

## Is use of hydrogen safe?

Today, more than 3.2 trillion cubic feet of hydrogen are used safely in the United States. Experience has shown that the risks of using hydrogen are similar to that of using other flammable gases such as propane or natural gas. Small hydrogen sensing meters alert users of any leak more readily than relying on odor detection.

It is a common misconception that hydrogen caused the fire of the famous Hindenburg Zeppelin accident in 1937. The airship's cotton skin was coated by a flammable material similar to early rocket fuel. Sparks from an electrostatic discharge as the ship was landing caused the skin to ignite. The hydrogen did not explode but flamed rapidly upward.

Many experts consider hydrogen a safer fuel than gasoline, which, as a highly flammable and volatile liquid, flows under a vehicle as it burns. In terms of public health, vapors from gasoline are a known carcinogen. Hydrogen is nontoxic.

## The hydrogen economy

The "hydrogen economy" is based upon moving away from a dependence on fossil fuels toward the use of hydrogen as the primary fuel. Approximately 85 percent of our electricity is derived through use of fossil fuels. The United States imports about 8 million barrels of foreign oil a day, approximately half of our use. The hydrogen economy promises to keep our energy dollars in America, providing significant economic and environmental benefits to our nation.

The hydrogen economy is drawing interest from around the world. Hydrogen fueling stations for cars and buses are being established in countries, including Japan, Germany, Spain, the Netherlands, Iceland, Australia, Canada, and the United States. Iceland has established a national goal to make the transition from a fossil fuel to a hydrogen economy by 2030 because of the long-term economic advantage, energy independence, and clean power they foresee.



*In the future, drivers will be able to fill up their fuel cell cars with hydrogen at fueling stations such as this one in Richmond, California. Existing stations will someday dispense hydrogen fuel.*

## Resources

- How Stuff Works web site has general information about hydrogen: [www.howstuffworks.com/hydrogen-economy.htm](http://www.howstuffworks.com/hydrogen-economy.htm).
- The National Renewable Energy Laboratory web site offers specific information on obtaining hydrogen from renewable sources: [www.nrel.gov/documents/hydrogen.html](http://www.nrel.gov/documents/hydrogen.html).
- The National Hydrogen Association web site provides comprehensive information about hydrogen: [www.hydrogenus.com](http://www.hydrogenus.com).
- "Fuel Cells – Power Where It Is Needed," is an OEA fact sheet on commonly asked question about fuel cells: [www.moea.state.mn.us/p2/fuelcells.cfm](http://www.moea.state.mn.us/p2/fuelcells.cfm).

## For more information

For more information about pollution prevention energy technologies and fuels, visit the OEA web site: [www.moea.state.mn.us/p2/energy.cfm](http://www.moea.state.mn.us/p2/energy.cfm).