

Australia can become a key player
in the global hydrogen market.



DECARBONISING WITH HYDROGEN

By Maartje Feenstra, Dr Scott Dwyer and Professor Charlene Lobo,
University of Technology Sydney

Australia has the potential to be a key player in the global hydrogen market, but a cost-effective hydrogen storage solution is needed to achieve this vision.

Australia is one of many countries that have signed a pledge to reduce carbon fossil fuel emissions to net zero by 2050. To reach this target, all sectors of the economy must develop their own sustainable pathway.

One particularly promising pathway is using green hydrogen (i.e. hydrogen and hydrogen-derived fuels produced from renewable electricity sources such as solar and wind). In some sectors, hydrogen competes with other technologies such as direct electrification, but for the maritime, aviation, chemicals, iron, and steel production sectors, green hydrogen or its derivatives are typically viewed as the only solution.

Australia has all of the attributes required to become a key player in the global hydrogen market. In particular, our abundance of cheap renewable solar and wind energy gives us the potential to produce cheap hydrogen. However, transporting this energy across the world and using it where needed requires a means of cost-effective hydrogen storage with high efficiency, high volumetric energy density, and high mass energy density. Therefore, hydrogen storage technologies are a key research topic,

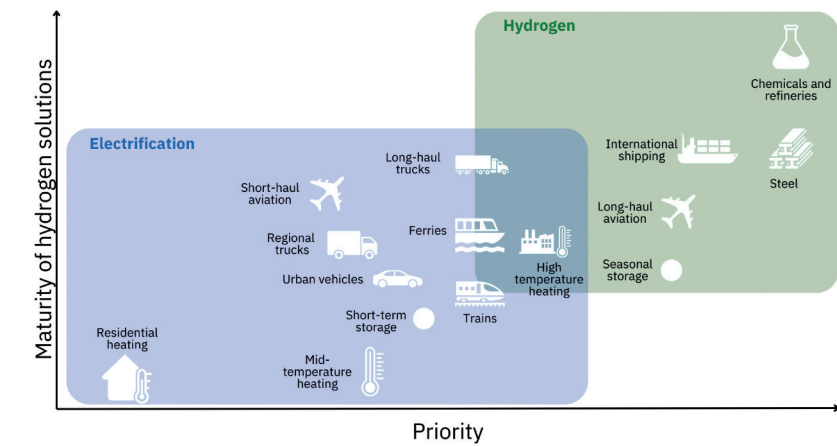


Image: University of Technology Sydney

Figure 1. Low to high priorities for various applications of hydrogen. Adapted from IRENA.¹

including advances in existing hydrogen derivatives like ammonia and methanol, as well as promising novel solutions such as boron hydrides.

Key sectors for green hydrogen

Green hydrogen is a versatile chemical energy carrier that could fulfill various purposes across many economic sectors. However, because the production of green hydrogen requires renewable energy sources, it is key that green hydrogen is applied in those sectors where it is a critical commodity and not in those where other technological solutions

would be a better fit. The International Renewable Energy Agency (IRENA)¹ has organised hydrogen applications from low priority to high priority (Figure 1). In the low priority areas, such as residential heating and urban vehicles, there are existing electrification alternatives with higher overall efficiency and lower cost. However, in the high priority areas, such as long-haul aviation and international shipping, there are no alternatives providing both high volumetric and mass energy density at reasonable cost, and green hydrogen is thus a critical commodity for sustainability strategies.

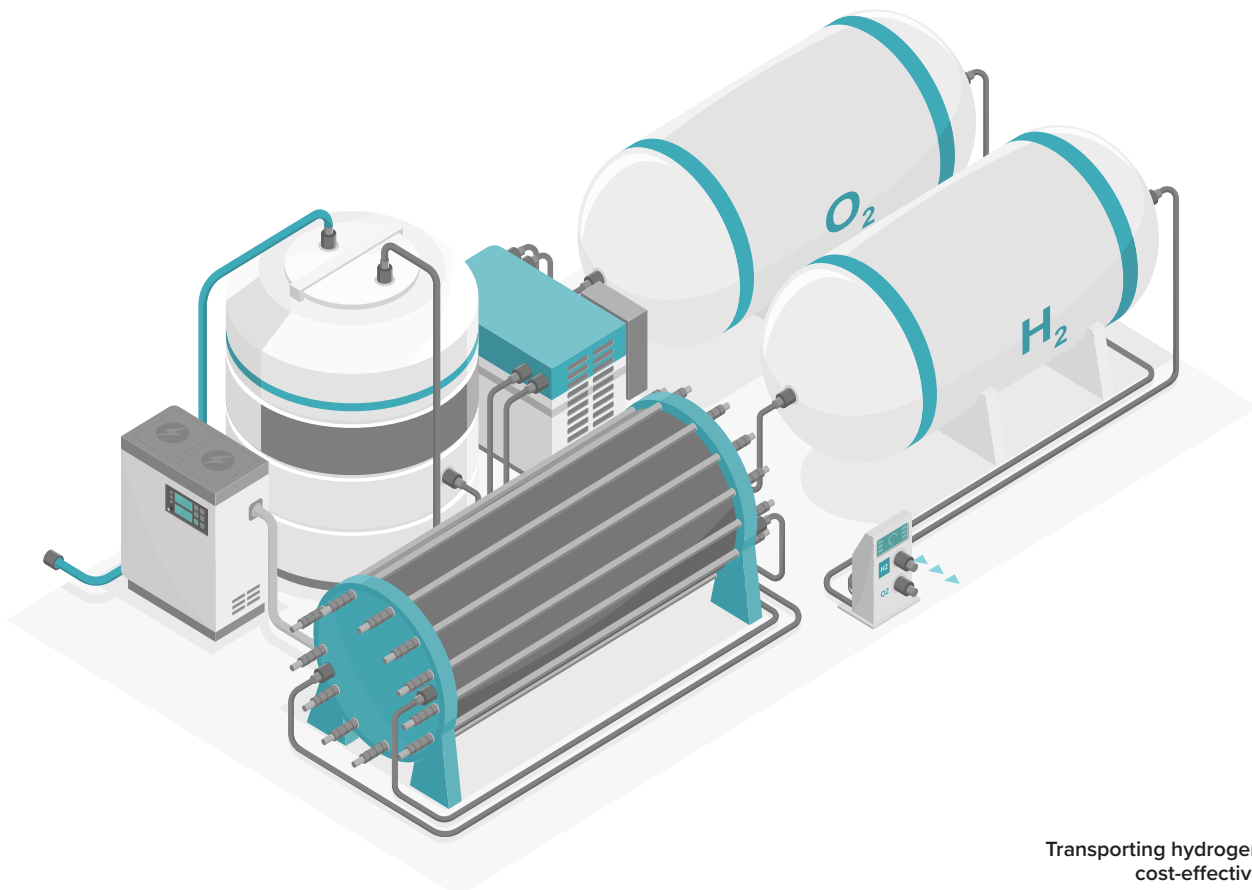


Image: Allahfoto/shutterstock.com

Transporting hydrogen requires cost-effective storage.

Hydrogen market opportunity

Global status

While hydrogen has had previous peaks in the last 20 years, it is now displaying an unprecedented momentum. On a global level, there are now ten major (>200MW) hydrogen plants under construction. The first of these projects to be completed was in Kuqa, China, owned by Sinopec. With 260MW of electrolyzers, it should be capable of producing 20,000t of green hydrogen per year (although it has been reported to be having challenges and isn't expected to be operating at full capacity until 2025). There are also several other large projects under construction in China and a 200MW green hydrogen facility powered by offshore wind in the Netherlands. The renewable hydrogen produced by these facilities will be used for oil refining and coal deep processing. There are also several GW-scale global hydrogen projects that are in various stages of planning and engineering up to 2040.

Green hydrogen in Australia

The Australian and Western Australian state governments have invested \$140 million in Australia's first large scale hydrogen project in Pilbara, Western Australia². The Pilbara Hydrogen Hub is envisaged to be a major centre for clean hydrogen production and export while serving the needs of the local green steel and iron production industries. Australia also has more than 114 other hydrogen-related projects in various stages of development, including projects developing synthetic fuels, hydrogen hubs, hydrogen process heating, hydrogen mobility and many more applications. In December 2023, six hydrogen projects were shortlisted for a \$2 billion hydrogen fund from the Australian Renewable Energy Agency (ARENA) with a combined proposed hydrogen capacity of more than 3.5GW³. Final funding recipients will be selected in late 2024, hereby opening the opportunity to propel Australia into the position of a global hydrogen market player. Another noteworthy 2024 development is the development

of a local Australian electrolyser manufacturing line (capable of producing 2GW of electrolyzers annually), opened by Fortescue in Gladstone⁴.

Research and technology developments

Green hydrogen is currently produced at higher cost than fossil-fuel based hydrogen. In the long term, larger plants and cheaper renewable electricity will lower the price of green hydrogen, but the current cost gap limits early technology implementation. Therefore, policy and regulatory mechanisms are necessary to accelerate research and technology deployment. Both the USA and Europe have recently introduced regulatory frameworks designed to accelerate the emergence of supply and demand markets for green hydrogen and other renewable energy technologies.

The *US Inflation Reduction Act* (IRA) awards up to \$3 per kilogram of hydrogen with a greenhouse gas emission of lower than 0.45kg of CO₂ per kg of hydrogen⁵. In response to these regulatory developments in the USA, Europe developed the Hydrogen Intermediary Company, which is designed to compensate producers for the difference between supply and demand prices⁶. Funding for the mechanism will be provided by public funding bodies, with a commitment of €4.5 billion from the German government alone.

Australia's national hydrogen policy is based on the National Hydrogen Roadmap released in 2018⁷, in which the focus is on investing in technology scaling up projects for pilots, trials, demonstrations and hydrogen supply chains. In light of the recent international policy developments, in 2023 the Australian government revised the National Hydrogen Roadmap, which led to the establishment of a \$2 billion fund for large hydrogen projects^{8,9}. Moreover, the 2024 Federal Budget included several billions for hydrogen production tax incentives and research and development¹⁰. With an existing innovation ecosystem composed

of universities, research institutes, incubators, funding agencies, start-ups, technology companies and many more contributors, hydrogen projects can now be pushed to larger scale applications in Australia.

A significant part of this roadmap is research and development of new hydrogen storage technologies besides compressed/liquefied hydrogen. This includes storage in gaseous hydrogen compounds such as ammonia (NH₃), methanol or boron hydrides such as diborane (B₂H₆) and Mg(BH₄)₂ with the boron hydrides still in the early stages of technology development.

The path forward

The authors' recommendations for Australian policy priorities that can help realise the full potential of energy storage technologies are:

- Further research to better understand the "sweet spot" for specific energy storage technologies, which can be through lab- and desk-based research projects involving industry funded projects, PhDs, and post-doctoral research
 - Partnerships between industry, academia, and governments that can lead to supportive policies, secure funding, and identify use cases and new partnerships
 - A strong internal market for hydrogen energy storage is possible given Australia's abundant renewable energy resources and is an area in which supportive policy could play a major role in creating demand and local employment opportunities
 - Connection to critical industries (maritime, aviation, chemical industry, steel and high temperature applications in industry) that rely on hydrogen for their trajectory towards net zero
 - Leveraging existing and new funding programs, which can provide access to funding and industry partnerships
- The opportunity for hydrogen storage is significant and the sectors in which these technologies can compete with other forms of energy storage is becoming clearer. ■

1 IRENA, Global Hydrogen trade to meet the 1.5°C climate goal part 1, trade outlook for 2050 and way forward 2022

2 Department of Climate Change, Energy, the Environment and Water (DCEEW), New Hydrogen Hub for Pilbara

3 ARENA, Six shortlisted for \$2 billion Hydrogen Headstart funding

4 Fortescue, Fortescue officially opens Gladstone Electrolyser Facility

5 US Environmental Protection Agency, Summary of Inflation Reduction Act provisions related to renewable energy

6 HINT.CO GmbH, Hydrogen Intermediary company

7 COAQ Energy Council, Australia's national hydrogen strategy

8 S&P Global, Australia to revise, renew its 2019 hydrogen strategy

9 ARENA, \$2 billion for scaling up green hydrogen production in Australia

10 Australian Hydrogen Council, Federal budget sets bold vision for Australia's hydrogen industry