Green hydrogen could be the fuel of the future. Here's why it's not yet a silver bullet

By Angela Dewan, CNN

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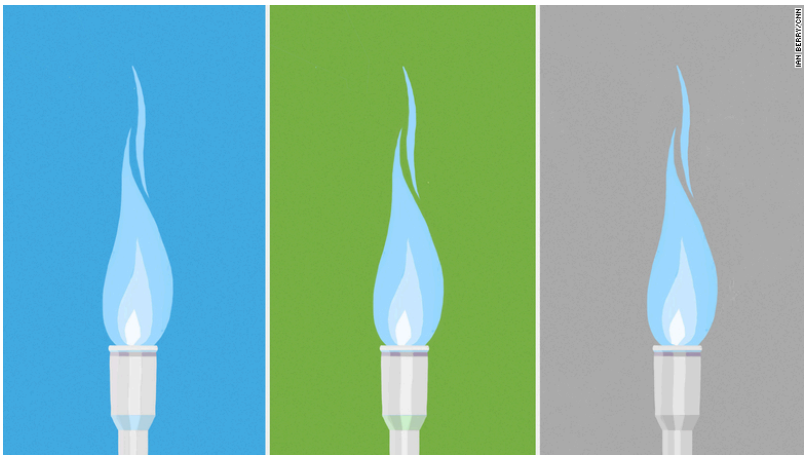

Green hydrogen is seen as a potential solution for heavy industries that can't depend on other clean energy sources, like wind and solar.

(CNN) As the climate crisis escalates, the world is banking on carbon-free energy to achieve a future with zero greenhouse gas emissions, or a net-zero future, where we remove just as much greenhouse gas from the atmosphere as we emit.

One potential form of clean energy is green hydrogen -- which can be derived from sources like water, rather than fossil fuels, and is produced with renewable energy. It can be used to power heavy industry and fuel large vehicles, like planes and ships.

Facilities to produce this cleaner form of the gas have popped up across the globe -- in the United States, western Europe, China, Australia, Chile

and South Africa, among other countries. The burgeoning global green hydrogen market is projected to be worth $11 trillion by 2050, by Goldman Sachs' estimates.

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But critics of green hydrogen say using solar or wind energy to produce another fuel right now is a waste of precious renewables, as the world struggles to transition away from fossil fuels. At the same time, plans to use blue hydrogen -- which is produced using fossil fuels -- are coming under increasing scrutiny.

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Why do we need green hydrogen?

A big part of the shift away from fossil fuel involves electrifying some of the everyday machines we use that are powered by oil and gas -- cars and local transport, and heating for homes in some countries, for example. For those already electrified, like computers and home appliances, electricity from nuclear and renewables like wind and solar are replacing coal.

But there are some industries that require so much energy that traditional renewables can't meet their demand. That's a problem, because those industries are among the top emitters of greenhouse gas. This is where experts say green hydrogen has huge potential.

"Electricity from sources such as wind, solar and nuclear is essential for decarbonising our energy system -- but it cannot do it alone, and long-distance transport and heavy industries are home to the hardest emissions to reduce," said Uwe Remme, an energy analyst at the International Energy Agency.

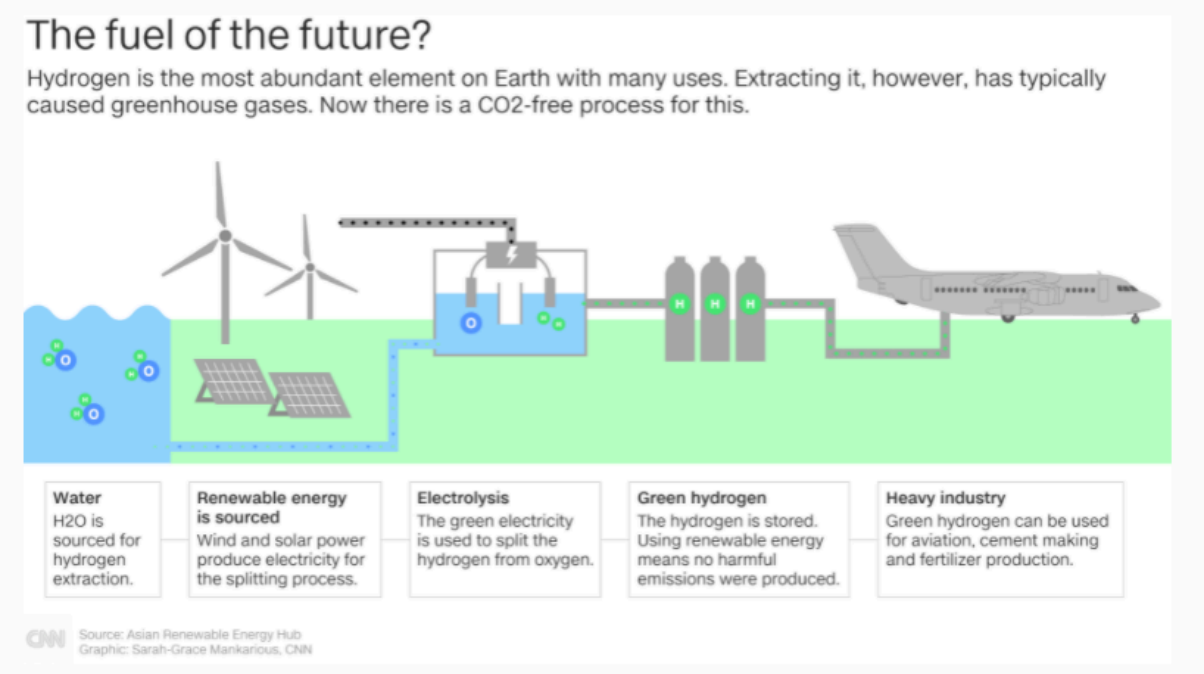
"Hydrogen is versatile enough to fill some of these critical gaps -- in providing vital feedstocks for the chemicals and steel industries or crucial ingredients for low-carbon fuels for planes and ships," Remme told CNN. Operating a plane or a large ship, for instance, requires so much energy that any battery used to store electricity from solar or wind would likely be too large and heavy for the vessel. Green hydrogen, on the other hand, can come in liquid form and is lighter. According to Airbus, which is developing a zero-emissions commercial aircraft, the energy density of green hydrogen is three times higher than jet fuels we use today.

Start-up aviation company ZeroAvia flew the world's largest aircraft powered by a hydrogen fuel cell at Cranfield Airport in England on September 24, 202, to demonstrate the potential of hydrogen as a jet fuel.

While liquid green hydrogen would emit zero carbon, it has some limitations. When burned in the open atmosphere it releases a small amount of nitrous oxide, which is a potent greenhouse gas. If the

hydrogen is fed through a fuel cell, however, it will only emit water and warm air.

Some small planes have managed to fly with hydrogen-fed fuel cells, though the technology hasn't yet been scaled up commercially.



Green, blue or gray?

Hydrogen is Earth's most abundant element. It's found in many things, including fossil fuels, water, plants, animals and even humans, but it never appears naturally in pure form. That means to get pure hydrogen, it needs to be separated from other molecules through processes that also require energy.

Green hydrogen is produced when renewable energy is used to derive the hydrogen from a clean source. This most commonly involves the electrolysis of water -- sending an electric current through the water to separate molecules.

Gray hydrogen is the most commonly used form of hydrogen today. It is relatively inexpensive, but is derived from natural gas and typically uses fossil fuels as the energy source. It's used mostly in the chemical industry to make things like fertilizer, and for oil refining. In the process of extracting the hydrogen from natural gas, the remaining carbon dioxide is allowed to escape into the atmosphere, which further contributes to climate change.

Blue hydrogen is generated with the same process as gray hydrogen, but most of the carbon emitted during its production is "captured" and not released into the atmosphere, which is why it's described as a low-emissions gas.

So, which one is the best climate solution?

It ultimately depends on the energy used to produce it.

Gray hydrogen has long been seen as a cleaner "bridging" alternative as the world weans off coal and oil, but it's still a major contributor to climate change.

Recent studies have also shown that gray hydrogen emits more greenhouse gas than energy experts initially thought. Methane, a powerful greenhouse gas and the main component of natural gas, often leaks from pipelines into the atmosphere.

A hydrogen electrolysis plant operated by Linde AG, in Mainz, Germany, on July 17, 2020.

If green hydrogen generated from water and the electrolysis process to extract the hydrogen molecules is powered fully with energy from renewable sources like solar and wind, then green hydrogen could be a zero-emissions option.

But it's not there yet.

The machines used to carry out this electrolysis are costly and the process isn't particularly efficient.

In 2020, of all the low-carbon hydrogen produced, 95% of it was blue, according to a recent report from the IEA. But by 2050, as the green-hydrogen industry develops, it should be more readily available, easier to produce and cost competitive with blue hydrogen by 2030, the IEA reports. By 2050, the share is projected to be 35% blue hydrogen and 62% green, providing governments and businesses are successful in developing the industry.

Jess Cowell, a campaigner with Friends of the Earth Scotland, is opposed to any use of blue hydrogen, saying that it simply allows fossil fuel companies to stay in business and keep emitting. There may be a future for green hydrogen, Cowell said, but now is not the time to invest in it.

"You run the risk of diverting existing renewable capacity to green hydrogen generation, and right now, that's an incredibly inefficient process," Cowell told CNN.

A bus powered by gray hydrogen in London, England, on Sept. 11, 2020.

It doesn't make sense right now, Cowell explained, to use hydrogen for purposes like heating homes, which is being discussed in the United Kingdom as an option. If renewable electricity sources are being used to create hydrogen.

"So what we want to see is using that renewable electricity for direct electrification," Cowell said, explaining that the gas-fired boilers typically

used to heat homes in Scotland and the UK more widely should be electrified and run on wind and solar energy, rather than hydrogen.

Why is blue hydrogen controversial?

Blue hydrogen has been controversial in many countries, including the UK, where the government recently released its "twin-track" hydrogen strategy, which showed heavy use of the blue kind alongside development of green hydrogen.

The UK's chair of the Hydrogen and Fuel Cell Association, Chris Jackson, resigned in mid-August after the plan was published, saying in a statement to CNN the strategy was not consistent with his "personal views on the role of hydrogen in the transition to a net zero world."

Jackson is also the CEO and founder of Protium Green Solutions, which has a focus on renewables and green hydrogen.

Jackson said in the statement that he appreciated that green hydrogen was not a silver bullet.

"Equally, I cannot ignore or make arguments for blue hydrogen being a viable and 'green' energy solution (a fact also validated by external studies)," he said.

One such study -- which was published in Energy Science and Engineering in early August and has been peer reviewed -- found that while blue hydrogen emitted 9-12% less carbon dioxide than gray hydrogen, it actually emitted more methane than natural gas itself.

Overall, blue hydrogen's greenhouse gas footprint was 20% larger than burning natural gas or coal for heat, and 60% greater than burning diesel oil for heat, the study found.

There are also some questions around whether storing carbon after it's captured, which usually involves injecting it into the ground, is sustainable.

"Our analysis assumes that captured carbon dioxide can be stored indefinitely, an optimistic and unproven assumption. Even if true though, the use of blue hydrogen appears difficult to justify on climate grounds," the study concludes.

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Remme, from the IEA, however, said that study made some assumptions that underestimated how much greenhouse gas could be captured, and that even if blue hydrogen were not as clean as the green type, it had a place in the world's transition away from fossil fuels.

"There is a role for both blue and green hydrogen, but we have to ensure that blue hydrogen is produced with the highest environmental standards," he said. "The technologies are already available today to avoid these emissions, and they are often also cost-effective and save money."