Hydrogen: The Good, The Bad, The Ugly

The urgency of the climate crisis means we must make a rapid and dramatic reorientation of our energy and electricity systems. Increasingly, hydrogen is emerging as an element that can play a significant part in a transition to clean, renewable energy and transportation systems. But the ways hydrogen is created and used are not equal. Hydrogen has been used to greenwash fossil-fueled power plants and support shortsighted, technological Band-Aid solutions like carbon capture (which merely locks us into decades more of fossil fuels). For these reasons, we must exhibit caution when hydrogen is being proposed as a panacea to climate woes and fossil fuel reliance. Hydrogen is only acceptable when it is extracted from water. This "green" hydrogen is non-polluting and has the potential to support a renewable energy and clean economy renaissance. But even then, we must assure that "green" hydrogen is not used to prop up continued fossil fuel use.

Hydrogen 101

Hydrogen for industrial use is typically produced from other compounds that contain hydrogen, such as fossil fuels, water or biomass. Like electricity, hydrogen is an energy carrier, meaning it is capable of storing and delivering energy. It also can be used to power vehicles. Depending on where hydrogen is sourced, it can be clean or dirty. To get useable hydrogen, it must be separated from the other elements it's found in, such as hydrocarbons and water.[1]

Only a small portion of hydrogen produced is used for energy purposes; most goes into petrochemical and chemical feedstock, oil refining and metal processing. But there is a growing demand for powering vehicles and creating synthetic fuels.[2] Hydrogen has the potential to support a renewable energy system and fuel zero-emission cars. How it's produced and used determines whether it's sustainable or not.

Hydrogen Production

Natural gas is responsible for over 95 percent of U.S. hydrogen production, which is subsequently used to power fuel cell electric vehicles, produce ammonia for fertilizers and other products, refine petroleum, treat metals, process foods and more.[3] According to the U.S. Department of Energy (DOE), steam-methane reforming is the most commonly-used method of hydrogen production.[4] Steam-methane reforming produces hydrogen by applying high-temperature steam to methane from natural gas. It can also use other fuel products to produce hydrogen, including ethanol, propane and gasoline.[5] Steam reformation not only relies on fossil fuel-based feedstocks, but also on fossil fuels for heat; it emits waste carbon dioxide.[6]

Nuclear energy can also be used to create hydrogen by splitting steam from nuclear plants into hydrogen and oxygen — in many ways a ploy to save a failing and dangerous industry. DOE admits that creating hydrogen from nuclear could create a new revenue stream and "help build an economic case to keep the nation's at-risk reactors up and running."[7] In November 2020, Xcel Energy and Idaho National Laboratory came together to form the first partnership of its kind pairing a commercial electricity generator with high-temperature steam electrolysis technology. The project is backed by $10 million from the DOE.[8]

Hydrogen can likewise be produced from biomass — a dirty energy source that includes archaic, polluting energy like burning wood.[9] This can also be combined with carbon capture and storage technologies (CCS), which are an expensive and false climate solution. In California, a delayed biomass facility was repurposed to manufacture hydrogen through the gasification of biomass and was equipped with CCS because of the combustion that occurs during the process.[10]

Securing a carbon-free future requires a shift towards sustainably-sourced hydrogen rather than continuing to rely on dirty and dangerous fuels. It can play a critical role in transitioning the U.S. (and the globe) towards a clean energy revolution.[11] Through electrolysis, water can be split into hydrogen and oxygen using renewably-sourced electricity. As the cost of wind and solar power continues to decline, hydrogen production from electrolysis will become a more competitive alternative to steam-methane reforming.[12]

Hydrogen's Potential

In order to be climate-friendly, hydrogen must be sourced from water and be used for sustainable purposes. Although hydrogen is an energy carrier that has the capacity to deliver and store a large amount of energy, only a small fraction is used for these purposes.[13] One huge perk is that hydrogen could provide an energy storage backup for when renewable energy is intermittent. This could also make sustainable energy supply systems more resilient and lessen overall energy costs.[14]

Hydrogen can also be used to power electric vehicles. Fuel cell electric buses (FCEBs), typically fueled by hydrogen, use a chemical reaction to produce energy in the form of electricity. Since there is no combustion involved, fuel cell vehicles do not emit toxic pollutants.[15] FCEBs are also nearly two times more fuel efficient than compressed natural gas buses.[16] While FCEBs produce virtually no tailpipe emissions, their total emissions of greenhouse gases and other pollutants depend on the source of the hydrogen.[17]

Hydrogen Glossary

Green hydrogen: Green hydrogen is the only acceptable hydrogen. The sustainable energy source is produced through electrolysis (splitting water into hydrogen and oxygen) using renewable electricity like wind or solar.[18]

Gray hydrogen: Gray hydrogen is made from natural gas through the process of steam-methane reforming.[19]

Blue hydrogen: Blue hydrogen is when carbon capture and storage, an expensive false solution, accompanies projects producing hydrogen from fossil fuels.[20]

Turquoise hydrogen: Turquoise hydrogen is produced by using methane pyrolysis, which directly splits methane into solid carbon and hydrogen. The solid carbon can then be used for industrial uses.[21]

Hydrogen's Downfall

Despite the many promises that hydrogen holds, it's being used for dirty purposes that simply perpetuate climate chaos. For one, hydrogen has helped prop up "renewable" natural gas (aka biomethane), which is just as climate-polluting as fossil fuel-based natural gas. Power-to-gas and artificial photosynthesis processes can create biomethane by transforming water into hydrogen, then combining hydrogen with carbon. Absurdly, power-to-gas technology frequently relies on renewable energy.[22] When power-to-gas doesn't use real renewable energy (like wind and solar), it typically utilizes dirty energy sources under the guise of "renewable."

Hydrogen technology is also being added to fossil-fueled power plants and painted as "green." Power producers Em-

berClear, Bailco and Danskammer, for example, are dolling out over $3 billion for power plant facilities that will initially run on natural gas, and eventually substitute gas with "green" hydrogen that is stored and produced on-site.[23] But "green" hydrogen is anything but clean when used to extend the life of dirty fossil fuel power plants.

Meanwhile, National Grid has proposed flooding its gas distribution system with "renewable" natural gas and hydrogen; the utility said that hydrogen would be converted from "renewable" electricity[24] — likely climate-polluting biomethane.

It has been suggested that large scale projects producing hydrogen from fossil fuels or utilizing fossil fuels should include CCS to reduce carbon dioxide emissions, even though these CCS-equipped "blue" hydrogen facilities are incapable of capturing all of the carbon.[25] However, CCS technology has failed, is unproven and faces insurmountable technical, financial and environmental barriers.[26] Large-scale deployment of "blue" hydrogen also means that there would be large quantities of greenhouse gas emissions dumped into the air from the extraction, production and transportation of fossil fuels. It props up dirty energy industries and is a distraction from real climate solutions, like moving to 100 percent clean, renewable energy.

Conclusion

With the climate crisis closing in on us every day, it is understandable that people are looking for quick-fix solutions. While hydrogen offers some truly unique benefits that could cleanly and cheaply support a renewable electricity system, we must be discerning when hydrogen is thrown around as a cure-all. The only way we can successfully keep our planet from tipping over the 1.5-degree Celsius threshold is by keeping fossil fuels in the ground and transitioning to 100 percent, zero-emission clean energy. Hydrogen can play a role in this, but only if it's produced from water using renewable energy like wind and solar.

Endnotes

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info@fwwatch.org
202.683.2500 (DC) • 510.922.0720 (CA)