Curtin University
INSTITUTE FOR ENERGY TRANSITION

FACT SHEET 003

Hydrogen

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What is hydrogen and how is it produced?

Hydrogen can be produced through a process called ‘electrolysis’. Electrolysis uses electricity to split water (H_2O) into hydrogen and oxygen. Depending on the power source of the electricity used, hydrogen production can be carbon-free[1].

Hydrogen can be used as a fuel as an alternative to natural gas. Currently, natural gas is burnt for heating, cooking, generating electricity and transport – hydrogen has the potential to be a clean alternative for all of these uses.

Hydrogen ‘colours’

Several different types of hydrogen exist, defined by colour codes based on how they are produced. When the electricity for electrolysis comes exclusively from renewable sources, it is referred to as ‘**green**’ hydrogen. This is the kind of hydrogen that is a ‘clean’ (ie emission-free) alternative to conventional natural gas.

‘**Blue**’ and ‘**grey**’ hydrogen, both use natural gas for production. In these processes, natural gas is reacted with high-temperature steam, producing hydrogen and carbon monoxide (CO). The CO is then reacted with steam again to produce more hydrogen and some carbon dioxide (CO_2). If hydrogen is ‘blue’, then this CO_2 has been trapped through a process known as carbon capture and storage. When ‘grey’ hydrogen is produced, this CO_2 is simply released into the atmosphere.

Other types of hydrogen, such as ‘**pink**’ (using electricity generated from nuclear power) and ‘**black**’ or ‘**brown**’ (extracted from coal), also exist.

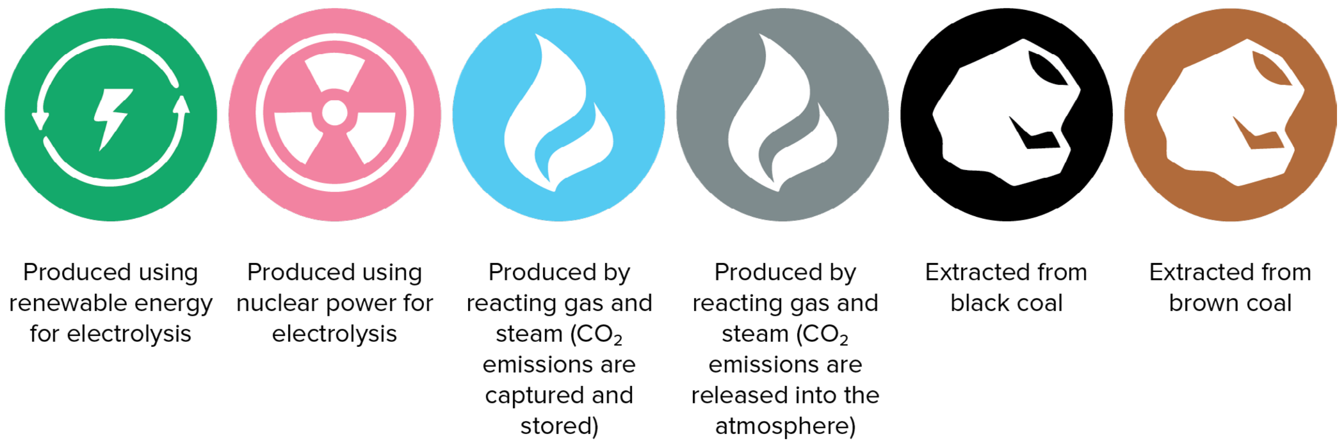

Figure 1: Hydrogen ‘colour codes’ and their meanings

Why use hydrogen?

Green hydrogen can be used in the place of natural gas in a number of contexts. Not only is green hydrogen emissions-free, but each kilogram of hydrogen also contains about 2.4 times as much energy as natural gas[1], making it a cleaner and more energy-dense alternative, based on its weight.

Hydrogen is especially useful for **heavy industry**[2]. It can be used as both a feedstock (a raw material used for processing) and for generating high temperatures. For example, green hydrogen can be combined with nitrogen to produce green ammonia, a crucial ingredient in fertiliser production. Hydrogen can also be burnt instead of coal, producing higher temperatures without releasing any emissions. This is useful for processes like refining iron ore, which creates green iron that can be used to create green steel.

Hydrogen can also be used as a **vehicle fuel**. Rather than burning petrol to create the energy used to power a vehicle, fuel cells react hydrogen with oxygen to produce electricity, which is then used to power the motor. This reaction produces only water vapour and heat, and the fuel cells are lighter than electric vehicle batteries and can be recharged quicker[3].

Hydrogen can also be used to **'firm' renewables** (read more about this in our firming explainer HERE). Essentially, to ensure there are no 'gaps' when there is an ultra-high demand for electricity or lower than usual amounts of renewable energy are being generated, gas peaking plants can burn gas to even out the amount of energy available to go around. Eventually, green hydrogen could replace gas in this context if it is cost-effective[4].

Why aren't we all using hydrogen already?

The main barriers to widespread hydrogen usage are scale and cost. Electrolysis requires a significant amount of electricity, so if we want to produce green hydrogen at an industrial scale, then the number of renewable energy sources (wind and solar farms) will also need to increase.

Hydrogen is also difficult to transport in a safe and stable way. Transporting liquified hydrogen requires ultra-low temperatures and transporting hydrogen in compressed gas form requires ultra-high pressure. The equipment needed for these processes is bulky, heavy and expensive.

Hydrogen can be converted into a chemical compound like ammonia, which is far easier to store and transport, but to get the hydrogen back at the end of the process is also energy intensive and can produce greenhouse gases.

Liquid organic hydrogen carriers are petroleum-like compounds that can absorb and release hydrogen, and they don't require extreme temperatures to remain in a liquid state. However, the processes of hydrogenation and dehydrogenation (or absorption and release) also require significant amounts of energy, and the carriers can become degraded over multiple cycles[5]. However, CIET researchers are investigating a new type of hydrogen carrier, which is a powder, which safely releases hydrogen when added to water[5].

Essentially, while hydrogen is being used today and has great potential as a future clean fuel, the obstacles of generation and transport, along with the associated costs and energy needs, must first be addressed before it is able to be used on a grand scale.

References

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