Hydrogen's Role in the Renewable Energy Transition

There are substantial opportunities and challenges as hydrogen is gaining prominence as a tool for energy storage.

CHAPEL HILL, NC - Scientists are investigating how hydrogen-powered fuel cells can be used to integrate more renewable energy into our electricity mix.

In the wake of climate change and the general consensus in the scientific community that greenhouse gasses exacerbate its effects, governments and companies around the United States have set goals to reduce greenhouse gas emissions. Research shows that one of the greatest contributors to global greenhouse gas emissions is burning fossil fuels for energy services like heating and electricity.

Hydrogen's Potential in North Carolina

In North Carolina, Duke Energy has a near-monopoly on electricity production. In response to 2021 legislation mandating a 70% reduction in carbon emissions by 2030, Duke Energy announced plans to double all renewable energy production by 2030 and completely phase out coal by 2035.

Considering that only 2% of their energy is produced by renewables and almost a quarter of their electricity is generated by coal power, accomplishing these goals requires a large-scale infrastructural shift to accomodate more renewable energy.

Since 2019, Duke Energy developed contracts with Siemens Energy and Bloom Energy to integrate hydrogen fuel cells into their energy infrastructure and accommodate renewables. However, these projects have not yet launched.

Why Hydrogen?

Using modern technologies, renewable energy, namely wind and solar, can be produced cheaply. However, renewables still face one major problem: intermittency. Simply put, solar energy isn't viable when the sun isn't shining, and wind energy isn't viable when the wind isn't blowing.

Additionally, wind and solar often produce more electricity than is needed. Without a mechanism to store this electricity, it goes unused.

Hydrogen fuel cells can help to solve both intermittency and efficiency issues associated with renewables. When the sun isn't shining and the wind isn't blowing, hydrogen fuel cells make it possible to still rely on renewable energy.

Dr. Noah Kittner, an Associate Professor at the University of North Carolina in Chapel Hill whose research is centered around the transition to sustainable energy, explains how hydrogen can help the renewable energy transition.

“You can use excess electricity that would otherwise be curtailed from wind and solar to produce hydrogen, and that hydrogen can be reconverted to electricity at a later time using a fuel cell,” said Dr. Kittner.

Few Examples of Hydrogen Fuel Cells

Hydrogen energy has only become economically viable in the last few years, so there is little public knowledge about hydrogen and few hydrogen fuel cell projects to look to.

One such project is set to be installed at the University of North Carolina in Chapel Hill this spring according to Grant Everist, a senior and student leader at UNC-CH who led the push to install a hydrogen fuel cell.

Though UNC’s hydrogen fuel cell will only power a small community garden, Everist said his team’s goal with the fuel cell project “is to shed light on the benefits that hydrogen fuel cell technology provides to the world and expose the people at this campus… it's really only within specific physics and chemistry classes that you would even come across this technology, if not on your own.”

Sustainability Issues with Hydrogen Production

Even though hydrogen itself is a completely carbon-neutral fuel, there are concerns in the scientific community as to whether or not hydrogen fuel cells should be classified as ‘sustainable’ because of how it is produced.

Presently, the cheapest and most common hydrogen used for fuel cells is blue hydrogen, which is produced by extracting hydrogen from natural gas by heating it to extremely high temperatures.

Everist likens the blue hydrogen dilemma to electric vehicles, which “don’t require gasoline, but oftentimes, [electric vehicles] are charged using charging points whose energy is generated by non renewable energy.” The technology is promising, but like with electric vehicles, there are underlying infrastructural issues that currently hinder hydrogen’s potential to be sustainable.

On average, 9 tonnes of CO_2 are emitted to produce 1 tonne of blue hydrogen, according to Dr. Feng, an Associate Professor in Chemical Engineering at Oregon State University who specializes in sustainable hydrogen research.

On balance, even though hydrogen is technically ‘carbon-free’, this means electricity from blue hydrogen produces more carbon emissions than natural gas or coal.

A Promising Solution: Using Water to Produce Hydrogen

Researchers have found a promising solution to the hydrogen production dilemma: green hydrogen, or hydrogen that is produced from water rather than fossil fuels.

According to Dr. Feng at Oregon State University, an electrolyzer can be used to split water molecules into hydrogen and oxygen. “In the daytime, we can use [renewable] energy to split the hydrogen from water, and then use the hydrogen at night when intermittent sources aren’t reliable,” said Dr. Feng in a phone interview.

Though this green hydrogen technology is promising, it is significantly more expensive than blue hydrogen. So, in the immediate future, most hydrogen storage technologies will continue to rely on blue hydrogen.

However, as governments and companies continue the push to reduce greenhouse gas emissions, green hydrogen shows promising potential to aid the renewable energy transition.