HYDROGEN FACT SHEET

QUICK FACTS

ABUNDANCE
Hydrogen is the most abundant element in the universe, constituting ~75% of its elemental mass.

HIGH ENERGY DENSITY
Each kilogram of hydrogen contains ~2.4 times as much energy as natural gas.

INFINITE SUPPLY
Production via electrolysis requires water and electricity only.

14 TIMES LIGHTER THAN AIR
Dissipates rapidly if unconfined.

COLOURLESS, ODOURLESS
A diatomic molecule, with each molecule containing 2 atoms of hydrogen; pure hydrogen is commonly expressed as H2.

NO CARBON FOOTPRINT
No greenhouse gases or pollutants emitted with use.

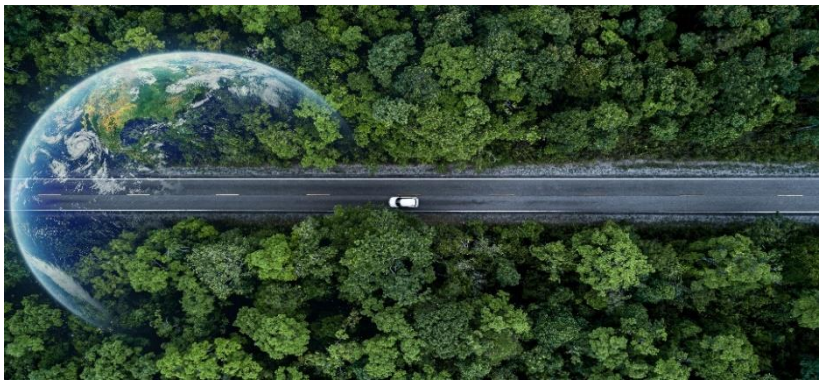
NON-TOXIC & NON-POISONOUS
It will not contaminate groundwater, nor will a release of hydrogen contribute to atmospheric pollution.

GOOD STORAGE CAPABILITY
Can be stored in large quantities for long periods of time.

Hydrogen is the simplest and most abundant element in the universe

INTRODUCTION

Hydrogen, the lightest and most abundant element in the universe, serves as a versatile energy carrier with immense potential for powering a sustainable future. With a single proton and electron, hydrogen exists in various forms, including gas, liquid, and as a component of numerous compounds. Its role as an energy carrier stems from its ability to store and release energy efficiently. When utilised in fuel cells, hydrogen combines with oxygen from the air to generate electricity, producing only water vapor as a byproduct. This clean and renewable process offers a promising solution for reducing greenhouse gas emissions and transitioning away from fossil fuels, making hydrogen a key player in the quest for a greener and more sustainable energy landscape.



HOW IS HYDROGEN USED?

Some common uses of hydrogen as energy include:

1. **Fuel Cells:** Hydrogen can be used in fuel cells to generate electricity through an electrochemical reaction between hydrogen and oxygen. Fuel cells are increasingly used in vehicles, buses, forklifts, and stationary power generation.
2. **Transportation:** Hydrogen fuel cell vehicles (FCVs) use hydrogen as fuel, producing only water vapor and heat as byproducts. FCVs offer fast refueling and longer ranges compared to battery electric vehicles.
3. **Energy Storage:** Hydrogen can store excess renewable energy generated from sources like wind and solar power. This stored hydrogen can then be used to generate electricity during periods of high demand or when renewable energy generation is low.
4. **Industrial Processes:** Hydrogen is widely used in various industrial processes, such as refining petroleum, producing ammonia for fertilisers, and manufacturing chemicals like methanol and hydrogen peroxide.
5. **Heating and Power Generation:** Hydrogen can be burned directly in boilers or turbines to produce heat and electricity. This application is particularly relevant for industries with high heat requirements, or for combined heat and power (CHP) systems.
6. **Energy Backup:** Hydrogen can serve as a backup energy source, providing resilience against power outages.
7. **Decarbonisation:** Hydrogen produced from renewable sources like electrolysis using renewable electricity, is termed green hydrogen. It can play a crucial role in decarbonising industries and sectors where direct electrification is challenging, such as steel and heavy transportation.

HYDROGEN SAFETY FREQUENTLY ASKED QUESTIONS

Is hydrogen safe to use?	Yes. Hydrogen is a well established energy carrier that has been safely used in Australia and internationally for many decades.
What happens if hydrogen escapes?	Hydrogen is lighter than air and will dissipate easily if unconfined. All hydrogen facilities and operations require leak detection and response systems similar to other industrial gas plants and operations.
Can hydrogen explode underground?	No. Hydrogen needs an oxygen mixture to ignite. Hydrogen that is stored underground is injected with very low impurities, including oxygen. The oxygen content in the stored hydrogen would be too low to cause ignition.
Has hydrogen been stored underground before?	Hydrogen has been successfully stored underground in salt caverns for many years in the USA and UK. Projects like H2eart and EUH2STARS in Europe are examples of underground hydrogen storage projects.
Has hydrogen been stored in sandstone rock formations similar to the Waarre sandstone in Southwest Victoria?	Currently, there are two active demonstration sites in Austria and Germany, and previous pilot work has also been undertaken in Argentina. Other European countries are actively looking to store hydrogen in porous rock formations.
Does hydrogen leak?	Hydrogen can be prone to leakage as it is a very small molecule with low viscosity. Proper ventilation and the use of detection sensors help to mitigate the risk of hydrogen accumulation and it becoming a hazard.
What is the risk of hydrogen combustion?	Oxygen (air) and an ignition source are required for combustion of hydrogen to occur. Hydrogen is flammable at concentrations between 4% and 75% in air, which is a very wide range compared to other common fuels. Safety measures such as, air/oxygen exclusion, proper ventilation and detection sensors are used to mitigate this risk.
Can an odourant be added to hydrogen to improve safety?	Odourants are not currently used with hydrogen for two reasons. 1. No known odourants are light enough to blend with hydrogen at the same dispersion rate. 2. Current odourants also contaminate fuel cells, which are an important application for hydrogen.

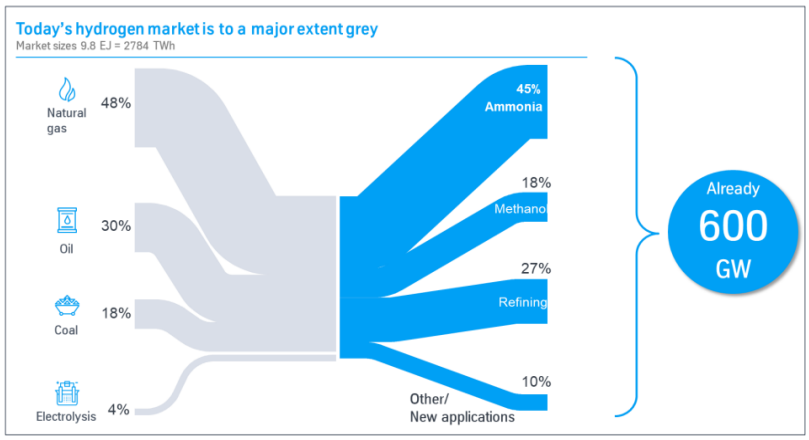
HOW IS RENEWABLE HYDROGEN PRODUCED?

Hydrogen, though abundant, isn't typically found in its pure form on Earth. Instead, it's commonly produced through various industrial processes. One of the primary methods is the well-proven process of electrolysis, which involves passing an electric current through water to split it into hydrogen and oxygen molecules. In order for hydrogen to be considered "renewable hydrogen" or "green hydrogen", this electrolysis process must be powered by renewable energy sources, like wind or solar, and also use a sustainable water source. The renewable electricity splits the water molecule inside of the electrolyser, into its constituent hydrogen and oxygen components. As there is no direct carbon emissions generated in the production of the hydrogen (because of the use of renewable energy), the potential energy residing in the hydrogen can be considered as clean, green or renewable.

HYDROGEN IN A GLOBAL CONTEXT

- Several factors contribute to the growing interest in hydrogen including decarbonisation goals, energy security, industrial applications, global collaboration, technological advancements, infrastrucutre development, and policy support.
- Worldwide hydrogen consumption is ~90 million tonnes per annum across various industriries including chemical manufacturing, petroleum refining, and food processing.
- The global market for hydrogen is ~USD 180 billion (75% of global LNG market).
- Almost every refinery in the world utilistes hydrogen in some way.
- Hydrogen is different to natural gas, however it is well understood and has been safely managed for decades worldwide.
- Hydrogen has been produced via the well-proven method of electrolysis since the very early 1990s.

Overal, hydrogen has emerged as a global energy solution with the potential to play a significant role in the transition to a sustainable and low-carbon future.



Source: ThyssenKrupp 2020

HYDROGEN TYPES

GREEN
Produced by electrolysis of water using renewable energy

BLUE
Produced from methane or coal (steam reformation) in combination with carbon capture and storage

RED
Produced by high heat and water using thermolysis with nuclear energy

PINK
Produced by electrolysis of water using nuclear energy

YELLOW
Produced by electrolysis of water using solar energy

TURQUOISE
Produced from thermal breakdown of methane or biomass at high temperatures, from 600-1,200◦C (pyrolysis) and solid carbon (allowing the carbon to be stored and used for other purposes without emitting CO_2)

GREY
Produced from methane or coal (steam reformation) with CO_2 emitted to the atmosphere

BROWN
Produced from brown coal (steam reformation) with CO_2 emitted to the atmosphere

BLACK
Produced from black coal (steam reformation) with CO_2 emitted to the atmosphere

GOLD
Naturally occurring hydrogen reservoired underground which can be feasibly extracted.

WHITE
Naturally occurring hydrogen reservoired underground which cannot currently be feasibly extracted.

ORANGE
Involves injecting a carbon-enriched solution into a reactive formation, then collecting hydrogen-saturated water from surrounding recovery wells.

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