



Australian Government
Department of Climate Change, Energy,
the Environment and Water

National Hydrogen Strategy Review

Consultation Paper | July 2023



Have Your Say

Submissions to this consultation paper can be made via the Department's Consultation Hub and by clicking the "Make a Submission" button.

- Submissions in relation to the National Hydrogen Strategy will be shared with the NHS Review States and Territories Reference Group established to assist with the review of the National Hydrogen Strategy.
- Submissions will also be published online after the consultation closes, however stakeholders may request that components of their submission be kept confidential and not published.

This consultation will close on 18 August 2023.

Copyright

© Commonwealth of Australia 2023

Ownership of intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the Commonwealth of Australia.

Creative Commons licence



Attribution

CC BY

All material in this publication is licensed under a Creative Commons Attribution 4.0 International Licence, save for content supplied by third parties, logos, any material protected by trademark or otherwise noted in this publication, and the Commonwealth Coat of Arms.

Creative Commons Attribution 4.0 International Licence is a standard form licence agreement that allows you to copy, distribute, transmit and adapt this publication provided you attribute the work. A summary of the licence terms is available from <https://creativecommons.org/licenses/by/4.0/>

The full licence terms are available from <https://creativecommons.org/licenses/by/4.0/legalcode>

Content contained herein should be attributed as *National Hydrogen Strategy Review, Consultation Paper, Australian Government Department of Climate Change, Energy, the Environment and Water*.

Disclaimer

The Australian Government as represented by the Department of Climate Change, Energy, the Environment and Water has exercised due care and skill in the preparation and compilation of the information and data in this publication. Notwithstanding, the Commonwealth of Australia, its officers, employees, or agents disclaim any liability, including liability for negligence, loss howsoever caused, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying upon any of the information or data in this publication to the maximum extent permitted by law. No representation expressed or implied is made as to the currency, accuracy, reliability or completeness of the information contained in this publication. The reader should rely on their own inquiries to independently confirm the information and comment on which they intend to act. This publication does not indicate commitment by the Australian Government to a particular course of action.

Introduction

Australia's first National Hydrogen Strategy was endorsed by all Australian governments and published in 2019. The Strategy contained 57 actions and principles outlining the initial steps Australia could take to develop a large scale domestic hydrogen industry.

Consistent with the adaptive approach to hydrogen industry development on 24 February 2023, the Energy and Climate Change Ministerial Council (ECMC) agreed to a Review of the National Hydrogen Strategy (the Strategy Review) to ensure the national strategy positions Australia on a path to be a global hydrogen leader by 2030 on both an export basis and for the decarbonisation of Australian industries.

While Australia was the third nation to publish a hydrogen strategy in 2019, at least 30 nations have now released hydrogen strategies, with many more in development. The hydrogen industry has emerged from the relative fringes to generate international excitement about the hydrogen opportunity.

International hydrogen markets have shifted dramatically and we are learning more about for which current and emerging uses hydrogen can have the biggest decarbonisation and economic impact. Many of the jurisdictions with hydrogen strategies are implementing financial incentive mechanisms to accelerate investment and industry development.

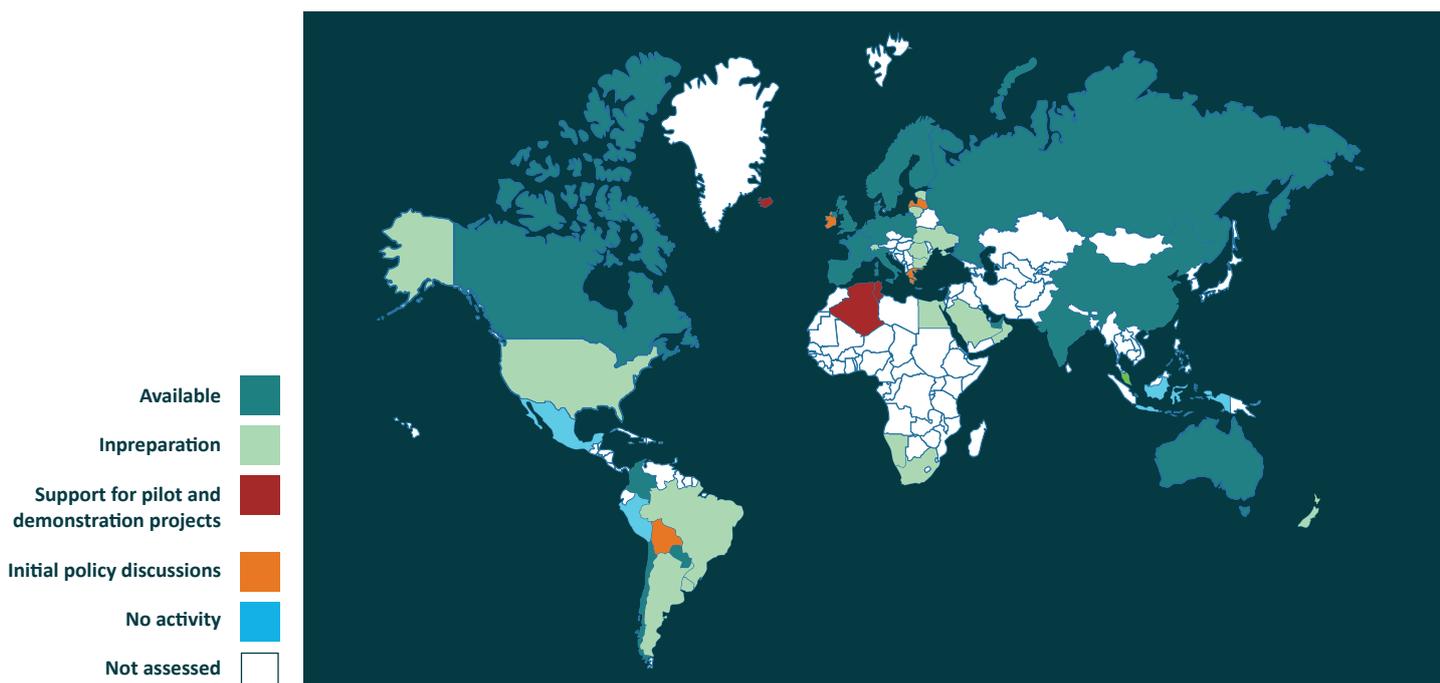


Figure 1: National hydrogen strategies as of August 16, 2022



Figure 2: The developing rationale for a world leading hydrogen industry

While positive for the emergence of a global hydrogen industry, these international actions present potential risks to Australia’s hydrogen industry in terms of increasingly competitive supply chains, the diversion of foreign investment away from Australia, and competition for our potential hydrogen-based export industries.

The 2022 State of Hydrogen Report¹ found that Australia is well placed to play a significant role in the global hydrogen industry due to our renewable energy potential, skilled resource and energy workforce and a long history as a trusted energy and resources exporter.² Australia has around 40 percent of all announced global hydrogen projects, with the Australian pipeline valued from \$230 billion to \$300 billion. This was confirmed by the REN21 2023 Global Renewables Resources report which found that *“Australia had the largest number of announced renewable hydrogen plants worldwide as of 2022; due to its abundant solar and wind resources, the country is expected to see some of the lowest levelised costs for producing renewable hydrogen by 2050.”*³

However by the end of 2022, only a single Australian project with a capacity of at least 10 MW had reached a Final Investment Decision (FID). This compares to almost 1400 MW of capacity in the European Union, and 300 MW of capacity in the United States, of such projects to reach FID.

1 DCCEEW (2023) State of Hydrogen 2022 Report at www.dcceew.gov.au/energy/publications/state-of-hydrogen-2022
 2 DCCEEW (2023) State of Hydrogen 2022 Report at www.dcceew.gov.au/energy/publications/state-of-hydrogen-2022
 3 REN21 (2023) Global Renewable Resources report. ren21.net/wp-content/uploads/2019/05/GSR-2023_Energy-Supply-Module.pdf

Compounding the disparity between the progress of hydrogen projects globally is the creation of new, extensive policy measures in other countries to support the development of their domestic hydrogen industries. The Inflation Reduction Act in the US is the most notable, providing, tradeable tax credits for hydrogen production that can be combined with tax credits for related renewable energy production and end use cases. A number of large economies have responded with similar, albeit not quite as extensive, support mechanisms.

So, while Australia has the foundations to be a global hydrogen leader there is a need to consider updated or additional actions to ensure Australia reaches its potential.

The Australian Government has taken a step in announcing the establishment of a \$2 billion competitive hydrogen production contract program. Hydrogen Headstart will focus on supporting the scaling up hydrogen production using renewable electricity which will in turn help reduce the cost of this technology over time. This acknowledges Australia's vast renewable energy resources and supports the Government's ambition to be a renewable energy superpower. Detailed consultation on the design features of the Hydrogen Headstart program will be through a separate consultation process.

This paper seeks submissions to assist the review of the 2019 Strategy. The paper provides commentary and poses some specific questions, the responses to which will assist the preparation of a revised Strategy. In addition, respondents to the paper should note the revised Strategy's three strategic objectives below.



Strategic Objective

- Australia is on the path to be a global hydrogen leader by 2030
- Enable domestic decarbonisation through the development of the hydrogen industry
- Ensure economic benefit for all Australians through the development of the hydrogen industry.

Unless otherwise requested, the submissions will be published online in full, and provided to States and Territories in advance of publication to support the review of the hydrogen strategies of individual jurisdictions and their engagement in the National Hydrogen Strategy Review.

Contents

National Hydrogen Strategy	01
How can Australia enable decarbonisation through the development of a clean hydrogen industry?	01
How could Australia further activate its hydrogen and related industries?	07
How can we ensure our hydrogen industry attracts the necessary investment?	12
How can we ensure our hydrogen industry develops in a way that benefits all Australians?	14
How should we develop the necessary infrastructure needed to support the development of our hydrogen industry?	16
How can we enable a hydrogen export industry (including the export of goods manufactured with hydrogen)?	18
Other feedback	19
Appendix A 2019 Summary of consultation matters	21
Appendix B 2019 National Hydrogen Strategy Actions	21

National Hydrogen Strategy

How can Australia enable decarbonisation through the development of a clean hydrogen industry?

The revised National Hydrogen Strategy will build upon the 2019 Strategy and focus on the role hydrogen technology needs to play for Australia to meet its commitment to achieve net zero emissions by 2050 and to reduce greenhouse gas emissions by 43% below 2005 levels by 2030. State and territory jurisdictions have also stated their own aspirations towards a Net Zero emissions target.

Hydrogen will contribute between 10% to 33% towards global and Australian emissions reduction⁴. Fortunately, hydrogen can be used in multiple applications and will be particularly important for hard-to-abate sectors which cannot be easily electrified.

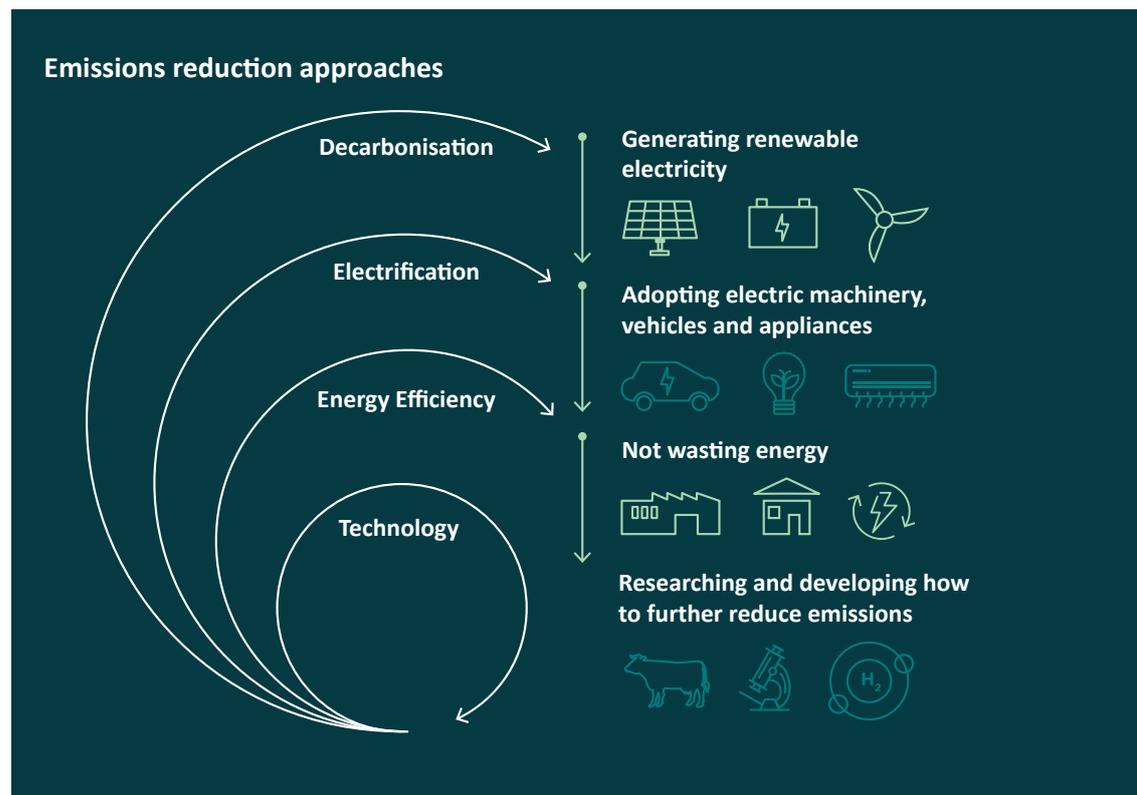


Figure 3: Hydrogen (Technology) provides an emissions reduction opportunity (Source Annual Climate Change Statement 2022)

⁴ Advisian (2021) Australian Hydrogen Market Study at www.cefc.com.au/media/nhnhwixu/australian-hydrogen-market-study.pdf, Australian Government (2021) Australia's Long Term Emissions Reduction Plan - A whole-of-economy Plan to achieve net zero emissions by 2050 at https://unfccc.int/sites/default/files/resource/Australias_LTS_WEB.pdf, CSIRO (2023) **Hydrogen – Fuels – Estimated Emission Reduction** – CSIRO, ARENA (2023) Industry Sets Path to Net Zero – Media Release at <https://arena.gov.au/news/industry-sets-a-path-for-net-zero>

Ammonia production – Domestic and Export

Australia already has a large, announced investment pipeline of 35 green ammonia or other hydrogen chemical derivative export projects worth over \$150 billion. The number of these proposed projects in this sector doubled in Australia in the last year and a financial investment decision was reached on the first 10 MW electrolyser project in Australia. Energy security issues arising out of Europe have meant that for periods in 2022, green ammonia prices were increasingly competitive. Both fuel security concerns and decarbonisation ambition is generating strong near-term interest from Japan and South Korea to import hydrogen chemical derivatives like methanol and ammonia and from Australia.

Decarbonising existing ammonia production provides a relatively straightforward opportunity given the industry already makes direct use of 425,000 tonnes of hydrogen per year produced from unabated fossil fuels. Current domestic production for both the mining explosives and agricultural sector results in approximately 4 million tonnes of carbon dioxide emissions per annum.

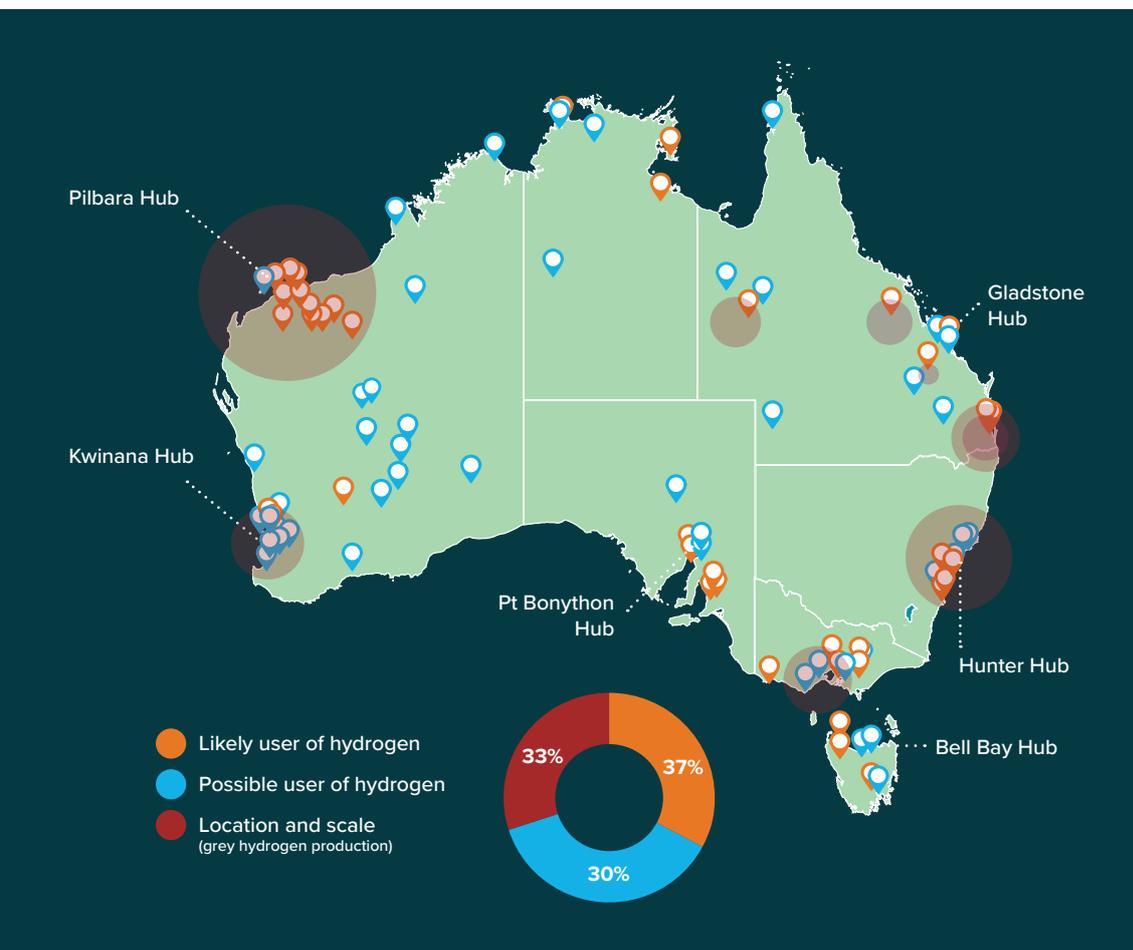
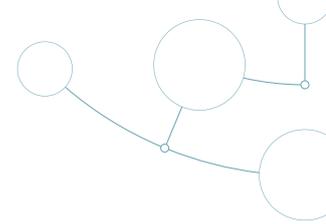


Figure 4: Location of Safeguard Facilities and potential to use hydrogen (Source DCCEEW analysis)



In addition to a direct reduction in carbon emissions, a large-scale switch within this industry would also produce a rapid improvement in the volume-driven economics for Australia's pipeline of hydrogen production projects, of which over 35 are focused on making ammonia for both domestic use and export. This large switch could also de-risk investment in a domestic electrolyser manufacturing sector because this shift would ultimately require in the order of 7,000 megawatts of electrolysis. By comparison, at the end of 2021, the cumulative installed capacity of electrolysers worldwide was 513 megawatts.⁵

Industrial process heat – Domestic

Australian industry accounts for 44% of the nation's end use energy, half of which is used in the production of process heat, primarily through the direct combustion of fossil fuels⁶.

Hydrogen can replace natural gas for industrial process, particularly where heat is required at medium to high temperatures. This includes as a replacement for natural gas for industrial heating purposes in iron pellet production⁷, alumina refining⁸ and food processing⁹. Switching to renewable hydrogen calcination in alumina refining would save 3.5 MtCO₂e p.a. Together, this would account for 23.7% of Australia's emissions from industrial processes and product use or the equivalent of taking 1.6 million cars off Australia's roads each year.¹⁰

Electricity grid firming – Domestic

Hydrogen can also play a key role to support the decarbonisation and transformation of national electricity grids through creating schedulable load, storing energy when generation is in surplus and making it available to help meet peak electricity demand¹¹. This approach is particularly synergistic with intermittent renewable electricity generation. Australia is considered a relative leader in the use of hydrogen for grid firming, considering the early development of the South Australian Government's 200 MW hydrogen-fired power station in Whyalla, the Tallawarra B gas generator under construction and the Hunter Power Project.

5 [Dr-Alan-Finkel-AHRC-2023-Presentation-Speech.pdf \(ahrc2023.com.au\)](#)

6 Lovegrove, K (2019) <https://arena.gov.au/assets/2019/11/renewable-energy-options-for-industrial-process-heat.pdf>

7 HyResource (2023) Grange Resources Renewable Hydrogen Study. CSIRO at <https://research.csiro.au/hyresource/grange-resources-renewable-hydrogen-study>

8 Rio Tinto (2021) [Media Release - Rio-Tinto and Sumitomo to assess hydrogen pilot plant at gladstones yarwun alumina refinery](#)

9 PV Magazine (2023) [Industry-first pilot using hydrogen in food manufacturing launches in NSW](#)

10 Deloitte (2023) [The Hydrogen Tipping Point](#)

11 HyResource (2023) [South Australian Government Hydrogen Facility – HyResource \(csiro.au\)](#)

Transport - Domestic and International

Hydrogen is already used in the transport systems of other countries and offers advantages in terms of weight, power density, range, and refuelling times. These characteristics are particularly valuable to heavy commercial vehicles including trucks, forklifts, mining vehicles, buses, trains, and marine shipping and ferries¹².

Australian firms are already manufacturing and testing the first hydrogen buses. Hydrogen trucks and mining trucks could help support decarbonisation of the heavy road-transport sector that contributes close to 40% of the Australian transport sector's greenhouse gas emissions. Australian firms are also leading global designers of hydrogen ferries.

Marine industry – bunkering – Domestic and International

Currently, Australia's supply of fuel oil for international maritime shipping is much smaller than Australia's share of seaborne international cargo (by weight). This reflects the practice of bunkering at ports with lower cost supplies of fuel oil. The maritime sector is taking large steps towards decarbonising its operations¹³. In a future in which ships are powered by hydrogen (or an equivalent derivative such as ammonia or methanol), this practice may change with bunkering occurring in Australia to take advantage of low-cost production of hydrogen. For instance, in 2022, Yara Clean Ammonia and Pilbara Ports Authority (PPA) signed a Collaboration Agreement to jointly facilitate the uptake of ammonia as a marine fuel in the Pilbara region in Western Australia.

Replacement of diesel generators

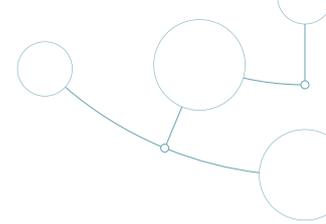
Many resource mining and remote communities in Australia rely on diesel or natural gas generators for their electricity supply. Studies by CSIRO and Advisian¹⁴ note that hydrogen has reached price parity with battery-diesel hybrid systems in remote power services. Replacing diesel with hydrogen presents a clear near-term opportunity and offers health and air quality benefits and potential synergies with associated heavy vehicle fleets. Australian start-ups are innovating in this space creating new domestic manufacturing opportunities.

As well as replacing diesel generators in rural and remote Australia, such technologies could also help Pacific Islands and parts of ASEAN nations transition from diesel generators to clean hydrogen generators and or clean hydrogen embedded into renewable micro-grids. Internationally and domestically hydrogen is already being used in micro-grid projects for civilian and Defence applications.

12 Samples of Australian hydrogen ferry design expertise - [Future-ready Fast Ferries: Developing pathways to Zero Emissions | Austal: Corporate](#) and [Austal to design hydrogen powered catamaran ferry - Australian Manufacturing Forum \(aumanufacturing.com.au\)](#) and [Gotland picks Austal to design world's first large hydrogen catamaran | TradeWinds \(tradewindsnews.com\)](#)

13 For example <https://climatechampions.unfccc.int/green-hydrogen-and-green-shipping/> and [Maritime industry joins forces with leading global miners in support of Australia-East Asia iron ore Green Corridor \(riotinto.com\)](#)

14 Advisian (2021) Australian Hydrogen Market Study at www.cefc.com.au/media/nhnhw1xu/australian-hydrogen-market-study.pdf



Sustainable aviation fuels – Domestic and Export

Aviation fuel for long distance flights is regarded as a hard to abate sector. To make jet fuel, it takes, two elements – carbon and hydrogen. The carbon can be extracted via carbon capture and utilisation from industrial processes or from the air using direct air removal and the hydrogen extracted from water. The end product is normally referred to as synthetic jet fuel. It can be shipped to international customers at much lower cost than the feedstocks. The key for Australia is achieving ultra-low cost renewable generation, at vast scale, to power the direct air capture equipment and the electrolyzers.

Green Iron and Steel production - Domestic and Export

As the world's largest iron ore producer, Australia can play a significant role in transitioning steelmaking to a net-zero emissions industry (currently around 7% of global emissions). Australia exports almost 900 million tonnes of iron ore each year, but only produces 5.5 million tonnes of steel.

There is the potential to establish a new onshore green iron ore and steel processing industry, utilising renewable energy and hydrogen to value-add to our significant iron ore exports. An Australian green iron industry could reduce global emissions significantly while creating new high-quality jobs in Australia and attracting increased national revenue and international investment¹⁵.

Agriculture and food sectors – Domestic and Export

Internationally progress is being made to utilise clean hydrogen to help decarbonise the agriculture and food sectors. Hydrogen fuel cells can be used to power farm equipment and machinery. Japanese multi-national Kubota plans to roll out a mass-produced hydrogen fuel cell tractor in 2025.

A wide range of researchers and companies¹⁶ are demonstrating that hydrogen can be used alongside carbon dioxide and natural bacteria to enable precision fermentation to create close to carbon neutral protein food, with the potential to form a food product substitute for palm oil and soy, animal livestock protein feed¹⁷, and many types of consumer food products and biomaterials¹⁸. CSIRO's 2022 National Protein Roadmap predicts that by 2030, Australia could realistically produce 225,000 tonnes of finished precision fermentation¹⁹ microorganism-based protein products, worth A\$2.2 billion at retail and 2,020 jobs by 2030²⁰. The global market for alternative lower carbon proteins is forecast to be worth as much as \$290 billion by 2035²¹.

15 Modelling by Accenture indicates the potential development of green iron and steel sector in Australia could create \$35.3 billion in exports, \$20.1 billion in direct and indirect value add and create up to approximately 111,000 direct and indirect jobs by 2040.

16 Solar Foods - [Home - Solar Foods](#) and [Solar Foods receives novel food regulatory approval for a protein grown with CO₂, hydrogen and electricity - Solar Foods](#) Air Protein [Air Protein Announces \\$32 Million Series A Funding - SynBioBeta](#)

17 Deep Branch - [Deep Branch – Clean ingredients for climate-friendly food](#) which has been promoted by the World Economic Forum at [This start-up recycles CO₂ and hydrogen into animal feed | World Economic](#) is focused on this application of creating low carbon livestock protein feed using hydrogen as one of the ingredients.

18 The company Kiverdi uses all-natural microbes to transform carbon dioxide and hydrogen into high-valued protein food, nutrients, and bio-based materials. [Kiverdi | Bio-Based Industries Consortium \(biconsortium.eu\)](#)

19 CSIRO (2021) [Precision Fermentation – Scaling the Next Manufacturing Revolution and CSIRO – Precision Fermentation](#)

20 CSIRO Futures (2022) [Protein - A Roadmap for unlocking technology-led growth opportunities for Australia](#)

21 Boston Consulting Group (2023) [Alternative-Protein Market to Reach at Least \\$290 Billion by 2035 \(bcg.com\)](#)

1. Is prioritising the decarbonisation of ammonia production the most prospective way to achieve both hydrogen industry growth and industrial decarbonisation in the short-term?
2. What other actions in the other sectors, will have the greatest decarbonisation impacts?
3. What sectors are best placed to be early adopters of hydrogen?
4. Are there specific barriers that may limit hydrogen uptake uptake in each of these sectors?

For example: are there particular infrastructure needs to enable hydrogen to contribute to grid resilience?

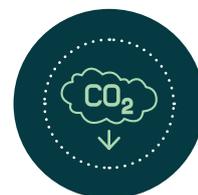
Is specific regulation needed to ensure hydrogen can assist in the decarbonisation of the heavy transport sector?

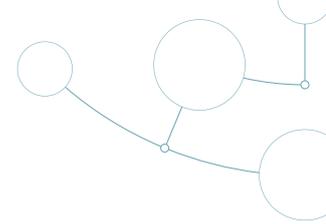
Is further planning needed before Australian ports can increase their share of bunkering for international shipping?

Or, are specific incentives needed to rapidly switch to hydrogen powered generators at remote community and mine sites?

5. What are the actions required to overcome those barriers and realise the opportunities?

For instance, what supply chain risks need to be addressed and overcome?





How could Australia further activate its hydrogen and related industries?

The 2019 Strategy supported the hub model as an early-stage approach to achieve the scale needed for a competitive industry. Hydrogen hubs are intended to make the development of supply chain infrastructure more cost-effective by aggregating various users of hydrogen into one geographical area. Plans for hydrogen hubs are also being progressed internationally for example in the United States, United Kingdom, Germany, the Netherlands, Japan and India.

The Australian Government is investing over half a billion dollars, and the states and territories have committed over \$400 million, to support the development of regional hydrogen hubs across Australia.

An alternative to the Hub model would be to target high-impact sectors which offer the greatest potential to scale up quickly, provide substantial decarbonisation or provide significant economic gain. For example, the Australian Government is already working with states and territories to help decarbonise heavy transport through Hydrogen Highways and related initiatives, and is consulting on the design of the \$2 billion Hydrogen Headstart program that is not specifically targeting hydrogen production projects in a hydrogen hub where other producers and users are collocated.



6. Should Australian governments adopt a more sector driven approach to hydrogen industry development?

Targets and mandates

National hydrogen targets were not considered immediately necessary in 2019, with the 2019 Strategy flagging targets as a future option as the market for hydrogen develops. Targets and mandates can take many forms and provide the industry with confidence of the future marketplace for hydrogen. The European Union, United Kingdom and the Netherlands all increased their hydrogen production ambitions in 2022.

Japan and Korea have introduced aspirational targets for an expanded role for ammonia fuel by 2030. Both regulated and aspirational targets can benefit industry development by signalling government and/or industry ambition to bolster investor confidence. In June 2023, the Korea H2 Business Summit, comprising prominent companies such as Hyundai Motor Group, SK Group, Posco Group, and LG Chem, announced goals of achieving more than 10 percent carbon emission reductions through hydrogen by 2030. Other countries have also introduced targets for the use of clean hydrogen in industry and for the transport sector (refer 2022 State of Hydrogen Report Table 12²²).

22 DCCEEW (2023) State of Hydrogen 2022 Report at www.dcceew.gov.au/energy/publications/state-of-hydrogen-2022

Without sufficient demand, hydrogen producers will be unable to lock in off-takers and secure investment to scale up production. For example, the NSW government’s renewable fuel scheme is based around a hydrogen production target and requires gas retailers and large users to buy certificates associated with the production of hydrogen in order to achieve the target. Some experts suggest starting with a sectoral target, which focuses on switching over existing uses of hydrogen in Australia, such as ammonia production, to clean hydrogen and having a realistic target date and package to support that transition²³. This could not only drive greater clean hydrogen investment but also create sufficient domestic demand in Australia that it could also de-risk greater investment in electrolyser manufacturing in Australia too. India and some European nations have signalled their intention to adopt mandatory quotas for the use of clean hydrogen by industry, and European nations have agreed to build hydrogen fuelling stations in all major cities and at least every 200 kilometres along the core Trans-European Transport Network, ensuring a sufficiently dense network to allow hydrogen vehicles to travel across the European Union.

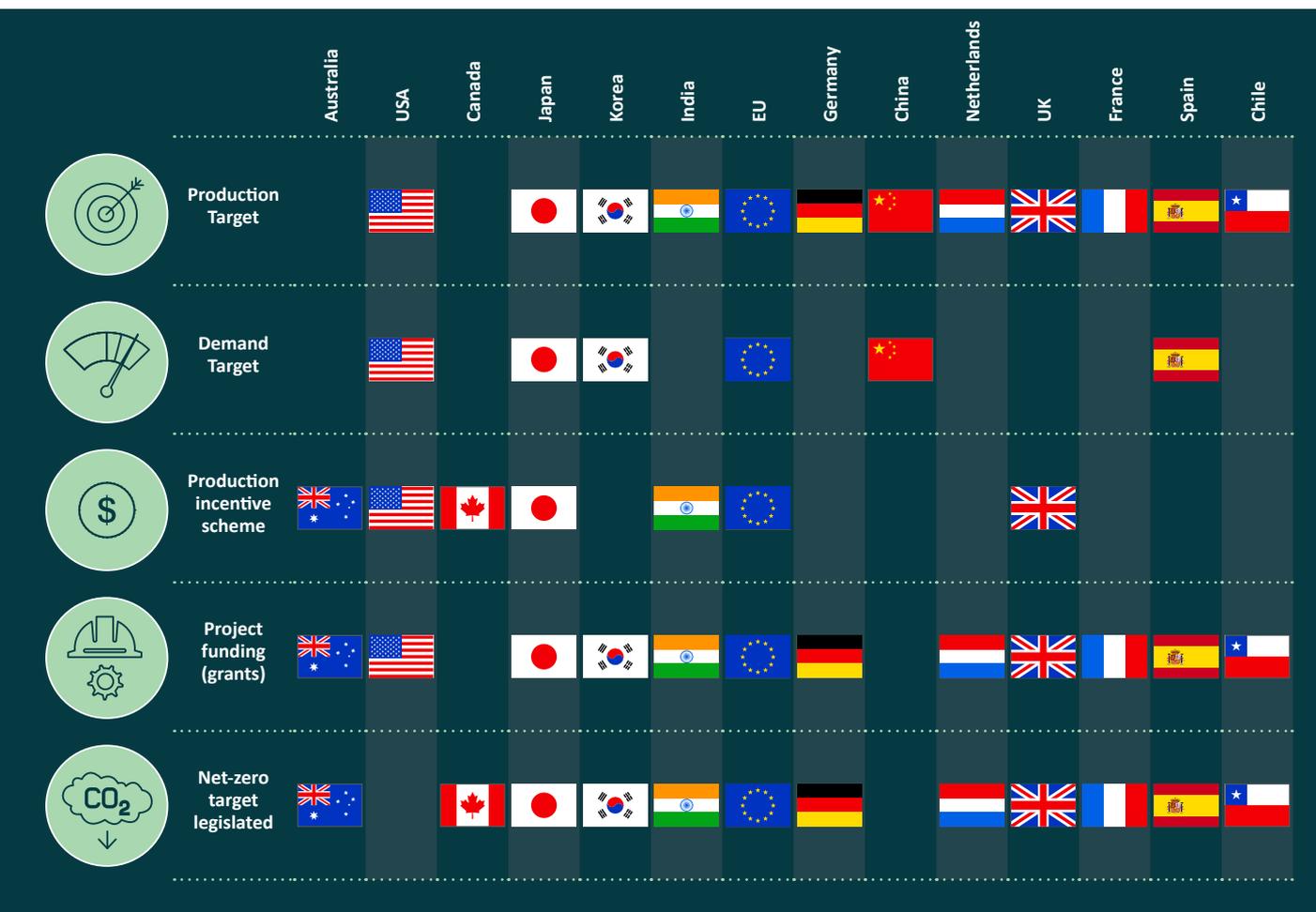


Figure 5: Summary of international hydrogen policy measures

23 Finkel, A (2023) Keynote Address – Australian Hydrogen Research Conference at [Dr-Alan-Finkel-AHRC-2023-Presentation-Speech.pdf \(ahrc2023.com.au\)](https://ahrc2023.com.au)



India's National Hydrogen Mission

In 2021, Prime Minister Narendra Modi announced India's National Hydrogen Mission. India's Hydrogen Mission seeks to transform India into a global green hydrogen production hub. The target of the Hydrogen Mission is to produce 5 million tonnes of green hydrogen by 2030. In order to create bulk demand and scale up green hydrogen production, the Indian Government will specify a minimum consumption share of green hydrogen or its derivative products as energy or feedstock. A legal provision for ensuring enforceability of consumption targets for green hydrogen and its derivatives will be established through the Energy Conservation Act, which will empower the Indian Government to specify the minimum share of energy and feedstock consumption from non-fossil fuel based sources that an industry must ensure.



7. Should Australian governments adopt national hydrogen production, use and/or export targets for hydrogen?
8. If targets are adopted, what type of activities and/or sectors should this target be tailored towards? For example, production targets, demand targets for sectors such as transport or a renewable gas target. Please describe how such targets would attract investment.
9. Should Australian governments use regulatory mandates to drive demand for hydrogen? If mandates were adopted, what type of activities and/or sectors could mandates be directed towards? Please describe how such mandates would attract investment.

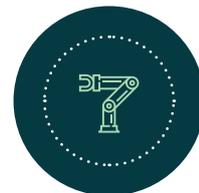
Addressing Supply Chain Risks

The 2019 Strategy supported early actions to develop clean energy supply chains to service new and existing users of hydrogen and to develop capability for rapid industry scale-up, including skills and training for the hydrogen economy. The financial incentives provided by the United States *Inflation Reduction Act*, as well as those being implemented by other countries in response to the United States' actions, will put near-term pressure on already constrained supply chains, potentially resulting in higher costs or project delays. Over time, growing global investment is expected to scale industry development, expanding supply chains and ultimately bringing down costs.

Australia's development of a hydrogen-ready workforce is critical given our scale of ambition. Understanding the extent to which existing qualifications need to be altered and whether entirely new courses are required is an important first step. Beyond that step, the workforce numbers and occupations required will be necessary information to plan for the growth of the sector. The Australian government is currently scoping the existing and planned workforce policies and initiatives as a first step to building Australia's future energy workforce.

The government is also conducting a comprehensive review of Australia's migration system to ensure it better meets existing challenges and sets a clear direction for the coming decades. The new National Net Zero Authority²⁴ will also support workers in emissions-intensive sectors to access new employment, skills and support as the net zero transformation continues.

10. What are the most significant supply chain barriers being faced by Australia's hydrogen industry? Where should Australian governments focus efforts on securing elements of supply chains needed to enable the accelerated growth of the hydrogen sector?
11. Should Australia develop and support local manufacturing capabilities to secure the hydrogen supply chain? What are the specific areas of opportunity (e.g. fuel cell or electrolyser manufacturing or hydrogen transportation related manufacturing)?
12. What are the barriers to developing and supporting local manufacturing capabilities?
13. What is the role of industry and governments to ensure the hydrogen industry has access to an appropriately sized and skilled workforce?



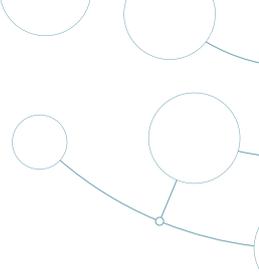
Timely access to electrolysers and fuel cells is going to be critical to creating and sustaining a globally leading clean hydrogen industry from 2030 in Australia. As illustrated in Figure 9 of the 2022 State of Hydrogen Report²⁵, according to the project pipeline to 2030, the International Energy Agency's forecasts a total global electrolyser capacity of 130 GW by 2030, including 30 GW of electrolyser capacity in Australia.

The scale of demand for electrolysers and associated renewable energy between now and 2050 to deliver the quantum of renewable based hydrogen needed for nations to achieve their net zero targets is significant. Producing all of the dedicated hydrogen output in 2019 (69 MtH₂) from electricity would result in an electricity demand of 3,600 TWh, more than the total annual electricity generation of the European Union. To reach IRENA's projection for hydrogen use by 2050 in a 1.5°C scenario some 5,000 GW of hydrogen electrolyser capacity would be needed, up from 0.3 GW in 2022²⁶. The electricity required to produce this scale of hydrogen in 2050 reaches close to 21,000 TWh, almost the level of global electricity consumption today. Australia and the broader Indo-Pacific region is anticipated to comprise roughly 21% of global hydrogen demand in 2050. In this context, Fortescue Future Industries has invested in an electrolyser manufacturing plant in Gladstone. Hysata's work with Fraunhofer IPT in developing a new capillary led electrolyser to deliver low-cost hydrogen in Port Kembla is also an example of how Australian companies can develop innovative electrolyser technology and IP.

24 [National Net Zero Authority | Prime Minister of Australia \(pm.gov.au\)](https://www.pm.gov.au)

25 DCEEW (2023) State of Hydrogen 2022 Report at www.dceew.gov.au/energy/publications/state-of-hydrogen-2022

26 IRENA (2022) [Geopolitics of the Energy Transformation – The Hydrogen Factor](#)



The market is in the early stage of the electrolyser manufacturing learning cost curves with significant technical opportunities available to improve their energy efficiency in ways that can reduce both CAPEX and OPEX. Electrolysers are complex, with cooling systems, water de-ionising and pumping, gas separation, electric power conditioning, safety monitoring, dehydrating systems and more. So, it will be important to have a skilled electrolyser workforce. The combination of supply chain bottleneck risks, the high costs of importing electrolysers and the need for a highly skilled electrolyser workforce indicate an opportunity for industry and Australian Governments to encourage the creation of a domestic electrolyser manufacturing sector²⁷.

The potential market for electrolysers in Australia is significant, which could underpin a domestic electrolyser manufacturing sector. The Australian Government's National Reconstruction Fund and Powering the Regions Fund provide a opportunity to support this type of domestic industry to develop.

Fuel cell manufacturing is, by comparison with electrolyser manufacturing, a lot more advanced overseas. However, fuel cells are also generally at most 60% energy efficient suggesting potential technical innovation and improvement is possible. There could also be a case for investing in fuel cell R&D&D to improve fuel cell efficiency, and then a local fuel cell manufacturing sector as part of strategically positioning Australia for long term global clean hydrogen industry competitiveness.



14. In addition to electrolyzers, where do you see a role for domestic hydrogen related manufacturing to address supply chain risks and ensure Australia meets its decarbonisation targets such as hydrogen buses/heavy vehicles?

²⁷ Finkel, A (2023) Keynote Address – Australian Hydrogen Research Conference at - [Dr-Alan-Finkel-AHRC-2023-Presentation-Speech.pdf \(ahrc2023.com.au\)](#)

How can we ensure our hydrogen industry attracts the necessary investment?

Australia has a substantial pipeline of announced projects, in the order of \$230-\$300 billion. However, Australia lags behind other nations in converting announcements into final investment decisions.

The significant cost gap between renewable hydrogen and high-carbon alternatives is a major barrier to advancing Australia's hydrogen industry. The recently announced \$2 billion Hydrogen Headstart program will support large-scale renewable hydrogen projects through competitive hydrogen production contracts.

The focus of this funding program plays to our comparative advantage in relation to renewable resources and available land, as well as the inherently low emissions of the technology and expectation of substantial reductions in production costs as both projects and associated supply chains scale up and technology improvements are realised. The renewable hydrogen production pathway is predicted to be on par with other production pathways between 2030²⁸ to 2040²⁹, with the analysis undertaken for the National Hydrogen Infrastructure Assessment indicating that renewable hydrogen being the most economic production pathway for most locations across multiple time horizons out to 2050³⁰. The 2022 State of Hydrogen also reported almost all (97%) of Australia's hydrogen pipeline intends making use of the renewable hydrogen production pathway. Given these observations there may be merit in reevaluating the current technology neutral approach in favour of a more targeted approach based on renewable hydrogen.

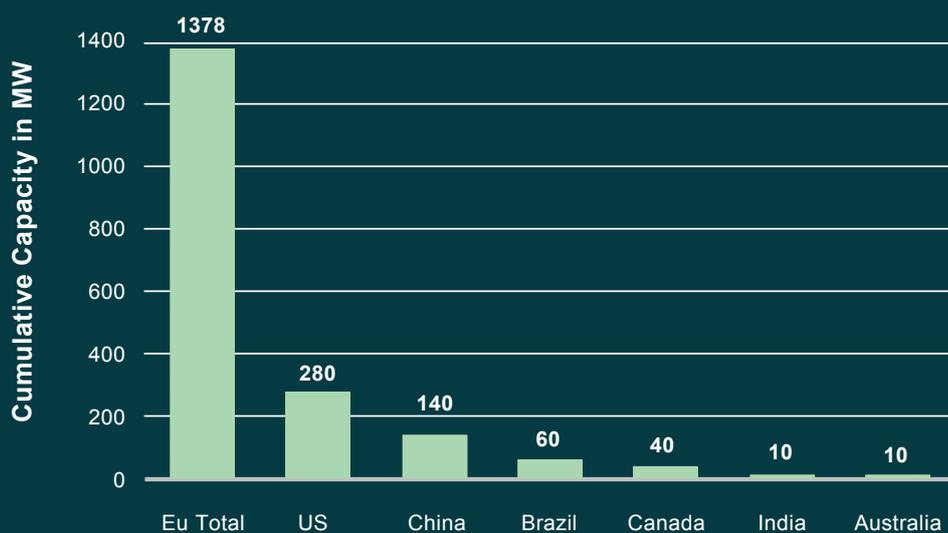


Figure 6: Cumulative capacity of >10MW reaching FID (Source DCCEEW analysis, IEA data)

28 [Green' Hydrogen to Outcompete 'Blue' Everywhere by 2030 | BloombergNEF \(bnf.com\)](#)

29 Deloitte (2023) Green hydrogen: Energizing the path to net zero at www.deloitte.com/content/dam/assets-shared/docs/gx-deloitte-green-hydrogen-report-2023.pdf

30 DCCEEW (2023) National Hydrogen Infrastructure Assessment at www.dcceew.gov.au/sites/default/files/documents/

The Australian Government is also providing \$5.6 million to support further analysis on the best ways to leverage Australia’s competitive strengths to become a renewable energy superpower, including through the production of hydrogen, with further actions to be identified by the end of 2023.

A range of mechanisms have been implemented internationally by various countries to unlock investment to support the growth of their hydrogen industries. The United States are introducing production tax credits via the Inflation Reduction Act, Canada is introducing an investment tax credit approach, the United Kingdom has introduced a contract for difference program while India is implementing mandates.



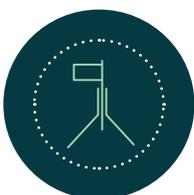
15. What in addition to the commercial cost gap is preventing Australian hydrogen projects progressing beyond a financial investment decision?
16. What signals are effective overseas and can apply to unlock greater investment?
17. Are there any other measures needed to unlock investment in the development of the Australian hydrogen industry including from international and Australian institutional investors?
18. When would it be appropriate to take a ‘tech neutral’ approach to developing hydrogen, and when would a more directed approach be warranted?

The 2019 Strategy highlighted the importance of ensuring regulation is hydrogen ready to enable the development of the new hydrogen industry. Australian governments have conducted a coordinated review of Australia’s legal frameworks to assure hydrogen safety, industry development and national consistency.

As a result of the review of legal frameworks, the Commonwealth, states and territories are developing a range of National Hydrogen Codes of Best Practice. The 5 national codes of best practice will provide greater regulatory certainty, reduced approval times and regulatory costs for technology companies, investors and project developers in the key supply chain priority areas:

- National Code of Best Practice Hydrogen Production
- National Code of Best Practice Ammonia Production
- National Code of Best Practice Hydrogen Refuelling
- National Code of Best Practice Hydrogen Appliances, Plant and Equipment
- National Code of Best Practice Ammonia Appliances, Plant and Equipment

In the 2023-24 Budget, \$38.2 million was provided for the creation of a Guarantee of Origin scheme to certify renewable energy and track and verify emissions from clean energy products, starting with hydrogen.



19. What further regulatory work is required as we accelerate the development of the hydrogen industry? What barriers do you currently see?

How can we ensure our hydrogen industry develops in a way that benefits all Australians?

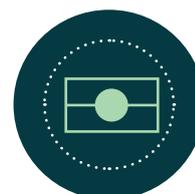
Australia's developing clean energy industries, including those dependent on hydrogen, have the potential to create tens of thousands of jobs. These opportunities could be in the same regions where carbon-intensive industries are currently located and provide new employment opportunities in regions where carbon-intensive jobs are forecast to decline. However, these developments will lead to increased demand on land, transport infrastructure, water resources, and social services. For example, addressing water security concerns has been highlighted as critical for community acceptance due to concerns hydrogen production may impact existing water uses and availability, especially in resource constrained areas. To start to address this, in 2023, the Australian Government and Australian Hydrogen Council released the Water for Hydrogen Study³¹. Other studies, information and actions could assist.

- 20. What actions do you view as being critical to build and maintain community support for Australia's developing hydrogen industry?
- 21. How should the interests of the emerging hydrogen industry with respect to water be balanced with other users?

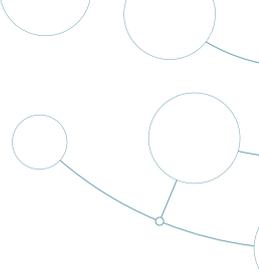


Much of the anticipated hydrogen industry growth will occur in remote and regional areas. This will create new economic opportunities, including for First Nations communities. Significant and early effort is required for capacity building to build community understanding of hydrogen projects and for local communities to be fully informed when engaging with potential hydrogen project proponents. There is also a need to better engage, empower regional communities and First Australians to identify how the clean hydrogen opportunity can complement and help enable the realisation of their visions for their economic future. There is also a need to improve capacity building and understanding within both regional communities, First Australian communities, and the clean hydrogen industry on options for best practice partnership agreements based on global best practice. The Australian Government committed \$2.0 million in the 2023-24 Budget to establish a fund to enable First Nations communities and businesses to engage with hydrogen project proponents, planning processes and program design.

- 22. How else can Australian governments ensure that First Nations communities are resourced to effectively participate, benefit and be empowered by the development of the hydrogen industry?
- 23. Is there more information that the communities including First Nations communities would like to receive about the renewable energy and hydrogen sector? What information should be provided?
- 24. What regulatory barriers will become more prominent as we accelerate the development of the hydrogen industry?



31 ARUP (2023) [Water for Hydrogen – Technical Report](#). Australian Hydrogen Council and DCCEEW.



Hydrogen can play a key role in providing energy security for Australia in case of supply disruptions, caused by international conflicts, natural disasters, and unforeseen outages, as well as reducing associated energy price volatility. Hydrogen can also play a key role in ensuring Australia can remain a reliable provider of energy security to its partners in the region, including Japan and the Republic of Korea. With appropriate frameworks there is an opportunity to ensure domestic and export hydrogen markets work in tandem to support functional domestic and global energy markets that work for all consumers and bolster investment confidence.

The Australian Domestic Gas Security Mechanism (ADGSM) is an example of a mechanism that ensures there is sufficient natural gas supply to meet the needs of Australian energy users, and operates as a measure of last resort. Other jurisdictions have implemented other mechanisms to support functional domestic energy markets, including Western Australia's gas domestic reservation scheme.

As flagged by the 2019 hydrogen strategy, both a reserve and price cap mechanism could be considered for hydrogen.

As the hydrogen sector matures, government will need to continue to evaluate how it can best support the hydrogen sector, while ensuring the hydrogen sector delivers economic and community benefit. It will be important to regularly examine the appropriate role of financial support as Australia and our trading partners decarbonise.



25. What market conditions would indicate the need for a hydrogen reserve, price cap or other fuel security measures?
26. How can Government/s ensure that the early strong investment in the sector transitions to government revenue as the sector matures?

How should we develop the necessary infrastructure needed to support the development of our hydrogen industry?

The 2019 Strategy included actions to complete a National Hydrogen Infrastructure Assessment (NHIA), to be reviewed and updated at least every 5 years. The first iteration of the NHIA provides insight into infrastructure options and associated challenges that will be confronted by an expanding hydrogen industry³².

The NHIA gave comprehensive consideration of potential infrastructure needs including renewable energy demand, transporting hydrogen, water availability, storage, and land restrictions across multiple time horizons and demand scenarios.

Analysis by ClimateWorks and the Australian Renewable Energy Agency (ARENA) found as much as 364,000 tonnes (44PJ) of hydrogen is required to be produced by 2030 and 2,230,000 tonnes (268PJ) is required by 2050 to support industrial decarbonisation³³. The International Energy Agency predicts that global demand for hydrogen could reach 115 million tonnes per year by 2030. This level of production will likely require extensive deployment of renewable electricity generation, many multiples of the current size of our electricity grids³⁴, which may saturate existing Renewable Energy Zones in coming decades³⁵.

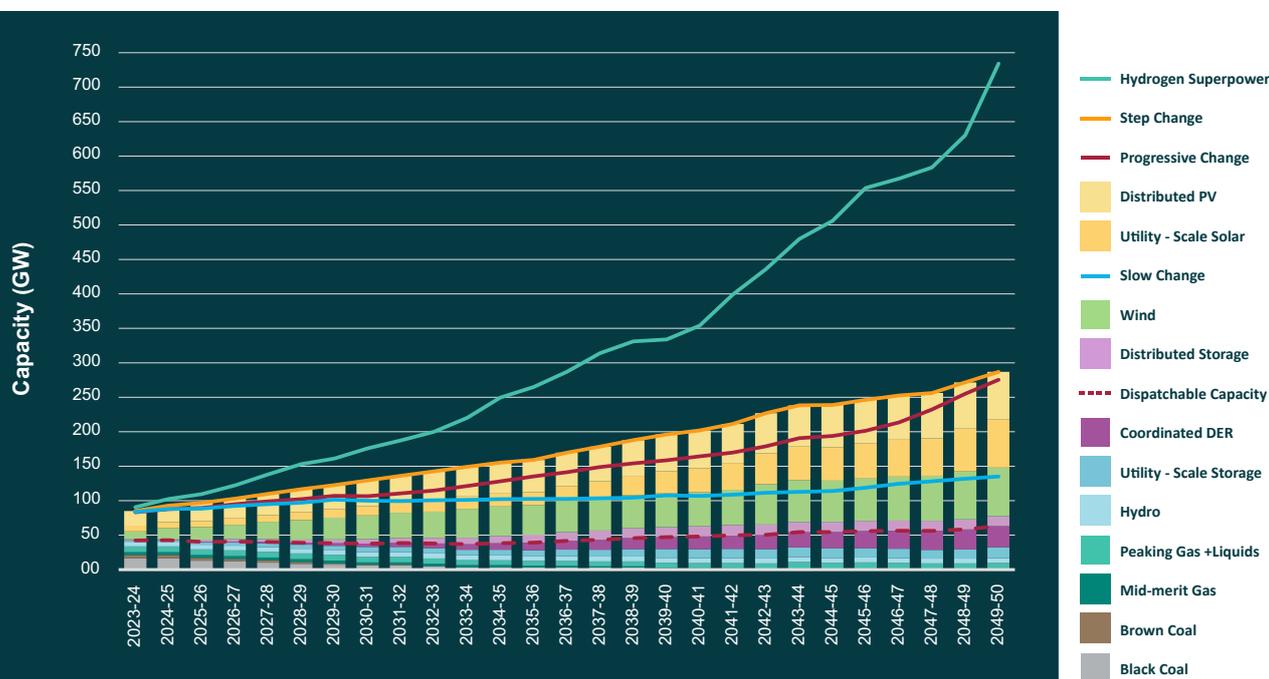


Figure 7: Substantial increase in NEM capacity to support high ambition hydrogen scenarios by 2050 (Source – 2022 Integrated Systems Plan, AEMO)

32 DCEEW (2023) National Hydrogen infrastructure Assessment www.dceew.gov.au/energy/publications/national-hydrogen-infrastructure-assessment

33 ARENA (2023) Industry Sets Path to Net Zero – Media Release at <https://arena.gov.au/news/industry-sets-a-path-for-net-zero>

34 ClimateWorks Australia & CSIRO (2023) [Pathways-to-industrial-decarbonisation-australian-industry-eti-phase-3-report.pdf](https://www.climateworks.org.au/wp-content/uploads/2023/08/Pathways-to-industrial-decarbonisation-australian-industry-eti-phase-3-report.pdf) (arena.gov.au), ARENA

35 [2022-integrated-system-plan-isp.pdf](https://www.aemo.com.au/energy-systems/integrated-system-plan/2022-integrated-system-plan-isp.pdf) (aemo.com.au), National Hydrogen Infrastructure Assessment: Final Report (dceew.gov.au)



27. How can the National Hydrogen Infrastructure Assessment be delivered to maximise the value to governments and industry?

For example, the existing approach could be repeated or alternatively specific infrastructure issues such as water supply and treatment, storage, hydrogen pipelines could be given particular attention.

28. How can Australian governments ensure the efficient use of existing infrastructure, and delivery of new infrastructure, including common user infrastructure?

29. How should the infrastructure needs of the hydrogen industry be balanced with other infrastructure users e.g electricity generation?

30. What are the trade-offs (or synergies) of developing a hydrogen industry with other government goals?

For example, the growth of the hydrogen sector may present trade-offs regarding the prioritisation of the 82% national renewable electricity target, or competition for existing water infrastructure. However, hydrogen also presents an opportunity to enhance grid stability and could contribute positively to regional water security issues through the development of shared infrastructure.

Existing gas infrastructure

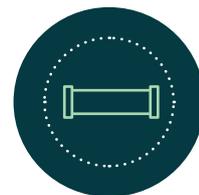
The 2019 Strategy places considerable emphasis on the importance of blending hydrogen into existing gas pipelines both as a source of demand to drive production, but also with a view to its likely use in residential heating.

To this end Energy Ministers agreed to amend the National Gas Law, National Energy Retail Law and Regulations to bring hydrogen and other gases into the National Gas Regulatory regime. Following introduction and passage through the South Australian Parliament, it is anticipated the new regime will be in force by the end of 2023.

However, Australian governments have subsequently committed to enabling the transition to renewable energy dominated electricity grids, and using electricity directly may provide a more efficient means of providing residential heating given the energy loss that is inevitable in the production hydrogen with renewable electricity. The Grattan Institute points to the common finding from a range of international studies regarding the higher network and consumer charges associated with the use of hydrogen for space and water heating in the domestic setting.

At the same time, Grattan point to the likely importance of hydrogen as an industrial fuel³⁶. Given the main uses for hydrogen today are already industrial, and there is likely to be a significant increase in demand for ammonia, methanol, high temperature industrial heat applications³⁷ reconsideration could be given as to its role in residential space and water heating. Other studies also point to hydrogen being used as an air fuel in the future too, meaning it would be needed for refuelling at airports that are connected via existing gas pipeline infrastructure to the existing gas networks.

31. How can existing gas infrastructure be repurposed to address priority use cases for hydrogen?



How can we enable a hydrogen export industry (including the export of goods manufactured with hydrogen)?

The 2019 Strategy included actions to support the development of bilateral partnerships to build future trade relationships and hydrogen markets. This is because our capacity to produce hydrogen most likely exceeds our domestic demand, while at the same time some of our nearby, and existing trade partners have a great need but relatively lower capacity to produce. Figure 8 points to substantial interest by Australian projects targeting export markets. The development of a hydrogen export industry will support investment in the sector and also provides at least some offset to the likely reduction in export income derived from fossil fuel exports. Although the scale of this benefit may be tempered by a delayed reaction to the US IR Act.³⁸

Australia has entered 8 clean energy partnerships with the United States, Japan, Germany, Singapore, United Kingdom, Republic of Korea, the Netherlands and India, each of which include hydrogen collaboration. Individual states and territories also have in place a variety of agreements and are engaging directly with potential international partners on hydrogen supply chain matters.

International partners such as Germany have introduced the H2 Global initiative to procure green hydrogen and derivatives. Through an intermediary, the German Government purchases green hydrogen products on the world market and then sells that hydrogen to the highest offtaker bid in the European Union. The long-term purchase contracts assist projects attract investment, while short-term sales contracts support green hydrogen take-up at the industry's early stage.

³⁶ Grattan Institute (2023) Getting Off Gas – Why, How, and Who Should Pay? At <https://grattan.edu.au/wp-content/uploads/2023/06/Getting-off-gas-why-how-and-who-should-pay.pdf>

³⁷ [The Future of Hydrogen \(windows.net\)](https://www.windows.net)

³⁸ Deloitte (2023) Australia's Hydrogen Tipping Point at <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/about-deloitte/deloitte-au-australias-hydrogen-tipping-point-report-updated-280223.pdf>

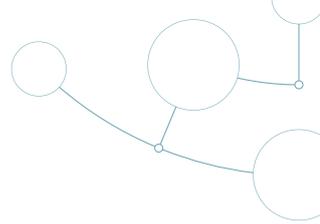


Figure 8 Planned hydrogen support exports - by country, 2030 (Source International Energy Agency, Global Hydrogen Review)



- 32.** How can agreements with other nations best support rapid growth to Australia’s hydrogen industry?
- 33.** How should Australia ensure that the necessary foreign investment in hydrogen industry, and export projects leads to lasting benefits for all Australians?

Other feedback

The 2019 Strategy emphasised the importance of collaboration and knowledge sharing across governments, industry, academia and communities. These factors will be critical to adopting an accelerated industry development model.



- 34.** What other issues should Australian governments consider in relation to revising the National Hydrogen Strategy?

Appendix A

Summary of consultation matters

How can Australia enable decarbonisation through the development of a hydrogen industry?

- 1 Is prioritising the decarbonisation of ammonia production the most prospective way to achieve both hydrogen industry growth and industrial decarbonisation in the short-term?
- 2 What other actions in the other sectors, will have the greatest decarbonisation impacts?
- 3 What sectors are best placed to be early adopters of hydrogen?
- 4 Are there specific barriers that may limit hydrogen uptake in each of these sectors?
- 5 What are the actions required to overcome those barriers and realise the opportunities? For instance, what supply chain risks need to be addressed and overcome?

How could Australia further activate its hydrogen and related industries?

- 6 Should Australian governments adopt a more sector driven approach to hydrogen industry development?

Targets and mandates

- 7 Should Australian governments adopt national hydrogen production and/or use targets for hydrogen?
- 8 If targets are adopted, what type of activities and/or sectors should this target be tailored towards? For example, production targets, demand targets for sectors such as transport, renewable gas target. Please describe how such targets would attract investment
- 9 Should Australian governments use regulatory mandates to drive demand for hydrogen? If mandates were adopted, what type of activities and/or sectors could mandates be directed towards? Please describe how such mandates would attract investment.

Addressing Supply Chain Risks

- 10 What are the most significant supply chain barriers being faced by Australia's hydrogen industry? Where should Australian governments focus efforts on securing elements of supply chains needed to enable the accelerated growth of the hydrogen sector?
- 11 Should Australia develop and support local manufacturing capabilities to secure the hydrogen supply chain? What are the specific areas of opportunity (e.g. fuel cell or electrolyser manufacturing or hydrogen transportation related manufacturing)?
- 12 What are the barriers to developing and supporting local manufacturing capabilities?
- 13 What is the role of industry and governments to ensure the hydrogen industry has access to an appropriately sized and skilled workforce?
- 14 In addition to electrolysers, where do you see a role for domestic hydrogen related manufacturing to address supply chain risks and ensure Australia meets its decarbonisation targets such as hydrogen buses/heavy vehicles?

How can we ensure our hydrogen industry attracts the necessary investment?

- 15 What in addition to the commercial cost gap is preventing Australian hydrogen projects progressing beyond a financial investment decision?
- 16 What signals are effective overseas and can apply to unlock greater investment?
- 17 Are there any other measures needed to unlock investment in the development of the Australian hydrogen industry including from international and Australian institutional investors?
- 18 When would it be appropriate to take a 'tech neutral' approach to developing hydrogen, and when would a more directed approach be warranted?
- 19 What further regulatory work is required as we accelerate the development of the hydrogen industry? What barriers do you currently see?

How can we ensure our hydrogen industry develops in a way that benefits all Australians?

- 20 What actions do you view as being critical to build and maintain community support for Australia's developing hydrogen industry?
- 21 How should the interests of the emerging hydrogen industry with respect to water security be balanced with other users?
- 22 How else can Australian governments ensure that First Nations communities are resourced to effectively participate, benefit and be empowered by the development of the hydrogen industry?
- 23 Is there more information that First Australians would like to receive about the renewable energy and hydrogen sector? What information should be provided?
- 24 What regulatory barriers will become more prominent as we accelerate the development of the hydrogen industry?

- 25 How can Government/s ensure that the early strong investment in sector transitions to government revenue as the sector matures?
- 26 How can Government/s ensure that the early strong investment in sector transitions to government revenue as the sector matures?

How should we develop the necessary infrastructure needed to support the development of our hydrogen industry?

- 27 How can the next infrastructure assessment be delivered to maximise the value to governments and industry?
- 28 How can Australian governments ensure the efficient use of existing infrastructure, and delivery of new infrastructure, including common user infrastructure?
- 29 How should the infrastructure needs of the hydrogen industry be balanced with other infrastructure users including electricity generators?
- 30 What are the trade-offs (or synergies) of developing a hydrogen industry with other government goals?
- 31 How can existing gas infrastructure be repurposed to address priority use cases for hydrogen?

How can we enable a hydrogen export industry (including the export of goods manufactured with hydrogen)?

- 32 How can agreements with other nations best support Australia's hydrogen industry?
- 33 How should Australia ensure that the necessary foreign investment in hydrogen industry, and export projects leads to lasting benefits for all Australians?
- 34 What other issues should Australian governments consider in relation to revising the National Hydrogen Strategy?

Appendix B

2019 National Hydrogen Strategy Actions

An adaptive pathway to clean hydrogen growth

- 2.1** Support an adaptive approach to industry development that means Australia can be ready to move quickly to scale up as signs of large-scale markets emerge. A ‘review-revise-adapt’ feedback loop will support and refine actions as technology and markets change. This adaptive approach will focus on actions that remove market barriers, efficiently build supply and demand, and accelerate the global hydrogen cost-competitiveness of Australia’s hydrogen industry.
- 2.2** Support an approach guided by four underpinning principles, namely to:
 - Take an adaptive and nationally coordinated approach to support industry development, including regular reviews
 - Prioritise regulatory consistency and a coordinated approach to project approvals
 - Support partnerships to activate the market
 - Put safety, environmental sustainability, and benefits to Australians at the forefront.
- 2.3** Support actions themed around seven areas: developing production capacity, supported by local demand; responsive regulation; international engagement; innovation and R&D; skills and workforce; community confidence; and national coordination.
- 2.4** Support a pathway for developing a local industry, initially by removing regulatory barriers to hydrogen use and encouraging it through policies to help early movers overcome investment barriers. Mandating use of hydrogen will require evidence that a net benefit to consumers will result, or there is a consumer willingness to pay where appropriate, and that industry can meet regulated requirements.

Large-scale market activation

- 3.1** Agree that early actions will focus on developing clean hydrogen supply chains to service new and existing uses of hydrogen (such as for ammonia production) and developing capability for rapid industry scale-up.
- 3.2** Agree to consider the most appropriate support to scale up the industry and activate markets in light of global signals.
- 3.3** Agree that mandatory national targets would not be appropriate at this time but should be re-considered periodically as the market develops.

Hubs and sector coupling

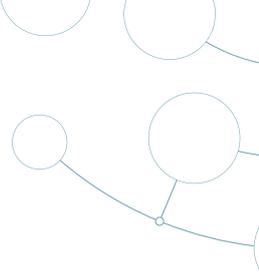
- 3.4** Support the hub model as a prospective early-stage approach to achieve the scale needed for a competitive industry.
- 3.5** Agree to consider each governments’ respective planning and funding timelines, and to the extent possible, harmonise funding application processes for hub projects.

Assessing our hydrogen infrastructure needs

- 3.6** Agree to complete an inaugural National Hydrogen Infrastructure Assessment by 2022 led and coordinated by the Commonwealth Government. The assessment will consider hydrogen supply chain needs such as electricity and gas networks, water supply networks, refuelling stations, roads, rail and ports, while taking into account local community concerns and priorities.
- 3.7** Agree to review and update the Hydrogen Infrastructure Assessment at least every five years, to highlight priorities for future infrastructure needs for competitive hydrogen supply chains.

Supporting research, pilots, trials and demonstrations along the supply chain

- 3.8** Agree that while other innovation priorities may emerge, the following areas should be priorities for research, pilot projects, trials, and demonstration projects:
- Switching current industrial hydrogen users to clean hydrogen
 - Investigating new opportunities for clean hydrogen such as clean ammonia exports, clean fertilizer, exports, industrial heating, iron ore processing and steel making
 - Using hydrogen in remote applications, such as in microgrids for mining and remote communities, in farming and marine applications, at remote defence facilities and as a fuel for heavy-duty mining vehicles
 - Opportunities for backup power supply, such as for mobile phone towers, hospitals and other types of critical infrastructure
 - Enabling blending of hydrogen with natural gas and eventual use of 100% hydrogen in gas networks
 - Using hydrogen for transport, with a focus on heavy and long-range road transport, rail and shipping
 - Optimising hydrogen and electricity system interactions, such as through timing hydrogen production to match variable renewable generation and through use of hydrogen for storage and dispatchable generation
 - Testing and proving of technologies that reduce the cost of making, moving, storing and using hydrogen
 - Using water from sustainable sources, such as waste water or seawater for hydrogen production
 - Developing cross-sector linkages and deriving value from sector coupling.
- 3.9** Support improved knowledge sharing from hydrogen-related projects, to help remove some of the information barriers the hydrogen industry faces and improve community awareness and rate of scale-up.
- 3.10** Agree to consider options to facilitate larger hydrogen projects through coordinating respective funding arrangements.



Using clean hydrogen in Australian gas networks

- 3.11** Support continuing pilots, trials and demonstrations of hydrogen in gas distribution networks, where distributors can satisfy relevant regulators that:
- The distribution network is comprised of materials confirmed to be safe and suitable for hydrogen blending
 - End user gas supply infrastructure (including installations and appliances) is safe and suitable for hydrogen blending
 - The distributor has adequate safety and training procedures in place
 - The effects of blending for gas network users of natural gas as chemical feedstock or for compressed natural gas have been considered and mitigated.
- 3.12** Agree to complete a review by the end of 2020. The review would:
- 13.** Consider the application of the National Gas Law and relevant jurisdictional laws and regulations to hydrogen and advise the COAG Energy Council of recommended options to best address regulatory ambiguity, remove unnecessary regulatory barriers and improve the consistency of laws across jurisdictions.
- 14.** Consider the economics of blending and of eventual use of 100% hydrogen in Australian gas networks.
- 15.** Advise the COAG Energy Council recommend options for setting and allowing updates of upper limits on the volume of hydrogen allowed to be blended in gas networks. This will focus on keeping consumers safe, encouraging innovation and effectively managing any appliance readiness end user and market effect issues.
- 3.16** Agree to consider changes to gas networks and markets to allow widespread blending, and later sole use of hydrogen, where such changes:
- Take place after the review at 3.12 and any actions that might arise from the review are completed
 - Carry acceptably low levels of safety risk
 - Are broadly supported by affected communities, and
 - Minimise impacts on gas prices and are in the long term interests of gas consumers.
- 3.17** Agree that, amongst other objectives, any government incentives to support the widespread blending of hydrogen in Australian gas distribution networks will:
- Where appropriate, encourage blending to occur in a manner that supports the development of hydrogen hubs
 - Be consistent with the COAG Principles of Best Practice Regulation, in particular with respect to net benefits to consumers.
- 3.18** Agree to not support the blending of hydrogen in existing gas transmission networks until such time as further evidence emerges that hydrogen embrittlement issues can be safely addressed. Options for setting and allowing for ongoing updates of safe limits for hydrogen blending in transmission networks will form part of the review in 2020.

Initial steps towards using hydrogen for transport

- 3.19** Agree to a shared vision of hydrogen being a clean, cost competitive fuel option for Australian land and marine transport, in particular for heavy duty and long range transport applications.
- 3.20** Support an adaptive approach to building demand for hydrogen as a transport fuel. The initial focus will be on transport tasks that do not require an extensive network of refuelling stations and offers compelling performance and industry development advantages.
- 3.21** Support refuelling stations on major freight and passenger road corridors, to support greater range for hydrogen vehicles.
- 3.22** Agree to include fuel infrastructure priorities in the proposed National Hydrogen Infrastructure Assessment so Ministers can periodically reconsider the need for action and calibrate relevant support mechanisms.
- 3.23** Agree to consider opportunities for new vehicle technologies, including hydrogen vehicles, in government fleets and large government contracts.
- 3.24** Support consortium based approaches to building refuelling infrastructure, with industry contributing to associated costs to promote long-term commercial viability.
- 3.25** Agree to promote open access to any government supported refuelling infrastructure, wherever practical.

Responsive regulation

- 4.1** Agree for each jurisdiction to review its existing legislation, regulations and standards as needed to determine whether their respective legal frameworks can support hydrogen safety and hydrogen industry development.
- 4.2** Agree to consider the principles and prioritisation criteria set out in the preliminary legal review, and the legislation, regulations, and standards it identified when undertaking the reviews outlined in 4.1.
- 4.3** Agree to coordinate reviews of legal frameworks where practical, and work together to:
 - Support the development of standards for the hydrogen industry, including technical safety standards, noting the role of Standards Australia
 - Consider and evaluate regulatory models to address and support:
 - hydrogen safety, noting the role of SafeWork Australia and state-based safety agencies
 - hydrogen industry development
 - with the aim of developing a nationally consistent approach as far as practicable
 - Where necessary, amend existing legislation and regulations or draft new legislation to address
 - hydrogen safety and support hydrogen industry development.

Shared principles for nationally consistent regulation

- 4.4** Agree to seek national regulatory consistency for any new regulations associated with hydrogen, that follows the COAG Principles of Best Practice Regulation.

A coordinated approach to planning and regulatory approvals for hydrogen projects

- 4.5** Agree to develop and incorporate 'hydrogen-ready' capabilities into planning and regulatory approvals mechanisms where required.

Integrating hydrogen into energy markets

- 4.6** Agree to ask energy market bodies to account for the possible effects of hydrogen industry growth in their planning and future reforms.
- 4.7** Agree to a future review, drawing on experience from pilot projects, trials and demonstrations, to consider options for energy market reforms to improve the integration of hydrogen into energy markets and to deliver additional benefits from hydrogen to consumers.
- 4.8** Agree the review in 4.8 will be completed by 2024.

Hydrogen's role in secure and affordable energy supply

- 4.9** Agree to consider the role of hydrogen in supporting Australian energy security by 2025. Areas for consideration will include:
- National Energy Security Assessments
 - Electricity, gas and liquid fuel emergency provisions
 - Mandatory reporting requirements, such as those under the Petroleum and Other Fuels Reporting Act 2017.
- 4.10** Agree to monitor impacts of hydrogen on energy costs, and where necessary, consider the need for changes to energy affordability and consumer protection policies.
- 4.11** Agree to not apply market constraints, such as domestic hydrogen reservations or price caps, at this time, but to revisit this stance periodically as the market develops.

Certainty around taxation, excise and other fees or levies for hydrogen

- 4.12** Agree to continue with the revenue arrangements that now apply to hydrogen, with the option to review them in the future.
- 4.13** Agree to consult with industry and the community before making any changes to current revenue arrangements that are specific to hydrogen.

Bilateral partnerships to build markets

- 4.14** Support development of bilateral agreements to indicate our commitment and capability as a hydrogen partner of choice and ensure arrangements meet our national interests.
- 4.15** Agree to work with bilateral partners to promote trade and investment in hydrogen, including advocating for Australian industries' engagement in the design of market settings that facilitate trade, long-term investment, regional price transparency, efficient market operation, and commitment to sharing industry knowledge and skills between partners.

Hydrogen certification

- 4.16** Agree that Australia will seek to play a lead role in the design and development of an international guarantee of origin scheme.
- 4.17** Agree that, as far as practicable, any Australian domestic scheme should build on or harmonise with international certification schemes.
- 4.18** Agree to initially develop an international certification scheme that verifies and tracks:
 - Production technology
 - Carbon emissions associated with production (scope 1 and scope 2)
 - Production location.
- 4.19** Agree that in addition to the above, any subsequent expansion of an international certification scheme could include water consumption and other factors.

Building community knowledge and engagement

- 5.1** Agree to develop a community education program to provide clear and accessible information about risks, benefits and safe use. The program will communicate the particular benefits hydrogen development can bring to regions as well as more general benefits such as economic growth, lower carbon emissions and reduced air pollution.
- 5.2** Support best practice for community engagement and its use to build community awareness and ensure community engagement for large or significant projects.

Responsible industry development

- 5.3** Support the development and implementation of a set of industry undertakings to guide the development of Australia's hydrogen industry. This work will be led and designed by the Australian Hydrogen Council in collaboration with governments. It will specify appropriate principles to safeguard the community, communicate issues and engage with regulators.

Skills and training for the hydrogen economy

- 5.4** Agree to develop nationally consistent training materials and guidelines for procedures to do with the production, handling, transport and use of hydrogen. The South Australian Government will work with agencies and industries from other states and territories to develop these guidelines and training materials and facilitate knowledge sharing on safe work practices.
- 5.5** Agree to ask the Australian Industry and Skills Committee to bring forward the hydrogen-related reviews and updates of training packages if Industry Reference Committees recognise an urgent need for this work be completed.
- 5.6** Agree to work together with industry to ensure in the longer term (2025–2030):
- Industry Reference Committees are reviewing, updating and developing units of competency and
 - qualifications, as hydrogen becomes relevant to the training packages of more industry sectors
 - Clear pathways are established between hydrogen-related education and training and hydrogen-
 - related employment, including recognition of prior learning and credit
 - Clear and accurate information is available to anyone interested in hydrogen-related education,
 - training and careers.
- 5.7** Agree that state and territory governments could consider a system of automatic mutual recognition across jurisdictions for hydrogen-related occupations under equivalent occupational licenses or registration.

Hydrogen training for Australian emergency services

- 5.8** Agree to ask the Australian Industry and Skills Committee and Public Safety Industry Reference Committee to update training packages for hydrogen safety, including the Public Safety Training Package that contains training materials and guidelines for managing of emergencies. This training package will be updated by creating or importing hydrogen-related units, drawing on work by the International Association for Hydrogen Safety (HySafe) and the U.S. Center for Hydrogen Safety. To enable this process, COAG Energy Ministers will write to the Chair of the Skills Council, which directs the work of the Australian Industry and Skills Committee.

Hydrogen training for regulators

- 5.9** Agree to review training and upskilling arrangements for regulators to ensure they have adequate understanding of hydrogen infrastructure, projects and technologies.

National coordination

- 6.1** Agree that establishing Australia as a major player in a global hydrogen industry by 2030 requires all jurisdictions to work cooperatively towards this goal.
- 6.2** Recognise that jurisdictions will progress actions in line with their own priorities and areas of strategic advantage.
- 6.3** Note that the Commonwealth will coordinate and publish an annual 'State of Hydrogen' report, informed by rigorous and objective technical advice.

