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EXPERTS IN GLOBAL INVESTING

Green hydrogen is central to plans to achieve net zero

A cost disadvantage needs to be overcome first.

The US has launched a 'hydrogen shot' known as '111' for one dollar for one kilo in one decade.[1] The UK intends to be the "Qatar of hydrogen".[2] Japan wants to be a "hydrogen society".[3] China, with 53 projects underway, is a "potential hydrogen giant" in a world where more than 350 hydrogen projects are proceeding as US$500 billion is invested by 2030.[4] Australia's government is investing A$1.2 billion to fulfil a national hydrogen strategy,[5] announcing A$275 million in its latest budget to create four 'hydrogen hubs' to generate producer economies of scale. [6] New South Wales is dangling A$3 billion in incentives to encourage A$80 billion of investment to make the state an "energy and economic superpower".[7]

Similar promises gush from Canada, the EU, France, Germany, the Netherlands and South Korea to total at least 50 worldwide,[8] while Queensland could soon be the site of the world's largest 'green' hydrogen plant. Fortescue Future Industries says it will spend A$114 million initially, and possibly more than A$1 billion in time, to build the world's largest electrolyser facility that through the process known as electrolysis would double the world's green hydrogen production capacity.[9] "Green hydrogen can save us," Fortescue proclaims.[10]

Green hydrogen is certainly central in the drive to net-zero emissions because electrolysers that split water into its two elements of hydrogen and oxygen produce energy that is emissions-free; the only by-product is water vapour when it's used as a fuel. As well as being a clean fuel that burns to high temperatures, green hydrogen is an energy carrier and an input ('feedstock') for synthetic fuels. The combustible element is light and energy dense by weight (2.6 times more energy than natural gas per kilo). It can be stored and transported.[11]

Hydrogen might be the most plentiful element in the solar system but it is only found in nature as a compound. That can be in gas, liquid or solid form. The element must be extracted; this is to say, manufactured. 'Green', 'renewable' or 'clean' hydrogen means the element was extracted from compounds using renewable power. The 'green' distinguishes these clean molecules from cleanish 'blue' hydrogen and dirty 'brown' hydrogen.[12]

Brown hydrogen is derived when CO2-polluting fossil fuels react with steam during a simpler and cheaper extraction process called steam methane reformation. (It's called 'grey' hydrogen when natural gas, usually methane, is used.)[13] Almost all the hydrogen produced today is dirty hydrogen, which has found niche use for decades in oil refining and to produce ammonia for explosives and fertiliser.[14] Blue hydrogen is hydrogen obtained using fossil fuels, typically natural gas, where the carbon produced is captured and stored to make it a low-emissions energy source.

According to the global industry body, the Hydrogen Council, announced clean hydrogen production capacity will boost production to 11 million tons by 2030. If achieved, that would be an increase of 450% on 2019 levels and compares with (almost all dirty) hydrogen production today of about 70 million tons. About 70% of the flagged production by 2030 would be green hydrogen, while the other 30% would be blue. While most of the hydrogen produced today is used near where it's made, by 2030 about 30% of the hydrogen produced is expected to be transported via ships or pipelines.[15]

Like fossil fuels, hydrogen (when combined with a fuel cell, the reverse process of electrolysis) can be combusted for industrial and household use and in stationary and mobile applications, including as hydrogen-power cells for electric cars, and is especially suited, advocates say, for heavier transport such as planes, rockets, ships and trucks. Hydrogen, first used to propel the earliest internal combustion engines 200 years ago is poised to help the world fight climate change for two main reasons.

One is that clean hydrogen helps to overcome the biggest disadvantage of renewable energy. Solar and wind power are unreliable because they rely on intermittent sources of energy. Hydrogen can make renewable grids reliable because it is easily stored as an energy source and dispatched when needed.

The other advantage of hydrogen is that it can replace fossil fuels used in manufacturing where furnaces need to reach 1,500 degrees Celsius. That hydrogen can replace the fossil fuels blamed for 20% of global carbon dioxide emissions means the element is the 'missing link' in decarbonising the 'hard-to-abate' areas of manufacturing, where electricity is not suited to generating the heat required. Such industries include agriculture, aviation, chemical manufacturing and steel making.

Another benefit of hydrogen is strategic. A report in 2020 from Harvard University's Belfer Center judged the countries best placed to dominate renewable hydrogen will be those with the infrastructure in place and lots of accessible fresh water – nine litres of water is needed to produce one kilo of renewable hydrogen. It so happens that liberal democracies such as Australia, Norway and the US are hydrogen friendly. This means western powers will be less reliant on authoritarian states such as Russia and Saudi Arabia that are the world's biggest exporters of fossil fuels. "The reshuffling of power could significantly boost stability throughout global energy markets," the report says. [16]

What's not to like about hydrogen? The element's big drawback is that it is more costly than dirty alternatives because it is expensive to manufacture. As a general rule, renewable hydrogen is about two to three times more costly to produce than fossil-fuel-based hydrogen.[17] In the EU context, green hydrogen costs from 2.5 to 5.5 euros a kilo versus 1.5 euros a kilo for brown hydrogen and 2 euros a kilo for blue.[18] In the Australian context, the cost of green hydrogen needs to plunge from an estimated A$8.75 a kilo now to below A$2 a kilo to be as cheap as fossil fuels. For the US to achieve its 111 shot, the cost of clean hydrogen must plummet by 80% from US$5 a kilo.

Reducing the cost is the defining challenge of green hydrogen – that the cost of solar photovoltaics plunged 82% from 2010 to 2019 provides much encouragement.[19] The hydrogen industry will likewise triumph if, first, electrolysers become cheaper due to technological advances and economies of scale, second if renewable power becomes more affordable, and third if hydrogen producers can achieve economies of scale. Governments, for their part, need to offer subsidies that encourage demand and supply. Another option is they could make clean energies more price competitive by legislating a tax on carbon.

While the intractable politics of climate change prevent the implementation of adequate carbon taxes, governments are providing the catalyst to engender the required economies of scale. Bloomberg New Energy Forum forecasts green hydrogen's cost could drop to US$2 a kilo by 2030 and US$1 a kilo by 2050 by when the element could supply up to 24% of the world's energy needs.[20] A world looms where clean hydrogen might play a defining role in helping the drive to net-zero emissions. The split between green and blue will depend on reducing the cost of green.

To be sure, the electrolysis performed to create green hydrogen comes with the environmental challenge that it removes water supplies from where the hydrogen is produced. Doubts surrounding carbon capture and storage undermine blue hydrogen's environmental credentials. Some dismiss it as a natural-gas company marketing ploy like 'clean coal' – a recent Cornell and Stanford study says blue hydrogen is "difficult to justify on climate grounds".[21] Hydrogen, being the lightest gas in the universe, is not dense by volume. This means it must be pressurised to pipe or liquified to ship, which adds to costs. Hydrogen is volatile and can explode. The petro-states and China could prove influential enough in hydrogen and thus negate the element's strategic benefits for the west. Batteries are likely to hold their cost advantage over hydrogen fuel cells for powering electric cars. Solutions other than hydrogen (such as better battery storage, interconnected grids and smart-grid technology) could overcome the intermittent handicap of renewable power. Beware too that two decades ago, hydrogen was touted as an energy solution. George W Bush in the 2003 State of the Union, for instance, set aside US$1.2 billion so the first car driven by a child born that year would be powered by hydrogen.[22] Yet 18 years later, the green hydrogen industry still barely exists.

But that's a reason for optimism. The push to derive the economies of scale needed to lower the price of hydrogen have barely started. Yet electrolyser costs have dived by around 60% over the past 10 years, and the coming economies of scale are expected to lead to a further halving by 2030, according to the financial-sector-backed Sustainable Markets Initiative, which expects green hydrogen to be price competitive against fossil-fuel-based hydrogen by 2030.[23] If so, the countries hyping the element are likely to fulfil their hopes for an element that today shapes as a key technological pathway to net-zero emissions.

POLITICAL SHORTFALL

President Joe Biden, to emphasise the priority he placed on climate change, announced the US would rejoin the Paris Agreement on his first day in office.[24] One week later on January 27, Biden took "aggressive" executive actions "to tackle the climate crisis" that included a writ that climate considerations be an "essential element" of US foreign policy.[25] In April, Biden committed the US to slashing emissions by 50% by 2030 from 2005 levels because climate change posed an "existential threat". [26]

Yet in August, the White House demanded Opec boost oil production because high petrol prices "risk harming the ongoing global recovery".[27] While on his way from Italy to the UN climate change conference of world leaders in the UK in October, Biden admitted the situation "seems like an irony".[28]

Rather than ironic, Biden's actions are incompatible. But that's understandable, especially for a president whose climate-change steps have been hobbled by a Congress under his party's control. The political resistance against tackling climate action has proved intractable for decades for three broad reasons.

The central political problem is that steps to lower emissions impose immediate costs and there are limits to what people will stomach. Economists (among others) argue the best way to reduce carbon emissions is to tax carbon. The IMF says carbon taxes need to rise from its estimate of US$3 a ton now to US$75 a ton by 2030 to reduce emissions as targeted.[29] But taxes are unpopular, especially among the working class, as the 'gilets jaunes' protests over higher oil and fuel prices in France from 2018 to 2020 showed. Carbon taxes are regressive because the poorer spend a greater proportion of their incomes on energy. The taxes cost jobs in targeted industries. They hurt the countries and communities dependent on these energies. They promote a general rise in prices that has flow-on effects for interest rates. A World Bank tracker highlights the world's failure to impose taxes on carbon. The gauge shows that installed or coming carbon taxes cover only 21.5% of global emissions.[30] These taxes are generally set too low to make much difference anyway. Some say the effective price of carbon emissions across the world is essentially zero.[31] As there's little sign that will change, policymakers must resort to regulatory actions, subsidies and possibly carbon tariffs on imports to change behaviours – and they come with political blowback too.

The second challenge is the 'free rider' problem. If most countries take action to reduce emissions, there is less incentive for the reluctant to do so. (The other way to view this difficulty is as the first-mover disadvantage.) The third is the sequencing problem. Emerging countries protest they are being asked to forgo prosperity to mitigate the damage caused when advanced countries became rich on cheap fossil fuels. Emerging leaders sabotaged the UN climate conference in Copenhagen in 2009 for this reason.[32]

The thorny politics explain why policymakers invest so much hope in technology. This is the context in which to view the promise of hydrogen. Bloomberg New Energy Group says seven indicators will determine whether or not a hydrogen economy emerges. The first is that countries legislate net-zero climate targets to force hard-to-abate industries to decarbonise. The second is that standards governing hydrogen use are harmonised and regulatory barriers removed, to reduce obstacles for hydrogen projects. Three, targets with investment mechanisms are needed to provide a motive for investment. Four, harsh heavy transport emission standards must to be set to promote a shift towards hydrogen as a fuel. Five, mandates and markets for low-emission products be formed. Six, industrial decarbonisation policies and incentives are established. Last, hydrogen-ready equipment becomes commonplace, which enables and reduces the cost of switching to hydrogen.[33]

Meeting 24% of energy demand with hydrogen in a 1.5 degree Celsius scenario will require huge amounts of additional renewable electricity generation. In this scenario, about 31,320 terawatts of renewable electricity would be needed to power electrolysers – more than is produced worldwide nowadays from all sources, the group says. Add to this the projected needs of the power sector – where renewables are also likely to expand massively if deep emission targets are to be met – and total renewable energy generation excluding hydro would need to top 60,000 terawatts compared with less than 3,000 terawatts in 2020.[34]

Even amid such production challenges for renewable energy, hydrogen's biggest barrier is price. Some of hydrogen's biggest supporters admit to doubts about overcoming hydrogen's cost disadvantage. Former Australian chief scientist Alan Finkel, who forecasts Australia will be the world's biggest hydrogen exporter, says "in practice the future costs of both green and blue hydrogen remain unknown".[35]

There are, however, plenty of optimists. A study by INET Oxford released in September found most energy-economy models underestimate deployment rates for renewable energy technologies and overegg their costs. The study suggests that if batteries, solar, wind and hydrogen electrolysers match recent exponential growth for another decade, the world will attain a "near-net-zero emissions energy system within 25 years".[36]

Marco Alverà, the CEO of Italy's energy-infrastructure giant Snam and the author of *The Hydrogen Revolution*, is another optimist. Green hydrogen priced at US$5 a kilo or US$125 a megawatt-hour compares with about US$40 a megawatt-hour for oil and about US$60 a megawatt-hour for natural gas in Europe, he notes. "What's needed to get us from the current US$5 a kilo to US$2 or even US$1? The answer is that we need to make more of it," Alverà says. "The potential economies of scale are staggering: just 25 gigawatts of electrolyser production capacity – globally – could bring the cost of hydrogen to US$2 a kilo when combined with cheap renewable power."[37]

Another cause for optimism is that nuclear energy, a reliable emissions-free source of power, is suited to power the electrolysis process that makes green hydrogen. The nuclear industry in the UK reckons it can produce 33% of the country's clean hydrogen needs by 2050.[38] Oil and gas companies moving away from fossil fuels are another possible driver of the hydrogen economy.

The US's 111 strategy will no doubt be successful if it is read as one dollar one kilo one day. And there's a good chance the day when such technological advances overcome the political failures to mitigate climate change will be soon enough.

By Michael Collins, Investment Specialist

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[11] Technically, hydrogen purrs. The electrochemical reaction between hydrogen in fuel cells and oxygen drawn from the air generates electricity more efficiently than does conventional thermal generation (where the chemical energy of fuels becomes thermal energy that turns turbines to create electricity).

[12] 'Pink' hydrogen is hydrogen made from nuclear, 'turquoise' if it is made using electricity to heat methane whereas blue and grey hydrogen are made from methane via the combustion of fossil fuels.

[13] Dirty hydrogen is often called 'black' hydrogen when it's derived from coal.

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[17] Pflugmann and De Blasio. Op cit. Page 10

[18] Sustainable Markets Initiative. 'Energy Transition. Briefing Note.' Page 9. a.storyblok.com/f/109506/x/043fbf2a45/lseg-smi-energy-transition.pdf

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[32] Andrew Charlton, economic adviser to Australian prime minister Kevin Rudd. 'I hate to say it, but Barnaby has a point on climate.' 29 October 2021. smh.com.au/environment/climate-change/i-hate-to-say-it-but-barnaby-has-a-point-on-climate-20211028-p593uu.html. A fourth challenge might be the 'not in my backyard' syndrome that hobbles the building of renewable energy plants including nuclear ones due to their visual pollution, damage to the natural environment and perceived risks.

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