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Fuelling the Future: How South Australia is revolutionising renewable energy sources with Green Hydrogen

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Contents

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Introduction

In order to reduce greenhouse gas emissions and the reliance of fossil based fuels there has been a global shift towards renewable energy (Squadrito, Maggio and Nicita, 2023). Renewable energy is made from natural resources that are clean and green. Different types of renewable energy are wind energy, heat/solar energy, geothermic energy, hydropower energy, ocean energy and bioenergy (Alliant Energy, 2024). Clean energy will result in the production of electricity without any damaging carbon emissions, but the reality of building and maintaining the plants for manufacturing can be catastrophic to the environment as open land has to be used and the methods of construction produces a high carbon footprint. Green energy is completely natural and has very little damaging impact to the environment (National Grid, 2024). It will not run out, does not cause any toxic pollution or release any carbon emissions.

In Australia, the use of fossil fuels, particularly coal, oil and natural gas are still mostly used to generate electricity, heat homes and businesses, and is a major source of energy in the transport system. It relies on imports of liquid fuels such as diesel which increases the carbon footprint (Geoscience Australia, 2023; Islam, Rasul, Emami and Chowdhury, 2023). The Australian Government has made progress towards becoming a more sustainable country by using more renewable energy sources. Solar energy and wind energy are becoming more widespread and this is helping to reduce Australia's carbon footprint, however this is not enough to prevent the massive amounts of emissions being produced. South Australia is Australia's leading state in renewable energy resources such as wind and solar power farms and the state's anticipated renewable energy production will be

approximately 85% by 2025 (Government of South Australia, Department of Energy and Mining, 2023, p13). To improve their emission status further, South Australia are beginning to implement the production and use of Green Hydrogen, a clean and green energy source with almost zero carbon emissions and no pollution risks to the environment.

What is hydrogen?

Hydrogen (H_2) is the first element on the periodic table and is the smallest of the chemical elements. It is a diatomic molecule which is made of two atoms loosely paired together presenting as a gas which makes it incredibly diverse, but volatile in its uses.

It is the most abundant element in the entire universe, and was named in 1783 by a pioneering chemist named Antione Lavoisier after he discovered it created water (H_2O) when burned in oxygen (O_2) (Hudson, 1992).

Hydrogen is an excellent fuel source, which makes it a perfect substitute for fossil based fuels but it is an energy vector rather than a primary source of fuel and so it requires a chemical process to create it (Acciona, 2020). There are several methods of chemical manufacturing for Hydrogen, but not all of them are environmentally sustainable. Hydrogen

manufacturing is grouped into colours which show where the hydrogen comes from and level of emissions released (NanoScent Labs, 2023).

	Terminology	Technology	Feedstock/ Electricity source	GHG footprint*
PRODUCTION VIA ELECTRICITY	Green Hydrogen	Electrolysis	Wind | Solar | Hydro Geothermal | Tidal	Minimal
	Purple/Pink Hydrogen		Nuclear	
	Yellow Hydrogen		Mixed-origin grid energy	Medium
PRODUCTION VIA FOSSIL FUELS	Blue Hydrogen	Natural gas reforming + CCUS Gasification + CCUS	Natural gas | coal	Low
	Turquoise Hydrogen	Pyrolysis	Natural gas	Solid carbon (by-product)
	Grey Hydrogen	Natural gas reforming		Medium
	Brown Hydrogen	Gasification	Brown coal (lignite)	High
	Black Hydrogen		Black coal	

*GHG footprint given as a general guide but it is accepted that each category can be higher in some cases.

Table 1: The Hydrogen Colour Spectrum. Cheng and Lee (2022)

Black and Brown Hydrogen uses heavy fossil fuels to manufacture hydrogen. It works through gasification which heats powdered fossil fuels to an extremely high temperature and turns it into hydrogen, carbon dioxide and carbon monoxide which is harmful to health. These toxic pollutants are released into the atmosphere. Australia creates hydrogen in this way and exports it to Japan (National Grid, 2023).

Pink Hydrogen is created using nuclear power. Nuclear reactors use electrolysis to produce hydrogen that is free from greenhouse gas emissions, however nuclear waste cannot be safely disposed of and the risk of catastrophic accident is high (National Grid, 2023).

Grey Hydrogen is the most produced type of hydrogen today with around 96% of all manufactured hydrogen produced. It uses natural gas to produce Hydrogen and Carbon

Dioxide (CO_2). The CO_2 is released into the atmosphere causing environmental damage. Grey hydrogen produces large amounts of carbon emissions and accounts for 2% of global carbon emissions (NanoScent Labs, 2023).

Blue Hydrogen is similarly manufactured, but it is considered to be more environmentally friendly than its grey counterpart since it uses a carbon capturing system which stores CO_2 underground until it can be repurposed, and is playing a part in reducing carbon emissions (Patel et al, 2024).

Green Hydrogen is the most effective environmentally friendly way of creating hydrogen. It is produced using renewable energy sources which results in electrolysis to produce hydrogen which is completely free of greenhouse gas emissions (Ajavonic, Sayer, and Haas, 2022). The use of solar and wind power during production creates a system where no waste products are left over.

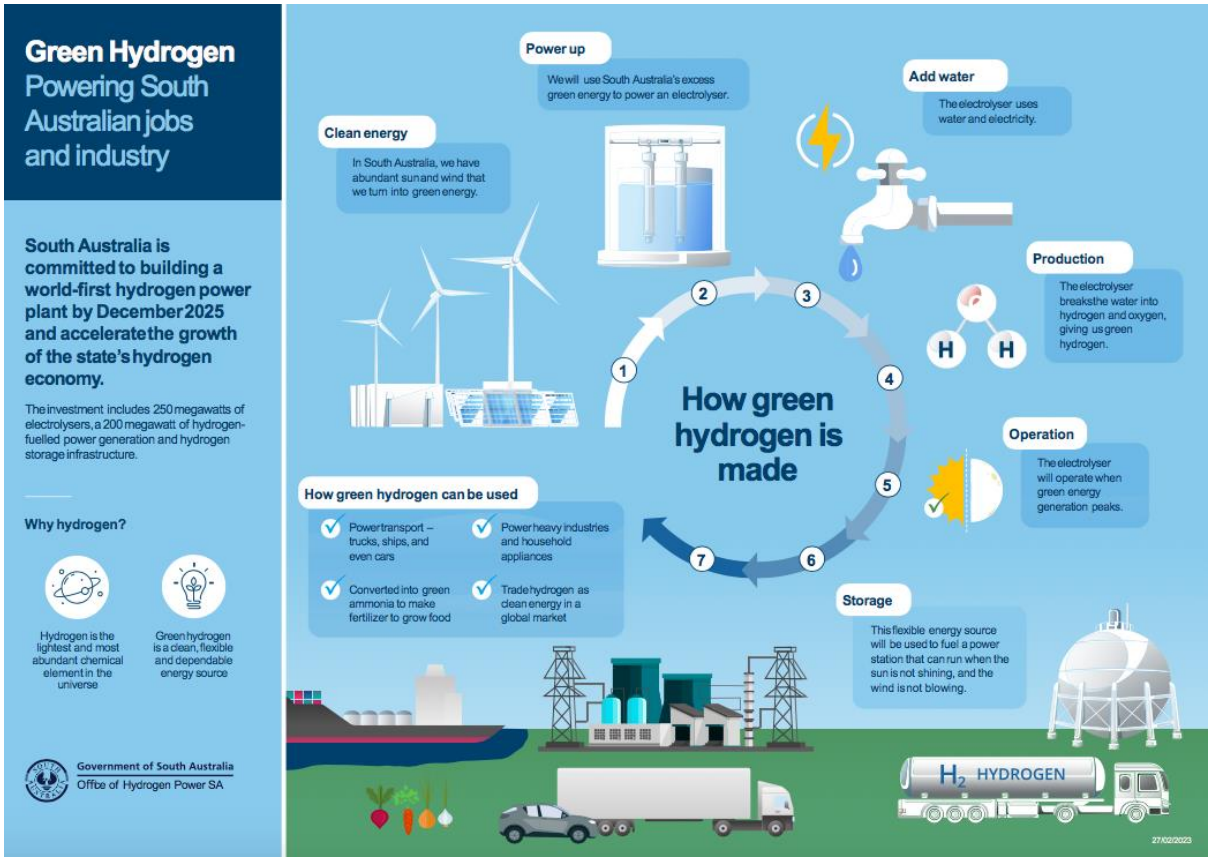

Fig 1: How green hydrogen is made. Office of Hydrogen Power, Government of South Australia (2024)

The case for Green Hydrogen

Boretti (2023) says that Green Hydrogen is a versatile and positive remedy to the global environmental crisis. By using an environmentally sound and renewable energy sourced system it will compliment and strengthen seasonal wind and solar renewable energy sources which South Australia has opted to use. This will eventually counteract the current energy price increases in the state due to an increased demand for supply of energy when weather conditions are not satisfactory and prevent unnecessary use of fossil fuelled energy production. With South Australia already using renewables for the majority of their power sources, the addition of Green Hydrogen will help South Australia to reach its goal of being a net zero carbon emissions state before 2050 (Government of South Australia, 2022).

South Australia's current energy practices and challenges

The South Australian government are committed to the global energy transition and has outlined their plan in the State Prosperity Project (Government of South Australia, 2024). South Australia hopes to harness the potential of renewable energy and build on their ideals for the future. There are many action plans and Acts that have been passed which will enable South Australia to transition to a clean energy state. The SA government are investing half a billion dollars into Green Hydrogen projects including building a renewable hydrogen power plant at Whyalla which is scheduled to begin in 2026 (Government of South Australia, 2024) and the Port Bonython Hydrogen Hub on the Spenser Gulf which offers a large underwater storage facility to enable export of clean hydrogen (Government of South Australia, 2024). The Whyalla Hydrogen Facility will become the world's largest Green Hydrogen producing plant. It hopes to provide a 250 megawatt (MW) facility, a 200 MW

power plant and 3600 tonnes of hydrogen storage (Australia New Zealand Infrastructure Pipeline, 2020).

The SA Premier has also revised his estimations of becoming a 100% renewables state from 2030 to 2027 (Government of South Australia, 2024).

Economic impacts of Green Hydrogen production in SA

There are several important economic implications to consider when looking at introducing the production of Green Hydrogen into SA. The benefits of a transition to renewable energy sources are enormous. Thousands of jobs will be created during the construction of the new stations and thousands more when production commences. To add to this, the delivery of safe, renewable energy sources will drastically reduce the cost of energy within South Australia making power bills more affordable for everyone (Government of South Australia, Department of Energy and Mining, 2023, p10).

Challenges and limitations

While green hydrogen will play a large part in reducing the amount of carbon emissions, there are some drawbacks to its use. Hydrogen is colourless and odourless and an extremely flammable and reactive gas which is prone to explosion. This can create issues with safety as it is not possible to detect a gas leak by human senses. Green Hydrogen must be liquified to allow safe storage in deep underwater storage areas to prevent explosions.

There are many people who believe that the use of Green Hydrogen in South Australia will not be cost effective. It is much more expensive to produce than other hydrogen manufacturing processes and the government is still researching and writing policies that will encourage its uptake in the future. A solution for this will be the decrease in price of

other sustainable renewable fuel sources which are required to produce the electricity which is needed for the electrolysis where Green Hydrogen is made (Acciona, 2020).

Conclusion

As long ago as the 1990's Australian scientist Mark Oliphant proclaimed that hydrogen power would be the future. He foresaw that the use of solar and wind power would be instrumental in the success of hydrogen power but that storage would remain a vital issue (Ellyard, 1992). Green Hydrogen is the future of sustainable and renewable energy sources in South Australia. For decades, we unknowingly produced hydrogen with the environmental backlash of pollution and emitting toxic carbon waste into the atmosphere. With more research and improvements in technology South Australia will lead the way in reducing carbon emissions and helping to heal the planet, and the use of Green Hydrogen as a renewable energy source will benefit the economy, work force, and environment of South Australia for generations to come.

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