

HYDROGEN

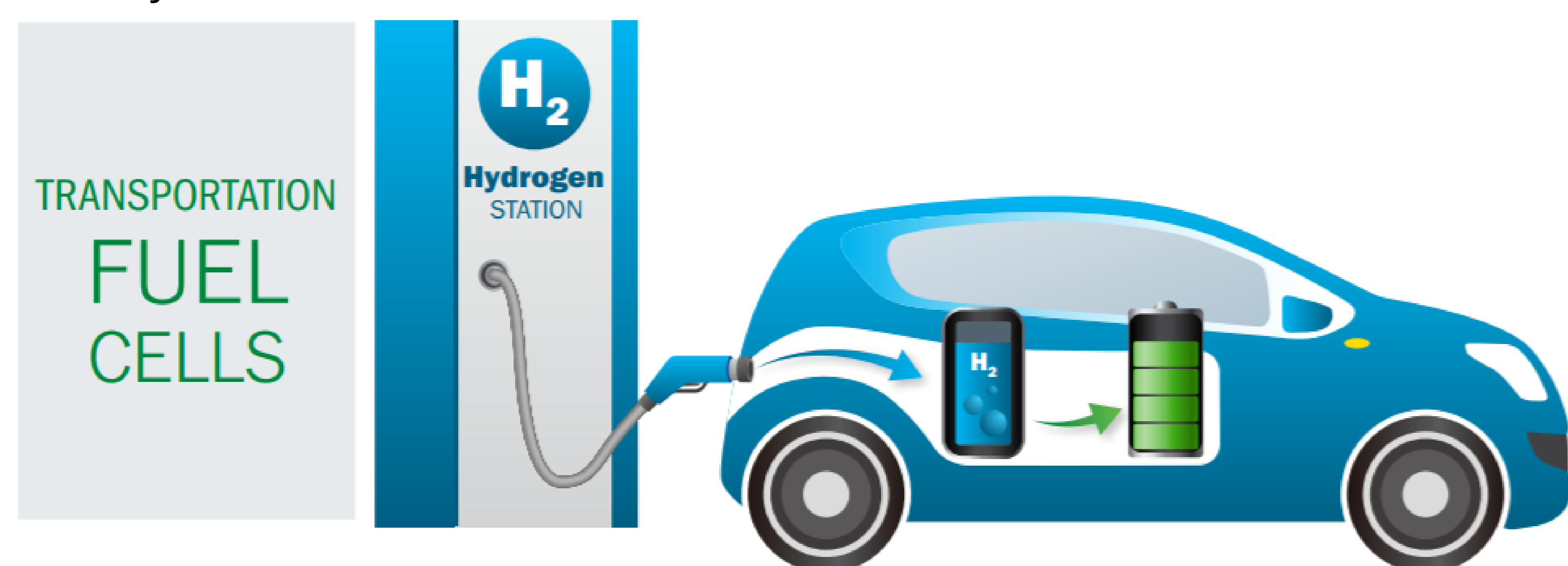


Hydrogen can be produced from diverse domestic resources with the potential for near-zero greenhouse gas emissions. Once produced, hydrogen generates electrical power in a fuel cell, emitting only water vapor and warm air. It holds promise for growth in both the stationary and transportation energy sectors.

HYDROGEN BASICS:

Hydrogen (H₂) is an alternative fuel that can be produced from diverse domestic resources. Although hydrogen is in its infancy in the market as a transportation fuel, government and industry are working toward clean, economical, and safe hydrogen production and distribution for widespread use in fuel cell electric vehicles (FCEVs). Light-duty FCEVs are now available in limited quantities to the consumer market in localized regions domestically and around the world. The market is also developing for buses, material handling equipment (such as forklifts), ground support equipment, medium- and heavy-duty vehicles, and stationary applications.

Hydrogen is abundant in our environment. It's stored in water (H₂O), hydrocarbons (such as methane, CH₄), and other organic matter. Currently, steam reforming, combining high-temperature steam with natural gas to extract hydrogen, accounts for the majority of the hydrogen produced in the United States. Hydrogen can also be produced from water through electrolysis.

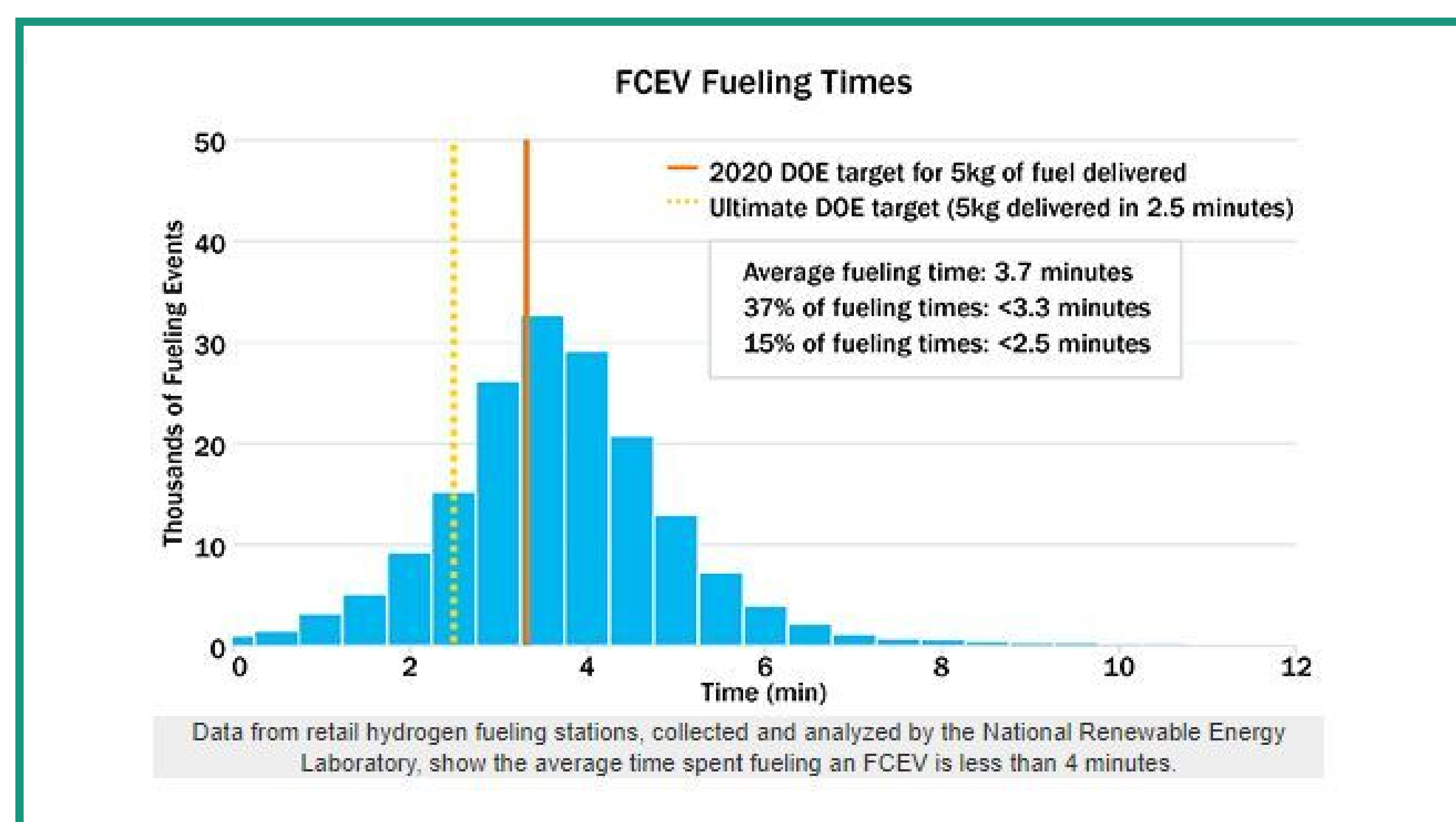


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HYDROGEN AS AN ALTERNATIVE FUEL:

The interest in hydrogen as an alternative transportation fuel stems from its ability to power fuel cells in zero-emission FCEVs, its potential for domestic production, its fast filling time, and the fuel cell's high efficiency. In fact, a fuel cell coupled with an electric motor is two to three times more efficient than an internal combustion engine running on gasoline.

The energy in 2.2 pounds of hydrogen gas is about the same as the energy in 1 gallon (6.2 pounds) of gasoline. Hydrogen has a low volumetric energy density, it is stored onboard a vehicle as a compressed gas to achieve the driving range of conventional vehicles. Most current applications use high-pressure tanks capable of storing hydrogen at either 5,000 or 10,000 pounds per square inch (psi). For example, the FCEVs in production at dealerships have 10,000 psi tanks. Retail dispensers, which are mostly co-located at gasoline stations, can fill these tanks in about 5 minutes.



HYDROGEN BENEFITS:

Energy Security

- Hydrogen can be produced domestically from resources like natural gas, coal, solar energy, wind, and biomass.
- Diversifies our transportation energy options

Public Health and Environment

- Hydrogen-powered fuel cell electric vehicles do not emit harmful substances—only water (H₂O) and warm air
- The environmental and health benefits are also seen at the source of hydrogen production if derived from low- or zero-emission sources, such as solar, wind, and nuclear energy and fossil fuels with advanced emission controls and carbon sequestration can cut greenhouse gas emissions

Fueling and Fuel Storage

- The storage capacity for hydrogen in light-duty vehicles should enable a driving range of more than 300 miles to meet consumer needs
- Fast filling time - average time spent fueling an FCEV is less than 4 minutes
- Fuel cell's high efficiency



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