



RENEWABLE HYDROGEN *FACT SHEET*

October 2019

RENEWABLE HYDROGEN

Renewable hydrogen can be made by passing renewable electricity through water to separate H₂O into hydrogen and oxygen. The resulting hydrogen effectively stores renewable electricity and is quickly becoming competitive due to declining costs, both of equipment to produce it and of wind and solar power. As a new use for renewable electricity it perfectly complements variable wind and solar that power grids must sometimes turn away due to lack of demand.

HYDROGEN USES

The US currently produces about ten million metric tons of hydrogen per year, mostly for industry including oil refining, fertilizer production, and steel manufacturing. This hydrogen represents the energy equivalent of about 7% of US gasoline sales and it is nearly all derived from natural gas; renewable hydrogen can make it all *climate-neutral*.

Renewable hydrogen also provides a low-carbon, emission-free *alternative to conventional* fuels including gasoline and diesel for transportation, natural gas for heating, and all fossil fuels for power production.

ENERGY STORAGE

Using renewable electricity to create hydrogen-based clean fuels can economically store energy in quantities and for durations needed to attain 100% carbon-free power grids even when wind and sun fall short. Hydrogen can be stored in tanks, injected into natural gas pipelines, or made into fuels such as ammonia, methane, and methanol that can be stored in conventional and often existing infrastructure.

FUEL CELL ELECTRIC VEHICLES

Fuel cell electric vehicles (FCEVs) get their power from hydrogen instead of batteries. Fuel cells silently and efficiently combine hydrogen from a fuel tank with oxygen from the air to produce electricity and pure water, the only tailpipe emission.

FCEVs are twice as efficient as gasoline vehicles in converting the available energy into motion. A typical 5kg hydrogen tank holds the energy of 5 gallons of gasoline, delivers the same range as a conventional passenger car and refuels in 3-5 minutes.

The US has more than 6,000 passenger FCEVs on its roads today. It also has 20,000 fuel-cell forklifts and a growing number of heavy-duty FCEVs including buses, trucks, locomotives, ships, and even aircraft.



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HYDROGEN FUELING STATIONS

A hurdle for widespread adoption of FCEVs is access to hydrogen fueling stations, still rare in North America today. A fueling station to service about 200 passenger vehicles costs roughly \$1 million.

SAFETY

Safety considerations for hydrogen are largely similar to those for natural gas, propane, and butane. Hydrogen is highly flammable but also non-toxic, colorless, and odorless. Higher pressures in hydrogen vehicles and fueling stations call for enhanced safety precautions such as two-way communication between the fueling pump and vehicle fuel tank, along with sensitive leak detection and monitoring. The US currently handles ten million metric tons of hydrogen per year, at least as safely as other fuels.

WATER

Production of renewable hydrogen uses modest amounts of water compared with other fuels. Roughly five gallons of water are needed to make a kilogram of hydrogen, about half the water used to make an equivalent amount of gasoline for transportation.

Some is returned immediately as greywater, with impurities at higher concentrations than the supply water but with no added impurities. One-half to one-third of the water used in production is regenerated when hydrogen is consumed at the point of use, released as pure water through vehicle tailpipes or collection systems.

ELECTROLYZER COSTS

Key to competitively priced renewable hydrogen are the fixed costs of electrolyzers that split water using renewable electricity. These costs have been dropping rapidly as manufacturers increase capability and capture economies of scale. Policy supports can speed continuing cost reductions.

HYDROGEN PRODUCTION COSTS

It takes 55-60 kilowatt-hours (kWh) of electricity to make a kilogram of hydrogen. With wholesale electricity prices around 3¢/kWh, production cost of hydrogen is about \$1.80 per kilogram. A kilogram of hydrogen propels a vehicle the same distance as two gallons of gasoline, making it comparable to \$0.90-per-gallon gasoline—at the wholesale level and excluding capital costs (electrolyzer, fueling station, land and labor).