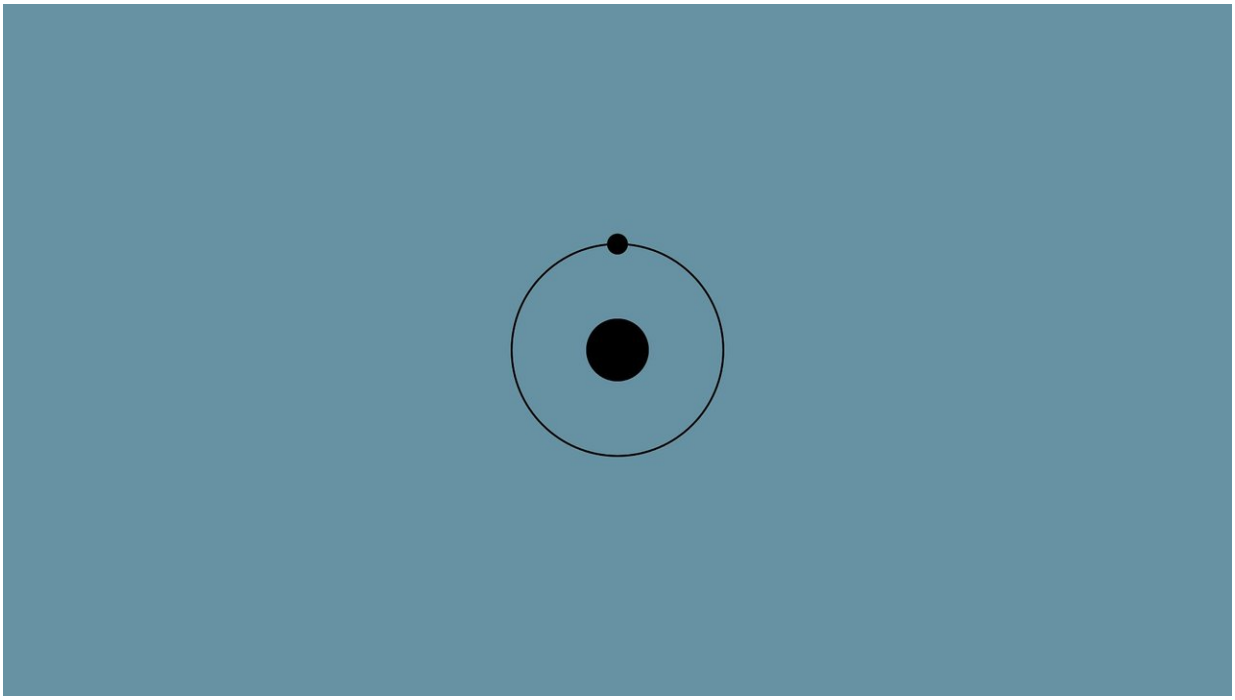
Fueling your curiosity: Answers to some of the top questions on hydrogen fuel

October 6 2022, by Savannah Mitchem



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Hydrogen represents a promising option for powerful and clean energy.

Scientists and engineers across the country celebrate National Hydrogen and Fuel Cell Day every Oct. 8, a date aptly chosen for the atomic weight of hydrogen (1.008).

Hydrogen fuel will play a role in fostering a cleaner environment and in reducing the use of fossil fuels in many industries. For example, hydrogen fuel cells are appealing as alternative power sources for vehicles, buildings and other applications due to their quick refueling time, high efficiencies, high energy densities and lack of harmful emissions or byproducts.

But before hydrogen can reach its full potential, it needs to be less expensive and easier to produce.

Scientists at the U.S. Department of Energy's (DOE) Argonne National Laboratory are working to improve performance and lower the cost of hydrogen and fuel cell technologies, with research and development solutions from the atomic to commercial scale.

As part of the national celebration, they answer common questions surrounding hydrogen as an energy carrier.

Where does hydrogen come from?

Hydrogen is the simplest chemical element, consisting of just one proton and one electron. It's also the most abundant element in the universe, constituting around 75% of all normal matter. The hydrogen molecule (two hydrogen atoms put together) contains a substantial amount of energy.

Vast amounts of hydrogen exist in water and living things, but hydrogen molecules don't typically occur by themselves on Earth. Here, hydrogen usually must be produced from other substances that contain it. Scientists currently use a variety of methods for this. A main current approach to producing hydrogen without the use of fossil fuels is to split water using nuclear energy or renewable energy sources, such as wind, solar, geothermal and hydro-electric power.

Scientists are also developing more efficient processes to support future hydrogen fuel production. One potential approach is to produce hydrogen from biomass, like bacteria and algae, by harnessing and mimicking biological processes such as photosynthesis.

What is a hydrogen fuel cell?

Hydrogen fuel cells convert the chemical energy stored in hydrogen and oxygen gas into electricity. Unlike with gasoline-fueled combustion engines, there are no carbon dioxide or other harmful emissions. The only exhaust is heat and water. And unlike with batteries, fuel cells don't require lengthy recharging.

Inside the cell, hydrogen molecules are split into protons and electrons. The electrons flow through a circuit, creating a supply of usable electricity. At the same time, the protons combine with electrons and oxygen molecules from the surrounding air to produce water and heat, the only emissions.

How can hydrogen fuel cells be used?

Hydrogen fuel technologies could be applied in many sectors of the economy. Hydrogen fuel cells can provide power for transportation, building infrastructure, energy storage for the grid and more.

For example, residential and commercial buildings could use hydrogen as backup power. Vehicles are already being powered by hydrogen fuel cells, and this technology will become more popular as the technologies improve. This applies not only to cars, but also to buses, trains, ships, planes and off-road and other heavy-duty vehicles. Retail stations across the nation could be safely storing and distributing hydrogen in the near future.

What are the barriers to large-scale implementation of hydrogen fuel?

Hydrogen presents a promising avenue for large-scale clean energy, but producing reliable, affordable and safe hydrogen comes with some challenges.

For example, clean hydrogen production often requires catalysts, which are substances that increase the rate of chemical reactions. Many of these catalysts use materials in short supply, such as platinum and iridium. There is current emphasis on developing approaches that will reduce the need for catalysts that contain these and other expensive and critical materials.

Building a national hydrogen delivery infrastructure is also a big challenge. Cities, highways, airports and more will require significant infrastructure changes to accommodate hydrogen storage, transportation and refueling.

Durability and performance also present challenges, both for the production of hydrogen from water and for the use of hydrogen in fuel cells. Under realistic operating conditions, fuel cells need to maintain performance for long periods of time (over a million miles for long-haul trucks) under all sorts of conditions.

Argonne scientists are tackling these challenges from many angles, leveraging world-class facilities and expertise to advance hydrogen science and accelerate fuel cell research and development.

Their research is making fuel cells more affordable and durable; improving the efficiency, durability and cost of fuel cell vehicles; quantifying the carbon footprint of different methods of hydrogen

production and use; and lowering the cost of hydrogen produced from the most abundant and carbon-free substance on Earth—water.

More information: Read more about Argonne's hydrogen work.

Provided by Argonne National Laboratory

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