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Why the hydrogen future is not imminent

Economy-altering breakthroughs take time

By Jason Hayes and Joshua Antonini | February 2025

Could the United States be standing on the brink of a "hydrogen economy"? While the dream of meeting our energy needs through so-called green hydrogen does not seem likely to come true anytime soon, many progressives see a possibility that the First Element may succeed where wind and solar power have so far failed.

The Rocky Mountain Institute, a prominent alternative-energy nonprofit, imagines that "hydrogen will be the building block of the clean energy economy," replacing fossil fuels in fuel, energy storage, grid balancing, industrial heating, feedstock chemical usage, and more.

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There's just one catch: getting the hydrogen.

Energy and market analysis group Doomberg notes the crucial basics of hydrogen production: "Hydrogen is not a source of energy, it is a carrier of energy, and not a particularly good one at that," Doomberg writes. "As a general rule, it takes about twice as much energy to produce hydrogen than can be usefully extracted from it."

Hydrogen has historically not been known to exist alone in nature, being highly reactive and bonding with oxygen in the air to form water, H20. As a result, energy must be expended to take hydrogenous compounds like water or methane (CH4) and isolate the hydrogen.

A magazine from the Society of Petroleum Engineers classifies how hydrogen is produced with an informal color categorization scheme that notes the supposed cleanliness levels of the process. This scheme "began by assigning green and gray 'colors' to hydrogen to distinguish between a 'nonpolluting' hydrogen production and one with associated carbon dioxide emissions." The color chart generally uses dark neutral tones (black, grey, brown) for fossil-fueled production and vibrant hues (green, yellow, pink) for alternative energies.

The overwhelming majority of hydrogen — 95% — is produced using natural gas. Whether carbon capture is involved determines if hydrogen is considered blue or gray. Green hydrogen is believed to have the lowest impact. But hydrogen production — of any color — still leaves a net energy loss.

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What if the hydrogen didn't need to be produced? Geologists around the globe have discovered significant deposits of naturally stored geologic (white or gold) hydrogen. (The informal hydrogen color categorization scheme does not officially name new forms of hydrogen production, so while some call geologic hydrogen white, others call it gold.) More than 50 new companies have formed to find and extract it, and the United States Geological Survey has thrown its weight behind geologic hydrogen's viability.

But right now, no commercial well or mine exists for geologic hydrogen.

With all these drawbacks, it's fair to ask whether hydrogen technologies can be considered shovel-ready. Are there reasons to believe hydrogen could be an energy solution?

Doomberg gives one ironic reason. "A sure-fire signal that humanity may be on the verge of a primary energy breakthrough is that environmentalists are already lining up to oppose it," the analyst writes. The California Air Resources Board has labeled hydrogen-powered trucks a "dead-end technology" because combusting hydrogen can still produce trace pollutants. To California regulators, "a hydrogen combustion engine does not meet the definition of a (zero emissions vehicle)."

Though it has not won over environmental regulators and faces stiff practical challenges, hydrogen could be a part of America's energy mix. Plenty of companies are out there driving innovations and doing important research. Sometimes, innovative bets pay off and make a significant difference — fracking being a very prominent example. However, the news media almost always looks at developing technologies through green-colored glasses.

A more realistic view recognizes that while technologies like fracking and products like lithium-ion batteries have been major breakthroughs, they took decades to reach their current state. In our paper "The Truth About Natural Gas," we discussed the decades-long progress of fracking from an expensive, trial-and-error idea in the 1980s to the refined and efficient option we rely on today. While lithium-ion batteries are ubiquitous in handheld gadgets, they still rely heavily on government intervention to promote, subsidize, or mandate their use in electric vehicles or as a backup power source at the utility scale.

Hydrogen is undergoing a transformation from an energy loser to a power source. But in a free economy, all kinds of energy are potentially open for use. Even after both the Obama and Biden administrations worked to outlaw coal, it remains a significant portion of our electricity supply. White/gold hydrogen has a great shot to be another source of energy, another option. But a green hydrogen-dominated future currently exists only in progressive fantasies.

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