Perspective

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Gaslighting green hydrogen

By Wade Graham

Miles Bron, the billionaire entrepreneur played by Edward Norton in the hit Netflix movie *Glass Onion: A Knives Out Mystery*, was clearly modelled on Silicon Valley megalomaniacs like Elon Musk, who believe they have invented the future and will own it, too. Holding up a small, whitish crystal, "bro" Bron pronounces to his assembled friends: "That's a new solid hydrogen fuel. It's incredibly powerful. It's radically efficient. Zero carbon emissions... it's going to be powering people's dreams all over this country by the end of this year." Then ensues an Agatha Christie-style murder whodunnit, set in a sprawling tech villa on Bron's private Greek island. The crystal, branded Klear Blanc, plays a minor but memorable pyrotechnic role.

The word hydrogen alone conjures a near-alchemical promise of unlimited power: it is the simplest, lightest element, each atom with just one proton, the most abundant element in the universe, with the highest energy content by weight of any common fuel. The sun is a big burning hydrogen ball. Many believe hydrogen will be the key to moving to a zero-carbon world. But the element H also conjures the threat of vast, out-of-control destruction: the *Hindenburg* disaster, the hydrogen bomb.

Is hydrogen our saviour from global warming? Is it overblown investor hype, from the Miles Brons of the world? Is it instead a dark, Trojan horse rolled to our unsuspecting threshold by the oil and gas industry? It just might be all of the above.

The hydrogen conversation can indeed be confusing. In the energy context hydrogen isn't one thing: there are different ways of making, using and storing it, and with each come different climate implications.

Today, most man-made hydrogen is derived from fossil fuels – called "grey" hydrogen: made by breaking down methane (natural gas) with super-heated steam, yielding hydrogen gas (H2) and carbon dioxide (CO2). Ninety-five per cent of US hydrogen is currently made this way; 60 per cent is used in oil refining, 30 per cent to make ammonia for fertiliser, and the rest for chemicals and industrial processes. Industries have decades of proven technical mastery in making, storing, moving, and using it. Its safety record is excellent – so we can put aside the *Hindenburg* scenarios. But fossil hydrogen is terrible from a climate perspective: for every kilogram of grey hydrogen produced, nine kilos of CO2 are released. While the oil and gas industries tout grey hydrogen as a necessary "transition" to something better, any broader role for it would be putting the fox in charge of the henhouse and getting in the way of real progress.

> Polluting industries have lately been busy generating a sinister rainbow of false alternatives

The opposite of "grey" is "green" hydrogen: made by water electrolysis, where an electric current is run through H2O to split it into H2 and O2. The H2 gas can be stored until it is turned back into energy, either by burning it for heat or into electricity again chemically, at room temperature, in a fuel cell, with the byproduct being pure water. It is an incredibly simple and elegant exchange – even I can begin to understand it. The cycle emits zero carbon, so long as the electricity used is made with true renewables – wind, solar, geothermal, or tidal – not biomass, nor hydroelectricity, which are called renewable but aren't carbon-free. As there is currently no single definition of "green" hydrogen, this gap is where the confusion, and the gaslighting, begins.

Polluting industries have lately been busy generating a sinister rainbow of false alternatives. "Blue" hydrogen is the same as "grey", but the carbon emissions are to be captured and stored. Never mind that so-called CCS, carbon capture and sequestration, sounds good but is logistically and economically unfeasible at real-world scales, and is undoubtedly the oil and gas industry's biggest and potentially most profitable sleight of hand / lie in the climate mitigation debate. "Turquoise" is also the same as grey, but would use a new, unproven-at-scale process of methane pyrolosis, allegedly consuming less energy than steam – a distinction without a difference. "Pink" (also called "purple" or "red") is hydrogen to be produced with nuclear-generated electricity, bringing with it the long-term poison waste problems of nuclear. Finally, there is, inevitably, "Black" (also called "Brown") hydrogen, to be produced by processing dirty lignite coal to release hydrogen or burning coal to power the steam-methane process. This would in all likelihood be Vladimir Putin's number-one choice.

Is renewable "green" hydrogen a climate silver bullet? No. Hydrogen is an energy "carrier" not a primary energy producer like coal. It may be the most abundant element in the universe but is either a diffuse atmospheric gas or is molecularly tied to most everything else on earth. To isolate it, it must be made, and the making currently incurs a net energy loss of 20-40 per cent. In spite of this, it is ideal for capturing surplus power when renewable ▸

Walden

output exceeds grid demand: a common occurrence in windy and sunny places. With purpose-built renewable generation, it is a way to store and move huge quantities of renewably produced energy, with no need for batteries or transmission lines. And, because of the extreme efficiency of converting hydrogen back to energy and the extreme inefficiency of burning fossil fuels, where 80 per cent or more of the energy is wasted as heat, the maths favours hydrogen over the full cycle.

That said, direct electrification with renewable power is best – plug it right in, where possible. But, for "hard-to-electrify" sectors, including shipping, aviation, ferries, heavy rail, steel, cement, and fertiliser, where massive scales and high temperatures mean that the same battery technology that propels a Tesla at frightening speeds can't be scaled, hydrogen is the likely best answer. The same goes for heavy vehicles where batteries would be far too big – lorries, trolleys and trams. Fuel cell electric is probably the best answer.

We are already running things on hydrogen: fuel cell forklifts predominate in many warehouses where combustion emissions would asphyxiate workers, and bus fleets, ferries and passenger cars are running on hydrogen all over the world. Let's not forget that most space rockets have hydrogen engines, while spacecraft, ever since the Gemini and Apollo programs, have used hydrogen fuel cells for power; the International Space Station splits water into oxygen for breathing and hydrogen for fuel. Even dirty power plants now running on gas can fairly easily be converted to burn hydrogen – putting the lie to the lie that we need natural gas as a bridge fuel for "when the wind isn't blowing and the sun isn't shining". Hydrogen makes that cliché obsolete.

Hydrogen, as they say in LA, has issues, but it isn't its issues. Direct burning for power releases toxic nitrous oxides, just as burning anything else does. This brings with it health and environmental justice concerns for communities near power plants or large industrial emitters – which is no change from the status quo. The gas, like methane, also likes to leak out, and has a potential for climate damage through secondary chemical reactions, but these are nowhere near as dire as those of methane, much less CO2. Nevertheless, we will need to design and construct tight storage and transport systems. And to minimise transport distances, it will be best to produce hydrogen close to where it will be used. Accordingly, hydrogen "hubs" where production is linked to end uses are being designed and built now in Europe, North America and Asia.

The main takeaway is to do hydrogen but to do it right – not like Miles Bron. And to unequivocally reject any colour but green – all the others are wolves in sheep's clothing.

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