CAN GREEN HYDROGEN BE SUSTAINABLE?

THE FUTURE OF GREEN HYDROGEN IN AUSTRALIA

Source: Australian Government Clean Energy Regulator

Green hydrogen, produced using renewable energy to split water into hydrogen and oxygen, is explored to store and transport renewable energy to help decarbonise specific heavy carbon footprint-related industries (energy storage, steelmaking, shipping, ammonia synthesis for agriculture). While this growing industry is still in an exploratory phase, Australia is positioning itself as a global leader.

Sequana's involvement ties to hydrogen in the water industry is strong, with the organisation working on many of the active projects around the country. At the heart of this innovative topic, Sequana's National Partner, Energy, Decarbonisation and Major Project Delivery, Ian Filby, Senior Associate Advanced Water Treatment, John Poon, Associate Director, Major Projects, Eric Garcin, Environmental and Process Engineer, Suhaib Malkawi, and Dr. Quentin Bechet, Environmental and Net Zero Engineer, together explore how sustainable this growing practice is.

Balancing opportunities and roadblocks, can green hydrogen be environmentally reliable?

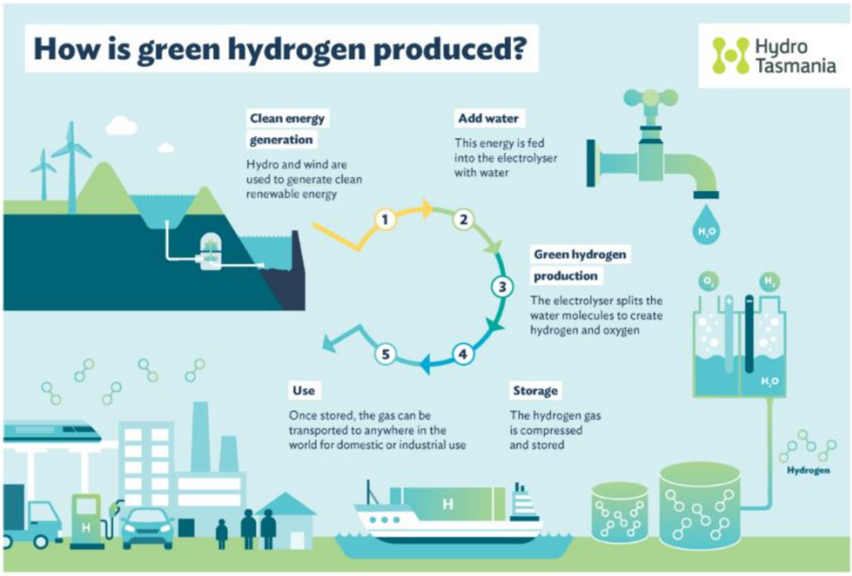
THE ORIGINS OF HYDROGEN

In the late 1700s, French chemists and husband-and-wife duo Antoine and Marie-Anne Lavoisier were experimenting with water vapour in their Paris laboratory. They passed steam through a red-hot iron tube, triggering a chemical reaction where the iron captured the oxygen atoms from the water molecules, leaving behind a flammable gas — hydrogen. When they ignited it, it burst into flame, revealing not only the energy hidden in water, but also that water itself was not an element, but a compound of hydrogen and oxygen. This moment was one of the bedrocks of modern chemistry — and the first time in modern history that usable hydrogen was extracted from water. Very simple concept, but don't try it at home!

AUSTRALIA'S CURRENT GREEN HYDROGEN STRATEGY, LEADING THE GLOBAL MARKET

"Australia is uniquely positioned to become a global leader in renewable hydrogen. With vast expanses of land ideal for renewable energy infrastructure, abundant solar resources, and a stable political environment that supports the issuance of credible green energy certificates, Australia has all the key ingredients for success. Together, these advantages create a compelling opportunity for the country to lead the world as the first large-scale exporter of green hydrogen," Dr. Quentin Bechet, Environmental and Net Zero Engineer.

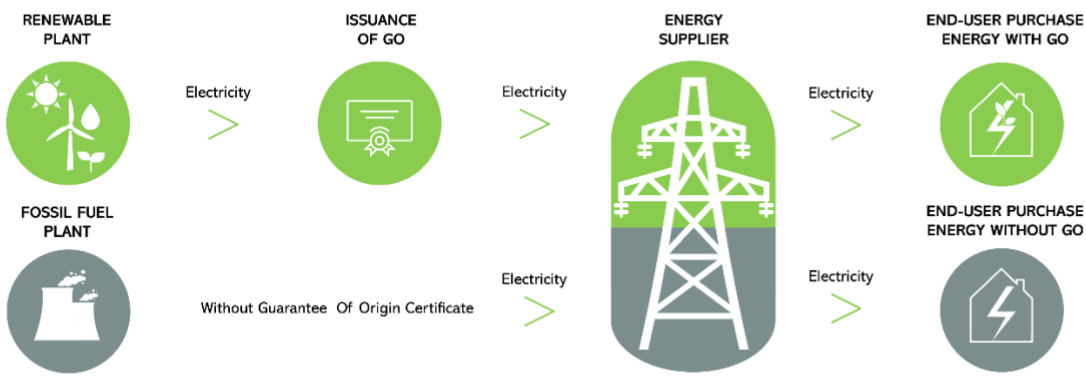
In Australia, green hydrogen flourished when the Australian Government first released its National Hydrogen Strategy in 2019. Presented by Australia's Chief Scientist, Dr Alan Finkel, to the Council of Australian Governments Energy Council in Perth, its purpose was to develop innovative hydrogen solutions to tackle water scarcity and provide suitable and sustainable water to the Country.



Source: Hydro Tasmania

The National Hydrogen Strategy, updated in 2024, outlines ambitious goals to scale up production and establish Australia as a major exporter. Considered a cornerstone of the global energy transition, hydrogen explores its vast potential in supporting the storage and transport of renewable energy with minimal environmental impact.

While Hydrogen is diverse and adopts the primary colours of the rainbow, certified green hydrogen sets the tone with lower emissions, representing the most viable option towards a clean energy future. Last November, Australia introduced the Guarantee of Origin (GO) certification to strengthen its leadership in sustainability and enhance international market access, working alongside global partners like the International Partnership for Hydrogen and Fuel Cells in the Economy.



Source: Aither

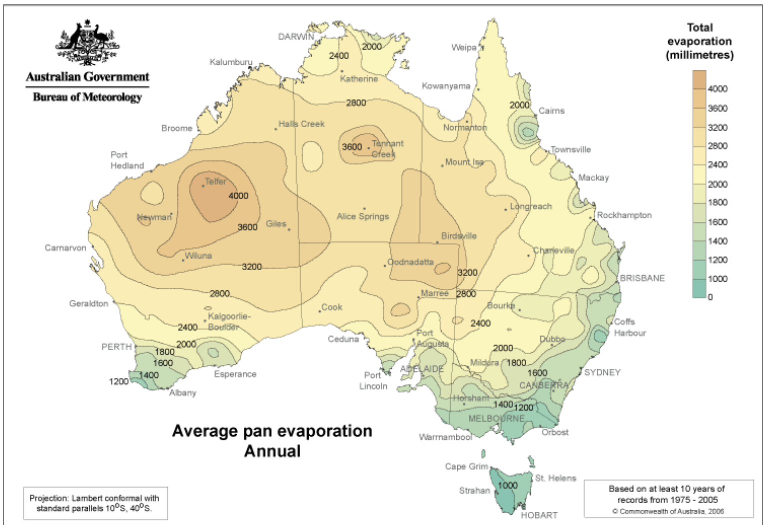
"The Guarantee of Origin is part of the overhaul of the Renewable Energy Target scheme, which will expire in 2030. The ambition for the new scheme will likely be to push further decarbonising our economy, and some high-emitting industries/products like fertiliser and steel could benefit from the advent of green hydrogen. Australia is well placed, from geography to climate conditions, to produce competitive green hydrogen, and therefore competitive decarbonised end products," Eric Garcin, Associate Director, Major Projects**.**

This certification, which follows existing renewable energy regulations, is likely to be extended to Green Mineral Products. The carbon footprint of steel primarily comes from the energy and heat used in its production. Recent advancements show that renewable energy and hydrogen can fully power steel manufacturing, paving the way for "Green Steel." As a result, Green Steel certification can build upon existing certifications for green energy and green hydrogen. Whereas certifications' foundations firmly ensure a sustainable path, we cannot help but ask the question – how much water does green hydrogen need?

GREEN HYDROGEN'S WATER NEEDS

With a bright future on the horizon for the hydrogen industry, the water sector is in higher demand than ever. Water infrastructure and practitioners play a crucial role in green hydrogen production. Indeed, green hydrogen relies on water as a primary feedstock—split into hydrogen and oxygen through electrolysis. Under ideal conditions, this process requires about nine litres of ultrapure water to produce one kilogram of hydrogen. However, in practice, much more water is consumed across the entire production chain, especially for cooling and conversion processes. In some cases, the total water requirement can range from 30 to 60 litres of water per kilogram of hydrogen made. This places significant pressure on water availability, particularly in Australia's drier regions, where competing needs from agriculture, communities, environment, and industry must be carefully balanced.

It's not just the purity of water that matters—it's also the quantity. Evaporative cooling, commonly used to maintain nominal electrolyser temperatures, can demand up to 2.5 times more water than the electrolysis component itself. If hydrogen is further processed into ammonia or liquefied for transport, additional cooling stages can push water use even higher, by up to threefold more. These processes are highly sensitive to local climate conditions: evaporative cooling is more efficient in hot, dry environments, while air-based or electric cooling systems may be better suited to cooler, more humid areas where evaporation is less effective. The evaporation values presented in the map below provide an insight into the dryness/wetness across Australian regions – the higher the evaporation is the drier the region. But even these dry areas can experience prolonged wet and humid periods, such as the monsoon season. This climatic variation will need careful consideration during the design stage to avoid under sizing of water infrastructure and harvesting needs.



Source: Australian Government Bureau of Meteorology

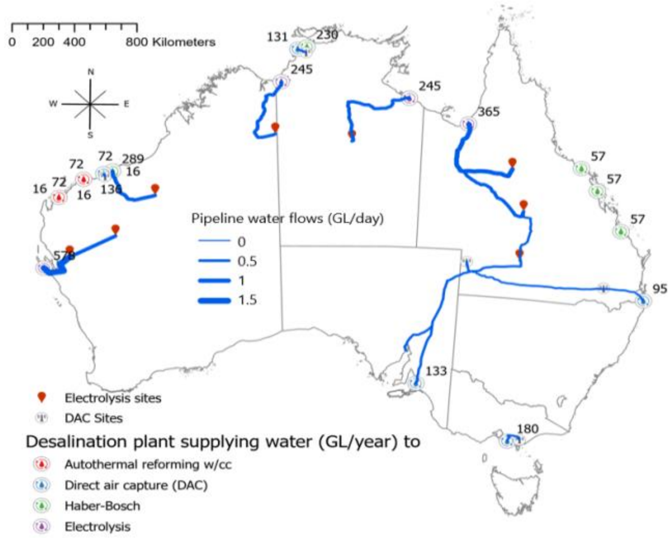
Competent water management and infrastructure development are critical enablers of green hydrogen projects—not just for hydrogen production, but also for supporting downstream industries such as ammonia synthesis for agriculture, hydrogen liquefaction for transport fuels, and emerging processes like green steel, where hydrogen replaces coal in carbon-intensive industrial processes. A secure and well-planned water supply infrastructure can unlock investment, ensure industry resilience, and support community needs alongside the energy transition. There is a reason why great human civilisations are linked to water.

Advanced water treatment technologies are not a luxury in green hydrogen production—they are a necessity. Regardless of the source, all water must be treated to an ultrapure, deionised state before it can be fed into electrolysers. This is not simply purified or clean water—it is pure H_2O, free from any salts, minerals, or contaminants that could compromise sensitive equipment and trigger electrolyser failure. Achieving this level of purity requires highly specialised assets, deep technical expertise, and robust water quality controls. Hydrogen production plants are, in essence, precision-engineered facilities operating at the frontier of water and energy science. It is notable that the same ultrapure water is needed for pharmaceutical, semiconductor and electronics advanced manufacturing. These sectors will be competing for the same water treatment assets as the green hydrogen makers.

As Senior Associate Advanced Water Treatment – John Poon emphasises “For the successful and sustainable development of nascent hydrogen industries, a comprehensive understanding of water resource demands–encompassing both input requirements and effluent management–is paramount for both industrial proponents and governmental regulators. While the economic opportunities are substantial, realising them necessitates rigorous planning and meticulous execution. Water, as a critical material input and potential environmental factor, demands the highest level of strategic consideration and proactive management throughout the project lifecycle. Its availability and quality are not to be underestimated and must be a central tenet of development, not a peripheral concern or something that can be easily fixed later. Like flour, how do you make sourdough bread without this key ingredient? The same logic applies to green hydrogen. This supply chain for water must be robust and present, otherwise the rest doesn’t matter”.

While the cost and complexity of water treatment depend heavily on the source water characteristics, every drop counts—especially in water-scarce regions. Using water sources, such as rainwater or high-quality groundwater, can reduce treatment costs. But in a climate of increasing water stress, seawater, recycled wastewater, stormwater, and other alternative sources are all viable—provided they are supported by the correct water harvesting, treatment and conveyance infrastructure. The ability to harvest, treat and manage a wide range of water sources is what will define successful, resilient hydrogen projects in the decades ahead.

“Before selecting a location for hydrogen production, it's essential to understand your water sources—how much is available, who else relies on it, and what the long-term demand looks like. It's not just about energy. Water is the new mine that fuels the clean energy transition. To get hydrogen right, we need to integrate water thinking from day one—not just to produce hydrogen, but to sustain communities and industries that we need for the future,” Ian Filby – National Partner, Energy Decarbonisation and Major Projects.



Downscaled energy sector water infrastructure for the "E+ Scenario" in 2060, including potential locations of desalination plants supplying water to various technologies (with units of supplied water in GL/year), and locations of electrolysis, direct air capture and water transmission routes. Extracted from Net Zero Australia (Figure 81).

MARCHING TOWARDS DECARBONISATION, SUSTAINABILITY AND GOVERNANCE

The renewable energy sector still, to this day, has carbon emissions to mitigate. The Net Zero Australia initiative aims to explore pathways for the country to achieve net-zero emissions across both domestic and export economies by 2060. In this scenario, hydrogen was assumed to be at the centre of this strategy, mainly as a way to store and transport the hydrogen from production facilities to consumption centres. This translated into an important water demand. Depending on the scenarios, Net Zero Australia predicted an increase in the water demand by a factor of between 2 and 3.5 from 2020 to 2060.

When it comes to decarbonisation, green hydrogen is produced using renewable energy sources like solar and wind, eliminating carbon emissions from the production process. Unlike grey or blue hydrogen, which relies on fossil fuels, green hydrogen offers a clean alternative for industries that are difficult to decarbonise, such as steel manufacturing, heavy transport, and aviation. Australia's National Hydrogen Strategy aims to accelerate the adoption of green hydrogen by reducing production costs and establishing hydrogen hubs. Government initiatives like the Hydrogen Headstart Program, which provides funding to bridge the cost gap between fossil fuels and green hydrogen, are crucial in making large-scale hydrogen projects viable.

Beyond its substantial water needs, pressuring water resources, Green Hydrogen's value chain also impacts the environment because of its large-scale hydrogen production, with potential effects on local ecosystems. To reduce the environmental impact on biodiversity via hydrogen and renewable energy infrastructures, proper planning and environmental assessments are necessary. Co-construction of nature-based solutions, ecological measure management and ongoing monitoring with Traditional Owners' groups are essential to preserve Australia's natural and cultural heritage. We recently explored how to march towards Net Zero in our latest Sequana Stream Webinar Series, urging proponents to start assessment and consultation early.

Risks and environmental assessments, and water management are not just support functions in the hydrogen value chain—they are strategic enablers. At Sequana, we believe that how we value and manage water determines the long-term viability of hydrogen projects, especially in regions with constrained or contested water resources.

But it's time to go beyond conventional thinking. The term "wastewater" itself is becoming obsolete. It reflects a linear, one-directional view of water use that no longer serves the scale and ambition of the clean energy transition. Whether it's seawater, municipal effluent, or industrial discharge—no water is truly "waste" when advanced treatment and resource recovery technologies are applied.

Take phosphate, for example. It's mined, applied to farms, consumed by plants and humans, flushed through kitchens and bathrooms, and ultimately diluted into our oceans—lost in a system that was never designed for recovery. Yet with the right treatment processes, this same phosphate, along with critical minerals like lithium, uranium, and rare earth elements, can be extracted from reject streams and converted into valuable by-products. Hydrogen might be the primary product, but water treatment can unlock a hidden economy of resource recovery.

"Many say that soon, water will no longer be the primary output of treatment—rather, it will be the by-product of rare mineral and nutrient extraction. The old boundaries between water, energy, and mining are dissolving. Hydrogen production is not just about clean energy—it's a gateway to rethinking how we use, reuse, and regenerate resources," Suhaib Malkawi, Environmental & Process Engineer.

Sequana's expertise lies in bridging these emerging intersections—engineering fit-for-purpose water strategies that support hydrogen production while unlocking additional value through circular resource planning, integrated treatment design, and future-focused risk assessment.

Sustainability not only expands to decarbonisation and environmental practices but also to meaningful governance and strong engagement plans with Traditional Owners, local communities and stakeholder groups. With that in mind and to reinforce community alignment when applying renewable energy to the hydrogen project, First Nations peoples are key. It is an opportunity for the sector to positively shape considered clean energy policies and programs with Aboriginal and Torres Strait Islander peoples.

At Sequana, we bring to life meaningful action to become catalysts for change, shaping the future of Australia's water, energy and environment sectors and driving a sustainable water sector, leaving behind a lasting legacy of excellence for future generations.

Australia's potential to lead the global green hydrogen market is significant, given its renewable energy resources and strategic initiatives. However, addressing water availability, environmental concerns and other hurdles is essential to turn this potential into a reality. With supportive government policies, technological advancements, and international collaboration, Australia can play a pivotal role in the global transition to a low-carbon future.

THANK YOU TO OUR CONTRIBUTORS:

Ian Filby, National Partner, Energy, Decarbonisation and Major Project Delivery

With almost 27 years of experience, Ian Filby has broad experience across the private consulting and public sectors, bringing an ability to align engineering solutions and policy. His experiences' highlights encompass the development and delivery of capital projects on the billion-dollar scale in the water and energy sectors for the government. He uses his skills in infrastructure planning, design integration and project management and strong knowledge of the water, resources and energy sectors to provide decarbonisation strategies for our clients.

John Poon, Senior Associate, Advanced Water Treatment

John's depth of knowledge and experience in water treatment technologies places him at the forefront of the international water sector, and his more recent focus has shifted to the opportunities that hydrogen represents for deep decarbonisation. With over 35 years across the industry, John is both a thought leader and a leading practitioner, advising clients on strategic and technical options to deliver material benefits at the intersection of water, energy and the circular economy.

Eric Garcin, Associate Director, Major Projects

Eric has over 25 years of experience in the water industry, having worked across all aspects of the field, including engineering, procurement, construction, commissioning and operations. He is passionate about innovation and the environmental challenges we are facing today. With his holistic vision of the market drivers and strong water expertise, Eric is excited to strengthen Sequana's approach.

Suhaib Malkawi, Environmental and Process Engineer

With over 7 years of international experience across Australia, Jordan, and India, Suhaib Malkawi is a specialist in sustainable water management, process optimisation, and circular resource recovery. Suhaib combines academic rigour—having recently completed a PhD in water engineering—with practical expertise spanning major project planning, nutrient recycling, water quality improvement, and process system design for agriculture and industrial applications.

Dr. Quentin Bechet, Environmental and Net Zero Engineer

Quentin has over 15 years of experience in the environmental engineering sector, where he initially worked to research and develop sustainable solutions relating to biofuels, then later greenhouse gas emissions within the Australian water industry. Drawing on a broad range of technical, management, and strategic skills, Quentin strives to enhance the sustainability of human activities, with a primary focus on mitigating harmful emissions and securing the long-term availability of vital resources.