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Democracy Dies in Darkness

CLIMATE SOLUTIONS

Clean energy superstar or smokescreen for fossil fuel use? Here's what you need to know about hydrogen.

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Hydrogen, the lightest and most abundant gas in the universe, is increasingly being used as a fuel.

The gas releases relatively few planet-warming emissions as a fuel source, and proponents say it could be key in the fight to curb climate change. Yet others warn that using hydrogen as fuel could do the opposite.

The Clean Hydrogen Future Coalition website calls it an "Energy Superstar," and the International Energy Agency (IEA) calculated that demand for hydrogen has more than tripled since 1975.

"There is tremendous excitement around the globe," said Paula Gant, senior vice president for strategy and innovation at GTI, an organization aiming to unlock the potential of natural gas and other energy resources. "The moment has arrived for hydrogen."

But some urge caution, noting that almost all the hydrogen currently produced is derived from fossil fuels, especially natural gas. And a study published last year found that, if those embodied emissions are considered, purportedly "clean," hydrogen can have a greater climate impact than natural gas or oil.

"The environmental benefits of hydrogen are hotly debated right now," said Johanna Neumann, senior director of the Campaign for 100% Renewable Energy at Environment America.

Here are some answers to questions about hydrogen fuel.

What is hydrogen and how can it be used?

Hydrogen infamously burst into the public consciousness on May 6, 1937, when the Hindenburg airship exploded. The ill-fated blimp was docking in New Jersey after a multiday journey from Germany. The explosion, captured on film, killed 35 people.

While inflatable airships are now largely an antiquity, the flammable, light gas has more recently been used as an energy source. That happens in two primary ways: Hydrogen can be burned, or combusted, similar to natural gas or oil. It can also be used in "fuel cells," where hydrogen and oxygen mix in a reaction that creates electricity. And there is a litany of both realized and proposed uses for hydrogen, from heating homes to powering airplanes.

As of October, hydrogen fuel-cell power generators were in use at 113 sites across the United States, according to the U.S. Energy Information Agency. Other facilities have started to burn hydrogen to create electricity, as well.

Automakers have also put fuel cells into cars and other vehicles with a handful of models on the lot. The 2022 Olympic Winter Games in Beijing, for instance, used hundreds of hydrogen fuel-cell buses. And, last year, the Swedish company SSAB announced that it had produced the world's first "fossil-fuel free" steel using hydrogen produced with renewable energy — Volvo is putting the steel into construction equipment.

What are the different ways to produce hydrogen?

According to the IEA, hydrogen production relies "almost entirely" on fossil fuels, particularly natural gas. The most popular production method is known as "steam methane reforming," where methane — which is the primary component of natural gas — reacts with high-pressure steam to produce hydrogen, carbon monoxide and carbon dioxide.

Hydrogen is commonly referred to on a color spectrum, and when produced from natural gas it's known as "gray" hydrogen. There is also "blue" hydrogen, which also uses natural gas, but the carbon dioxide that's released during the process is, to varying degrees, captured instead of emitted.

It's also possible to use electricity to split water into hydrogen and oxygen — ideally using electricity from renewable sources. "On the color spectrum, that's green hydrogen," said Frank Wolak, president of the Fuel Cell and Hydrogen Energy Association.

There are a number of other stops on the color wheel as well, such as "brown" hydrogen, which comes from coal gasification, and "pink" hydrogen, which is produced when the electricity comes from nuclear power. But, whatever the nomenclature, the resulting hydrogen is molecularly the same.

Is hydrogen fuel cost-effective?

The cost of hydrogen, compared with that of other energy sources, ranges considerably by location, said Daryl Wilson, the executive director of the Hydrogen Council. While it may be approaching parity in some places, in others it may still be far more expensive than more traditional alternatives. At pumps in California, for instance, the analyst

still be far more expensive than more traditional alternatives. At pumps in California, for instance, the analyst company S&P Global Commodity Insights found that as of December 2021, hydrogen prices were about twice that of diesel.

Green hydrogen also remains far more expensive than hydrogen made from natural gas, said Wilson, explaining that green hydrogen costs around $5 per kilogram, whereas blue hydrogen can be less than $2 per kilogram. While he sees that changing over time, he predicted that in the near term, "there will be a significant uptake in blue hydrogen."

How climate-friendly and efficient is hydrogen?

The potential emissions savings from hydrogen is broadly a function of how it's produced, how it's used and what energy source it's replacing.

With a hydrogen fuel cell, the only emissions are water vapor. Greenhouse gas emissions are also relatively low when hydrogen is burned, but there are other air pollutants released such as nitrogen oxides, which are precursors to smog, said Mark Jacobson, a professor of environmental engineering at Stanford University.

As for production, green hydrogen generally results in fewer planet-warming emissions than hydrogen produced from fossil fuels. But even that process can be very energy intensive, explained Neumann, with Environment America — much more so than using renewable electricity directly. "We may get more decarbonization bang for the buck in the short run by using renewables for other purposes than to create hydrogen," she said.

Despite the embedded emissions, many countries — including the United States — consider blue hydrogen to be a "clean" fuel, as well, though production remains very limited, and it's unclear how effective carbon capture technology can be.

"I'd love to have carbon capture, but we don't have the technology because we really haven't gotten to that point," Sen. Joe Manchin III (D-W.Va.) told E&E News last fall about the technology broadly. "And it's so darn expensive that it makes it almost impossible."

There is also an effort to move away from the color scheme for classifying hydrogen toward more specific measures of emissions. "The carbon intensity is highly variable, even within the same technology," said Zane McDonald, executive director of the recently launched Open Hydrogen Initiative, a collaboration among GTI, the Energy Department's National Energy Technology Laboratory and S&P Global Commodity Insights. Policy decisions, McDonald argued, require more granular information, and the goal is to arrive at a more straightforward metric such as kilograms of carbon dioxide per kilogram of hydrogen.

"As the conversation around hydrogen matures," he said, "we see a need for a greater level of transparency."

Jacobson, however, hopes that initiative is not merely "a way to justify the use of fossil fuels as a source of hydrogen." He's the co-author of the study that found that when the full production process is taken into account, the "greenhouse gas footprint of blue hydrogen is more than 20 percent greater than burning natural gas or coal for heat and some 60 percent greater than burning diesel oil for heat." That's in part because the carbon capture equipment itself takes energy to operate.

Jacobson is among those who argue for a relatively limited use of hydrogen, such as in certain industrial processes and long-distance heavy-duty vehicles or aircraft, which are all stubborn areas to decarbonize in other ways.

While hydrogen is one way to store and transport renewable energy, Thomas Longden, an environmental economist at Australian National University who has researched hydrogen emissions, said that efficiency improvements and electrification should be a higher priority than switching to hydrogen.

"If you can use electricity, there's less energy loss," said Longden, also emphasizing that hydrogen should be reserved "for those difficult to abate applications." As Wolak put it, "you need hydrogen to decarbonize sectors that electricity cannot reach."

Who supports hydrogen fuels? Who is against it?

The bipartisan infrastructure bill that Congress passed last fall included $9.5 billion for the development of hydrogen. The bulk of that money — $8 billion — is aimed at developing four regional production hubs across the country for clean hydrogen.

The legislation requires that one hub be located in Appalachia, and West Virginia has already formed a working group to compete for that slot. "Clean hydrogen is a game-changing fuel that we can produce right here at home from our abundant resources," said Manchin at a recent Senate Energy and Natural Resources Committee hearing. That included natural gas, he said. And, despite earlier reservations about carbon capture technology, he added that it would be part of the path to ensuring that "hydrogen is produced from all of these domestic sources in the cleanest way possible."

The Clean Hydrogen Future Coalition was "extremely supportive" of the congressional investment. The group's board includes companies such as Shell, BP and Chevron, as well as the American Gas Association trade group, among others. The coalition's president, Shannon Angielski, is a principal at government relations firm Van Ness Feldman; the group spent at least $100,000 in hydrogen-related lobbying in 2021, according to disclosure forms.

Yet others, including members of Congress, see widespread use of hydrogen as a potential climate threat.

"We must be attentive to the reality that not all hydrogen is clean and reject efforts to further subsidize dirty hydrogen," wrote 19 liberal members of Congress in a letter to Democratic leadership in October. Rep. Alexandria Ocasio-Cortez (D-N.Y.) tweeted: "Blue hydrogen has worse emissions than coal, locks in more powerful climate destruction than what we're doing now."

Environmental advocacy organizations such as the Sierra Club and the NRDC have also stressed a measured approach to hydrogen. So have some scientists.

"Blue hydrogen is basically a smokescreen for more air pollution, mining [and] fossil fuel use with hardly any carbon dioxide benefits," Jacobson said. "We should only use green hydrogen, and it should only be used for certain applications."