Spotlight on Climate

Clean Electricity Produces Clean Hydrogen to Power Clean Vehicles

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(700 words)

Combustion vehicles choke our air with the noxious and deadly chemicals in their exhaust. We can all appreciate the fresh smell of clean air when we get up on the mountain or out in the forest. Wouldn't it be nice if we could breathe clean air in our cities and neighborhoods again?

Of course, the noxious fumes are the least of the problems from car exhaust. The CO_2 released from combustion vehicles is one of the biggest causes of climate change, and we hear every day about its global consequences. Couldn't we use cleaner vehicles to begin healing our cities and the Earth? In the September Spotlight we discussed electric vehicles, but how about vehicles powered by clean hydrogen?

Hydrogen from water is the cleanest fuel if we make it the right way. We know that pure water is H_2O. By running an electrical current through water, we can readily break apart the H_2O molecule into oxygen and hydrogen gas (H_2). This process is called electrolysis. When wind or solar power are used to generate the electricity, the product is called green H_2. When fossil fuels are used, we call it black, grey, or blue H_2 depending on the amount of CO_2 released. Green H_2 is the perfect fuel to power our economy because when you run it through a fuel cell it produces electricity, and the only 'exhaust' is water. There is no nitrous oxide, no carbon monoxide, no unburnt fuel, and no CO_2. Nothing but water.

What is this miraculous thing called a fuel cell? The first hydrogen-oxygen fuel cell was invented by Francis Bacon in 1932. The key part of this fuel cell is a Proton Exchange Membrane (PEM) that separates the electrons from the protons of the hydrogen atom and thereby generates an electrical current. This current can power an electric motor or do any and all of the other things that electricity can do.

So, green H_2 is clean, but how expensive is it? When you fill up at the pump, green H_2 costs about twice as much as gasoline, but Fuel Cell Electric Vehicles (FCEVs) are very efficient and get the gasoline equivalent of 65 to 75 miles per gallon. Commercial prices for green H_2 are significantly lower than what you would pay at the pump, and the Biden Administration has set a "1-1-1" aspirational goal: in 1 decade, have 1 kilogram of green H_2 cost $1 at filling stations. This will require improving the efficiency of electrolysis and an increased volume of H_2 sales, but it would further reduce the cost of driving, since one kilogram of H_2 gets you about as far as 2 gallons of gasoline. It takes about 3 to 5 minutes to fill your FCEV's tank. With a full tank your FCEV will have a range of up to 400 miles.

Three models of FCEV cars are currently available for purchase in the US. They range in price from $49 to $59k, but used FCEVs are readily available for under $30k. Globally, there are 5 models of FCEV trucks and 12 models of FCEV buses on the market. Dozens of car companies have developed demonstration models. Nikola Motors in Phoenix has developed an FCEV pickup called the Badger, with full off-road capabilities and a 600-mile range. Nikola also builds battery powered semi-trucks. A shift to H_2 would avoid the extra weight of batteries.

How available is green H_2 at the retail level? There are currently 165 green H_2 fueling stations in the US with over 4,300 expected by 2030. Fortunately, the Infrastructure Act of 2021 provides $8 billion grant funding for “Hydrogen Hubs”. The Center for an Arizona Carbon-Neutral Economy (AzCaNE) is developing a grant proposal to use such funding to build a Hub named the Southwest Clean Hydrogen Innovation Network (SHINe). This hub will demonstrate green H_2 production, transport, and sales to consumers over 5 years. Flagstaff could become one of those fueling locations where FCEV cars and long-haul trucks can purchase clean H_2 fuel.

In Flagstaff, a task force is being formed to investigate and promote H_2 availability and uses, to support the Hydrogen Hub grant process. Anyone interested in participating should contact David Spence at ds0268@gmail.com.

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