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Hydrogen emerges from the shadows

As costs fall, a third energy source will join wind and solar in transitioning the world from fossil fuels to renewable energy

After a century in relative obscurity, hydrogen energy is set to step up and play a critical role in transitioning the global economy's reliance on fossil fuels (coal, oil, natural gas) to a world that runs exclusively on renewable sources, such as wind, solar and, yes, hydrogen.

The hydrogen economy is racing towards mass adoption in the next 10 years as governments declare their visions and outline their road maps.

Suppliers and buyers in the hydrogen ecosystem are forming a queue that is largely dictated by their spot on the falling cost curve. Investors, too, have an important role to play as providers of capital to fuel the nascent hydrogen economy.

How it will work

First, a bit of chemistry. Hydrogen is the first among 118 basic and naturally occurring elements on Earth. At room temperature, it exists as a colourless, odourless and highly combustible gas, but it doesn't just float around in the air.

At room temperature, it usually occurs as a building block of other matter. In fact, 75% of all matter in the universe can thank hydrogen for being one of its ingredients. And each one of us has 10% hydrogen (by mass) in our bodies.

So, hydrogen should not be feared as something foreign and unfamiliar. On Earth, it joins forces with oxygen to form water and many other hydrocarbons. Water has two atoms of hydrogen and one atom of oxygen: the hydrogen energy economy sources hydrogen atoms from water molecules through a chemical splitting process called electrolyses.

Hydrogen is infinitely available and is totally renewable and climate friendly. It's not mined like fossil fuels, which leave a scarred landscape and gaseous emissions that are clearly suffocating living beings through pollution and warming the climate to a place where, if not addressed, we will soon reach a point of no return.

Rather, hydrogen is produced entirely from above-ground manufacturing. Just imagine electrolyses as a process that takes each drop of water, which is a cluster of hydrogen and oxygen atoms held together by tiny bonds or branches, and splits the hydrogen atoms from oxygen atoms.

Scientists have known for more than 100 years that pure hydrogen gas escaping from this process can be captured and stored in a high-pressure tank.

This stored hydrogen gas is a rich form of energy that can be used with incredible versatility, such as for heating your home or cooking a meal, in the same way that many homes burn natural gas, except that with hydrogen you get water vapour as a by-product instead of carbon emissions.

Similarly, we can use hydrogen instead of natural gas for power generation. The turbines at the heart of gas-fired power stations need relatively little modification to run on hydrogen.

The jet engine is a close cousin of the gas turbine, so hydrogen can be used to fly aircraft. Again, the main waste gas is water vapour (steam) in all of these applications.

While it is simple enough to understand the electrolyses process, you may be wondering where the energy to power the process comes from, as it's very energy intensive and not going to run on its own.

The idea here is to set up industrial-scale solar farms in the hottest and most sun-exposed parts of the world. The arid central parts of Australia, the Sahara Desert in Africa, and parts of the US and South America are all perfect places for setting up solar farms to generate renewable power to directly run giant electrolyses machines installed right next door. And we are not talking about massive use of landscape to set up wind and solar farms: only 1.2% of the Sahara Desert is sufficient to cover all of the world's solar energy needs.

We can apply the same method for wind turbine power stations installed in high-wind geographies to power electrolyses.

In from the (very) cold

The captured hydrogen gas can then be containerised in liquid form at low temperature (-252 Celsius) to ship to major cities anywhere in the world or even pushed through traditional natural gas pipelines.

If you are thinking it must be very expensive to keep hydrogen in liquid form at such low temperatures for a shipping journey, you are right.

To bring down the heavy cost of liquefying hydrogen, there is a smart and affordable work-around: it is called ammonia gas. Industrial chemists can mix nitrogen gas with captured hydrogen gas to form ammonia, in a molecule where one nitrogen atom binds with three hydrogen atoms (NH_3). These molecules carry the energy that was initially produced from renewable sources, such as solar and wind power.

Also remember that energy always transforms from one form to another and does not simply disappear – the trick is to maintain control over production and transformation.

Once pure hydrogen is attached to nitrogen gas to form ammonia, it can be converted to liquid form at a much more affordable temperature of -33°C for shipping. At the receiving country, the reverse electrolyses process strips nitrogen gas from hydrogen gas and the latter is then used in the local energy grid.

This is the process Australia plans to adopt as part of its vision to become a hydrogen superpower and use the continent's abundance of solar and wind energy, and ship this energy through hydrogen stored in ammonia to Asia and Europe.

So, how does hydrogen fit into the renewable energy future of the world?

While solar and wind energy can produce electric power during hot and windy days, these conditions are unreliable.

You need a third form of energy to bridge this inconstancy. You need a way to produce excess renewable and solar energy in countries such as Australia, then store it in the form of hydrogen (inside ammonia) and distribute it around the world to balance the intermittency of domestic sources of renewable energy.

You might now be wondering about the role of lithium-ion batteries, which are touted as a store of renewable energy. They are definitely more efficient than hydrogen fuel cells in converting the stored energy to usable energy, but hydrogen molecules pack a lot more energy and are a lot lighter to carry around.

By virtue of having a lot more energy density, hydrogen fuel cell cars can run for longer than lithium-ion versions. For example, the Toyota Mirai can hold 5kg of hydrogen in its tanks, giving it a range of 650km, which is similar to petrol cars, has quick refuelling like a petrol car, and its only by-product is water vapour.

A lithium-ion battery pack's range for each recharge cycle would be around 250km-300km and the vehicle is likely to be a lot heavier, which reduces the range. And you have to replace the expensive battery pack after some years, while hydrogen fuel cells last the lifetime of the car.

Additionally, lithium-ion batteries take several hours to recharge. This is where hydrogen fuel cells step in as a solution for heavy, commercial and mining industries that cannot rely on lithium-ion batteries, as they would be impractical in satisfying the requirements of energy intensity, duration and maximum uptime.

All this means is that, eventually, after the world has transitioned totally away from fossil fuels in the coming decades, it is estimated that 70% of its energy will be sourced directly from renewable sources such as solar and wind (and geothermal, hydro, nuclear, etc) and 20% from hydrogen.

As with most technologies, falling cost is usually the key driver of adoption. The Department of Energy in the US launched an Energy Earthshots initiative in 2021 aiming to get the cost of clean hydrogen to fall from $5/kg today to $1/kg by 2030, at which point it will become competitive with coal.

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3 FUNDS TO WATCH

Hydrogen ETF

The Global X Hydrogen ETF (ASX: HGEN) seeks to invest in companies that stand to benefit from the advancement of the global hydrogen industry. This includes companies involved in hydrogen production, the integration of hydrogen into energy systems and the development/manufacturing of hydrogen fuel cells, electrolysers and other technologies.

BNP Paribas Earth Trust – AUD

The Earth Trust (APIR: ETL6684AU) offers a market first: an environmentally focused market-neutral strategy for sustainable portfolios. The manager sees a significant potential in green hydrogen in particular, based on an estimate that it will take about $150 billion of annual investments to ramp up supply from today's 0.8 megatons to the 614 megatons needed by 2050.

VanEck Global Clean Energy ETF

This ETF (ASX: CLNE) gives investors a diversified portfolio of 30 of the largest and most liquid companies involved in clean energy production and associated technology and equipment globally.