Green Hydrogen

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Introduction

Hydrogen is the lightest element, less dense than air. It is nontoxic, non-metallic, colorless, odorless and tasteless, and is highly combustible. It is prevalent on Earth in the form of chemical compounds such as hydrocarbons and water. Lighter than air, it rises and diffuses when leaked.

Hydrogen can be made by electrolysis, a process that sends an electric current through water in a device known as a electrolyzer, to split hydrogen atoms from oxygen. To count as green (carbon-free) hydrogen, the electricity used to run the electrolyzer must come from renewable sources.

Currently, most of the hydrogen used as fuel is derived by splitting it off from molecules of natural gas. That requires a good deal of energy and also produces carbon dioxide, leading some to call it gray hydrogen. Blue hydrogen is the name used if the carbon dioxide produced is captured and stored. That version is counted as a low-emission fuel.

Why the World needs Green Hydrogen

As the nations of this planet have agreed to decarbonize our economies over the next few decades in order to address climate change, we need solutions for all significant sources of carbon emissions. Green hydrogen can help in multiple ways.

First, transportation accounts for about 16 percent of the world's carbon emissions. Electrification, with the electricity generated through carbon free renewables, appears to be the leading hope of decarbonizing the majority of this sector. However, commercial aviation, cargo and cruise ships, and long haul trucking, which account for roughly one-third of transport, cannot be electrified, due to the weight and volume of the batteries that would be required. They will require a carbon free fuel. Green hydrogen could well be the solution.

Airbus has unveiled plans for a zero-emission, hydrogen fueled passenger plane, which could be in service by 2035. The concept of emissions-free aviation relies on finding ways to produce large quantities of hydrogen from renewable sources.

Second, in heavy industries, such as steel making and others that require high temperatures in furnaces, which electricity cannot generate. Replacing the fossil fuels now used in furnaces that reach 1,500 degrees Celsius (2,732 degrees Fahrenheit) with hydrogen gas could make a big dent in the 20% of global carbon dioxide emissions that now come from industry. In steelmaking, green hydrogen could replace the coal that's now used not only to heat the furnaces, but also to purify iron ore. The byproduct is water vapor rather than CO2.

Third, the world needs improved batteries to store the energy generated by renewable energy sources, so that carbon free energy can be used when the sun isn't shining and the wind isn't blowing.

Green hydrogen fuel cells are one of the options under consideration, particularly for homeowners and other small scale solar generators who may want to disconnect from the grid.

Fourth, per the literature, the current gray hydrogen product generates 830 to 1,000 million tons of CO2 annually. That's a big number and eliminating that through changing to green hydrogen is a very good goal.

Hurdles

Green hydrogen currently costs between $2.50 and $4.50 a kilogram to make, according to an analysis by Bloomberg NEF. That would need to fall below $1 a kilogram to become competitive with hydrogen made from fossil fuel. BNEF projects it will reach that level by 2030 – but that hinges not only on a vast expansion of electrolyzer capacity, but also on a vast increase in clean electricity generation. Also, as the lightest known gas, hydrogen must be compressed to send through a pipeline or chilled to a liquid state to be transported by ship, adding to the costs compared to natural gas.

Storage and distribution networks are usually an issue with new energy products. In that regard, the current network for gray hydrogen could be converted for use by green hydrogen. In addition, some of the current natural gas pipelines can be switched to serve as green hydrogen pipelines, though the pipes would need to be strengthened, as hydrogen causes steel pipes to become brittle and crack. Pipes could be protected with coatings applied from the inside by robotic devices called pigs that are currently used for pipeline inspection and maintenance.

Rolling Out Green Hydrogen

The European Union has set the most ambitious goal: building electrolyzers that are capable of converting 40 gigawatts of renewable energy into hydrogen by 2030. It's made green hydrogen a central component of its Green Deal plan, envisaging as much as $560 billion of public and private investments by 2050 in the hope of kick starting a global green hydrogen market. Germany has declared that green hydrogen will play a central role in transforming the country's industrial base as it moves to zero emissions by 2045.

Japan is the world leader in hydrogen refueling stations, while South Korea is building fueling and other infrastructure in six cities where it hopes to make green hydrogen the main energy source by 2025. Australia will invest $214 million to speed development of four green hydrogen hubs with 26 gigawatts of capacity.

In the U.S. President Biden's administration has set a goal of reducing the cost of renewable hydrogen by 80% by 2030. Industry groups, including some fossil-fuel companies, are pushing for tax credits for green hydrogen production and for subsidies for converting natural gas pipelines to transport green hydrogen.

Per Bloomberg NEF the cost of electricity will account for the majority of the cost of producing green hydrogen by 2030, with electrolyzer-related costs accounting for the rest. Also, green hydrogen should out compete hydrogen made from natural gas by 2050 in all 28 (major) countries studied, and would even cost less than natural gas on an energy-equivalent basis in 15 of those 28 countries.

Sources: Bloomberg Green News, Jeff Green power point (one may write to uusj@sbcglobal.net for a copy), Airbus news, International Renewable Energy Agency, the European Bank for Reconstruction and Development, and Bill Gates' How to Avoid a Climate Disaster