Australian Academy of Technological Sciences & Engineering
50 YEARS 1975-2025

REPORT

公益社団法人 日本工学アカデミー
THE ENGINEERING ACADEMY OF JAPAN

The Australia-Japan renewable hydrogen value chain

MAY 2025

Australian Academy of Technological Sciences & Engineering

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An independent, non-government organisation and charity, the Australian Academy of Technological Sciences and Engineering (ATSE) is led by a diverse Fellowship of more than 900 leading Australian applied scientists, technologists and engineers. We are an evidence-driven voice to decision-makers, and our world-class science, technology, engineering and mathematics (STEM) education and careers programs are shaping the knowledge-makers and innovators we need to tackle our most urgent challenges – now and in the future.

Our vision is for a sustainable and prosperous Australia where engineering and applied sciences protect our environment, nurture a skilled workforce, grow competitive industries and enable all Australians to reach their greatest potential.

About The Engineering Academy of Japan

The Engineering Academy of Japan Inc. (EAJ) is composed of leading experts from academia, industry, and government institutions who possess a wide range of knowledge and have made outstanding contributions in engineering and technological sciences, and closely related fields. The EAJ aims to contribute to the advancement of Japan and the world to promote engineering and technological sciences overall and to maintain and improve ties between these areas of endeavour and the general public.

Executive summary

An Australia–Japan green hydrogen partnership can accelerate the transition to a competitive, low-carbon energy future by responding to global innovations and opportunities and addressing current infrastructure and policy challenges.

This report evaluates Australia and Japan's renewable hydrogen value chain, underscoring a strategic partnership to drive a low-carbon energy transition. Both nations focus on renewable green hydrogen for sectors such as chemical production (ammonia and methanol), steel manufacturing and fertiliser production. Despite strong market potential, significant investment is needed to develop large-scale production, overcome high capital costs, and build the necessary infrastructure for storage and transport. Additionally, closing the skills gap and establishing innovative financing models are essential to support industry growth.

To capitalise on these market opportunities and address the identified challenges, experts from both Australia and Japan recommend leveraging Australia's renewable energy resources and Japan's technological expertise through joint research and development, technology sharing, and harmonised regulatory frameworks. Strengthened collaboration between governments, industry, and research institutions is vital for creating a sustainable, integrated hydrogen supply chain and positioning the partnership as a global leader in clean energy. These initiatives are aligned with Japan's Hydrogen Society Promotion Act 2024 and Australia's revised National Hydrogen Strategy (2024), underscoring a mutual commitment to positioning hydrogen as a critical enabler of a sustainable, low carbon future.

Background

The Australian Academy of Technological Sciences and Engineering and the Engineering Academy of Japan initiated a project examining the two nations' green hydrogen value chains. This project was undertaken with the guidance of the project steering committee, formed from Fellows of both Learned Academies (see Appendix A for more details), who shaped the report's direction, provided regular governance, and guided the report writing team.

The report team consulted experts across the green hydrogen value chain in both countries, including government, regulators, industry and academia, through surveys and interviews. It used the Australian Academy of Technological Sciences and Engineering's (ATSE's) Technology Readiness Assessment (TRA) methodology to assess various aspects of the renewable green hydrogen value chain between Australia and Japan (Australian Academy of Technological Sciences & Engineering 2022). All findings were validated by the project steering committee and were subject to peer review by relevant experts.

Green hydrogen is a form of hydrogen gas that is produced using renewable energy sources, such as wind or solar power, through a process called electrolysis. The green hydrogen value chain includes several interconnected entities such as renewable energy providers, electrolysers, distribution facilities, and consumers (see Figure 1). The report provides an overview of the current green hydrogen value chain in the two nations, identifies key challenges, and provides discussion points for potential areas of cooperation.

Policy context

According to the International Renewable Energy Agency (IRENA), as of May 2024, 46 national hydrogen strategies and eight detailed roadmaps have been published—with many more countries actively drafting such documents (IRENA 2024). This trend underscores hydrogen's role in the energy transition as a potential fuel but also as a chemical feedstock essential for decarbonising heavy industry. Australia and Japan's renewable hydrogen strategies provide a strong policy foundation for bilateral collaboration.

Japan's policy framework

Japan was one of the early adopters of a hydrogen vision. In 2017, Japan released its "Basic Hydrogen Strategy" announcing an aim to become a "world-leading hydrogen-based society" (Government of Japan 2017). The strategy emphasised collaboration with Australia to develop key hydrogen technologies to demonstrate a "liquified hydrogen supply chain" and drive commercialisation. In June 2023, the Japanese government revised its Basic Hydrogen Strategy to support such initiatives. This updated strategy identifies nine key technologies, including fuel cells and water electrolysis devices, and commits over JPY 15 trillion (US $98.8 billion) in investment over the next 15 years (Government of Japan 2023). The strategy also aims to increase hydrogen usage to 12 million tons annually by 2040.

Complementary initiatives, such as the Green Innovation Fund and the Green Transformation (GX) Fund, further support the transition by funding research, development and infrastructure that are critical to lowering the production costs of green hydrogen and integrating it into existing industrial processes.

Australia's renewable hydrogen strategy

Australia's hydrogen pathway was first established in 2019 and updated in 2024 (Australian Government 2024a, 2019). The updated *National Hydrogen Strategy* in 2024 reflects a shift to "making hydrogen" and targeting its use for decarbonising specific sectors. Green hydrogen is seen as critical for chemical production, such as for generating ammonia that decarbonises the fertiliser industry, and for processes like producing direct reduced iron (DRI), which is a key step in decarbonising steelmaking. In addition, hydrogen is recognised as an essential feedstock for the future of shipping fuels and sustainable aviation fuels, as well as a direct energy carrier for remote power needs, heavy road transport, and high-temperature industrial processes.

To realise these applications, Australia has set an ambitious national target of producing at least 15 million tonnes of renewable hydrogen per year by 2050, with early export milestones, including reaching 200,000 tonnes by 2030. A range of incentives supports this production goal, for example, the Hydrogen Production Tax Incentive, the Hydrogen Head Start programme, the Australian Clean Hydrogen Trade Programme and others focused on building robust export supply chains, particularly with Japan (Australian Government 2024b, 2024c, 2024d, 2022a).

However, Australia's energy policy remains uncertain in terms of long-term government support, which hinders financing efforts. In contrast, Japan has displayed a stronger commitment to hydrogen as part of its broader energy transition strategy, acknowledging that the required transformation scale remains enormous.

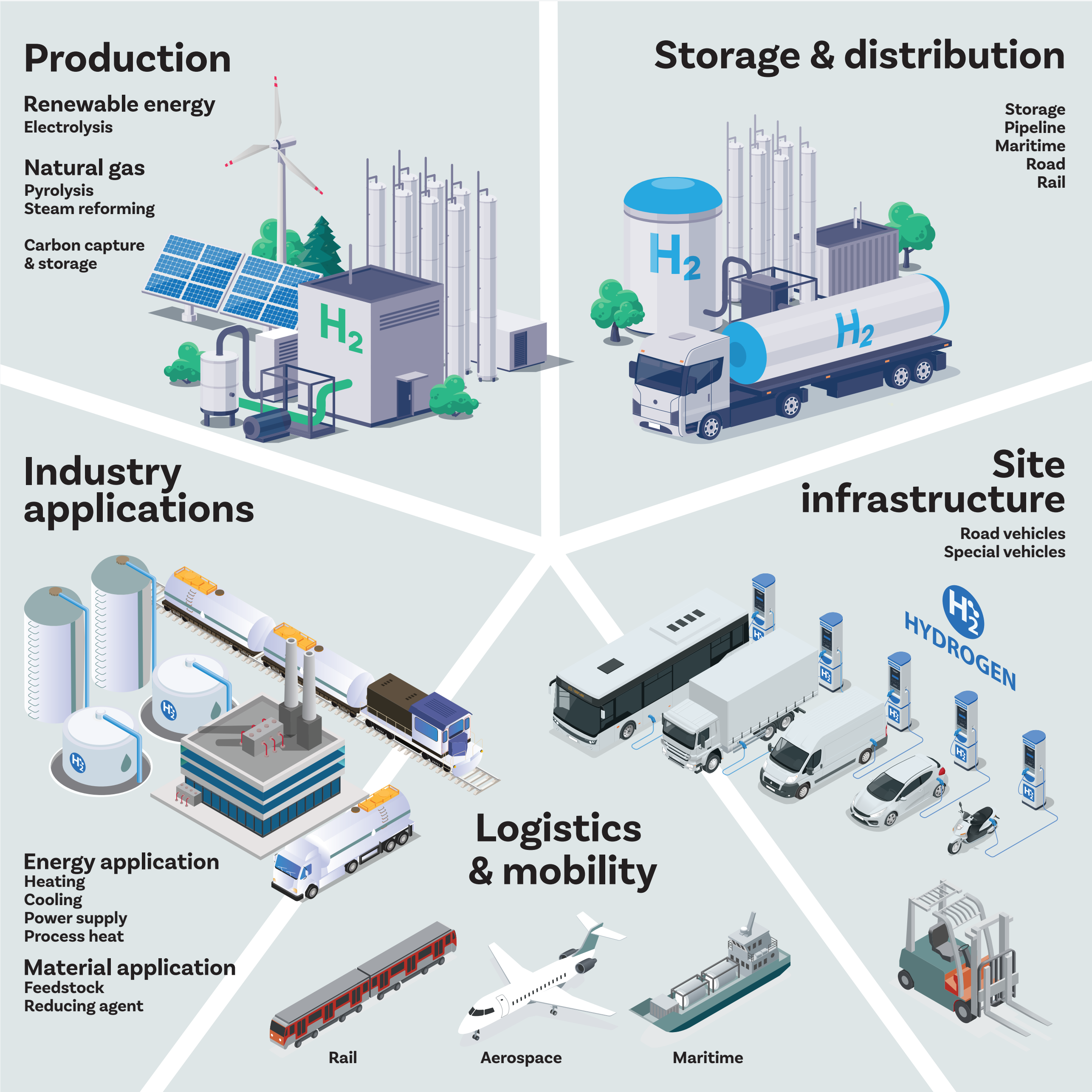


FIGURE 1 Renewable Hydrogen value chain (adapted from Rezaei et al. 2024)

Announced funding support	
Japan	**Australia**
Green Innovation Fund: 2 trillion Yen for hydrogen, storage batteries, and carbon recycling (International Energy Agency 2021) Green Transformation (GX): 20 trillion Yen for green transformation, including hydrogen technology (Ministry of Economy 2024) Clean Hydrogen Production Subsidy: 3 trillion Yen over 15 years with CO2 emission limit for eligibility (Japan Organization for Metals and Energy Security 2024)	Hydrogen Production Tax Incentive: A$6.7 billion over 13 years from 2027–28, providing A$2 incentive per kilogram of renewable hydrogen (Australian Government 2024c) Hydrogen HeadStart program: A$4 billion for revenue support for large-scale renewable hydrogen projects and A$500 million for hydrogen hubs in regional Australia (Australian Government 2024b, 2024d) Australian Clean Hydrogen Trade Program: A$150 million, with first round focusing on export to Japan (Australian Government 2022a)

The convergence of priorities

The green hydrogen space relies on low-cost clean electricity and technology. Currently, the levelised cost of green hydrogen in Japan is two to three times higher than that of the global leader, China (Adithya Bhashyam 2023). While costs are expected to converge in the coming decades, Japan's limited capacity for renewable energy means that renewable electricity will likely remain expensive, making it difficult to reconcile with the need for low-cost, clean electricity. The challenge escalates with the significant cost advantage of Chinese electrolysers, which signals strong competition in the global market for technological leadership (Dan Murtaugh 2022).

The converging policy priorities in Japan and Australia underscore the need for terawatts of new renewable power and hundreds of billions of dollars in investment, not only in production facilities but also in the supporting infrastructure required to transport, store and utilise hydrogen effectively. Experts in our consultations noted that it is important to have alignment through bilateral agreements—for example, Australia's Guarantee of Origin framework for green hydrogen explicitly integrates with the EU's established green hydrogen certification system. Similar frameworks are needed with other trading partners, such as Japan.

Japan and Australia's complementary approaches create a strong platform for bilateral collaboration. Japan's substantial investments and technology-focused initiatives, when paired with Australia's ambitious production targets and comparative advantage for renewable energy generation, form a solid foundation for developing a resilient green hydrogen ecosystem.

The renewable hydrogen value chain

Experts consulted by ATSE highlighted that the partnership between Australia and Japan is strategically important for both countries, with a clear focus on two key areas: midstream transport and end-use technologies.

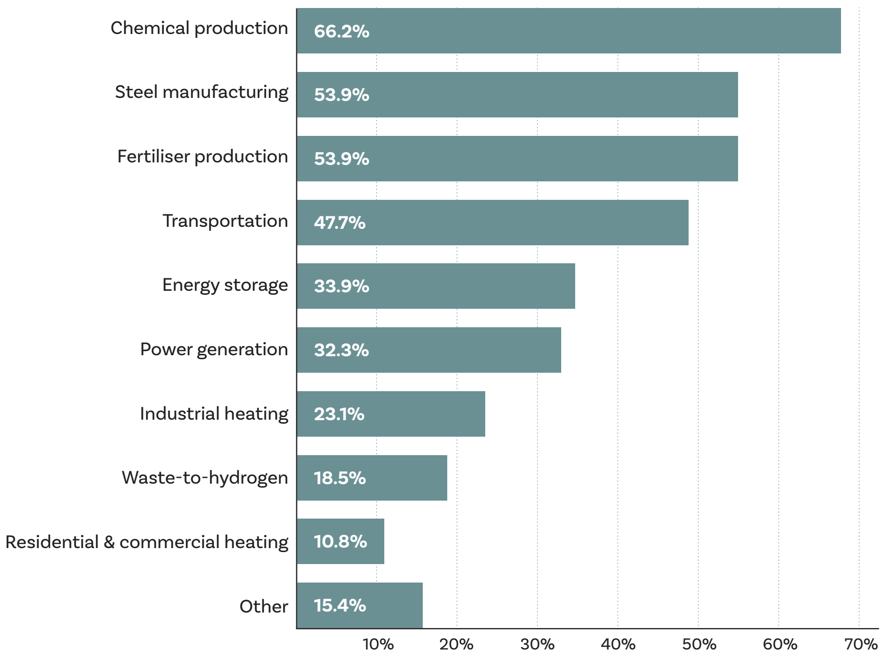


FIGURE 2 Response outcomes to the question: which sectors do you believe have the highest potential for renewable hydrogen adoption?

66% of those surveyed and interviewed highlighted chemical production, including ammonia and methanol, as the sector with the highest potential for renewable hydrogen demand. This was closely followed by steel manufacturing and fertiliser production, at 53.9% each. Other significant industries included transportation at 47.7%, energy storage at 33.9%, and residential power generation at 32.3%. These insights underscore the need to concentrate investment and innovation on industries with the greatest opportunities for large-scale hydrogen integration.

Innovative business models, including government-led infrastructure investments, are needed to attract industry investment. Emphasis on lifecycle resource recovery, such as designing systems for reuse and adopting models such as equipment rental, could further enhance economic sustainability. The complex nature of hydrogen technologies, particularly in terms of renewable energy systems and hydrogen generation, requires a collaborative approach that spans multiple domains, including energy conversion, storage, transport and related business models.

FIGURE 3 Experts identified initiatives that would most effectively support collaboration in hydrogen development between Australia and Japan.

ATSE's consultations highlighted initiatives to enhance collaboration between Australia and Japan. Leading recommendations include joint R&D projects, particularly in engineering solutions, knowledge sharing through cross-border educational exchanges, and infrastructure development for hydrogen supply chains. These initiatives provide a roadmap for fostering bilateral partnerships and driving innovation.

Technology Readiness Assessment

Using ATSE's *Technology Readiness Assessment Methodology*, we engaged experts to evaluate the technological readiness of the green hydrogen value chain between Australia and Japan (ATSE 2022) . Five key dimensions of the value chain were assessed—production infrastructure capacity, storage and distribution, transportation infrastructure, skills availability, and financing availability—using the ranking system outlined below. Their assessments were further validated through consultations, which helped shape the technological readiness indicators presented in this report.

SCALE	NOT READY	A LOT OF WORK REQUIRED	MODERATE WORK REQUIRED	SOME WORK REQUIRED	READY
READINESS INDICATOR	○	◔	◑	◕	●

ASSESSMENT					
	Production infrastructure capacity	Storage & distribution infrastructure	Transportation infrastructure	Skills availability	Financing availability
READINESS	◔	◔	◔	◑	◔

Production infrastructure capacity

Of the experts consulted, 72% indicated the absence of large-scale production capacity and the cost associated with current production as a key barrier to growing the current value chain. Reducing the cost of electrolysers and renewable energy generation technology were noted as other essential factors for making green hydrogen more competitive with other competing energy sources (Australian Government 2023).

A report released by the European Patent Office and the International Energy Agency stated that, between 2011 and 2020, Japan accounted for 24% of hydrogen-related patent applications worldwide (International Energy Agency and European Patent Office 2023). Japan had 5,258 total patent families between 2010-2020 (IP Australia 2023). This positioned Japan as the global leader in patent applications, which is attributed to the nation's focus on early-stage development and application of new technologies The geographical distribution of hydrogen R&D clusters in Japan illustrates this national focus (see Figure 4). However, Japan's limited domestic energy resources hinder its development of hydrogen energy. Australia ranks 16th globally as a source of innovation as shown by patent filings originating from Australian applicants (IP Australia 2023). 193 patent families originating from Australia have been filed in hydrogen technologies. Leading Australian patent applicants include the Commonwealth Scientific and Industrial Research Organisation (CSIRO), AquaHydrex, Monash University and Hydrexia. Australian applicants focus on hydrogen production through electrolysis, accounting for 31% of the patents originating from Australian applicants (IP Australia 2023). Figure 5 shows the location of hydrogen R&D clusters across Australia, highlighting where this innovation is taking place.

Respondents noted the limited availability of renewable energy sources co-located with production plants or sustainable water supply, which contributes to the limited production infrastructure capacity to scale renewable hydrogen production. Many production sites require new and augmented water infrastructure, such as desalination and water purification plants, dams, and pipelines, particularly where there is competing local demand for water resources. This infrastructure is necessary to ensure the reliability of supply (Australian Government 2023).

Our consultations highlighted that these production challenges are compounded by evolving energy policy and slow progress in developing necessary production infrastructure capacity. Experts noted that while there has been some investment in research and pilot projects, particularly through agencies like ARENA, the transition from conceptual work to practical, large-scale implementation of production capacity remains slow. Australia's renewable energy generation capacity, a precursor for green hydrogen production, is underdeveloped, which is further hindering progress in this area.

Fukuoka

Key RD&D infrastructure

Kyushu University (several laboratories on campus including the world's largest hydrogen research facility

Hydrogen Energy Test and Research Centre (HyTReC)

Centre for Research Activities and Development of LArge-scale pressure vessel equipment (CRADLE)

QPIT: Kyushi University Platform of Interdisciplinary Energy Research

Key demonstration projects

'Hydrogen Highway'

Kyushu Station

'Fukuoka Hydrogen Town' (Itoshima City)

'Hydrogen Town' Kitakyushu City

'Demonstration of hydrogen generation from sewerage biogas source'

Fukushima

Key demonstration project

Fukushima Hydrogen Energy Research Field (FH2R)

Yamanashi

Key RD&D infrastructure

Electric power storage technology research site

Clean energy research centre

Fuel cells nanomaterials centre

Fuel cell evaluations / testing facility (Yamanshi Industrial Technology Centre)

Hydrogen Technology Centre for HRSs

FIGURE 4 Japan's hydrogen R&D clusters

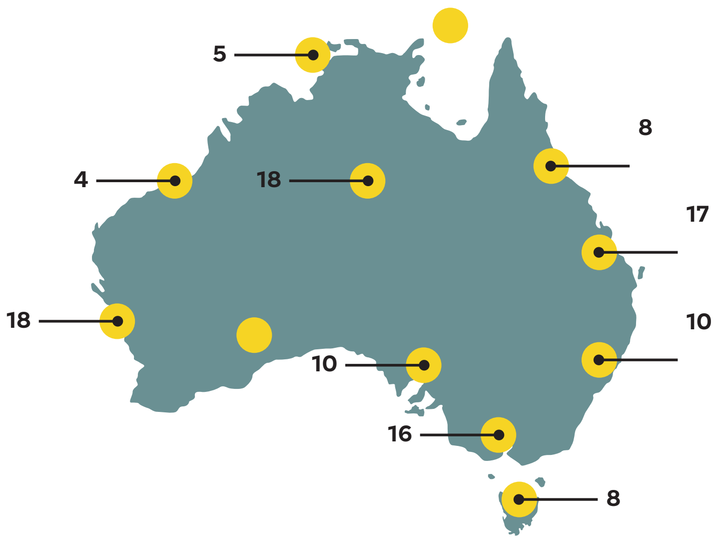


FIGURE 5 Australia's hydrogen R&D clusters (CSIRO n.d)

Storage and Distribution Infrastructure

Storage infrastructure is considered one of the least-ready components of the hydrogen supply chain, with 72% of respondents indicating that there are several clear gaps to address. Respondents pointed out that while storage has been addressed at small volumes, the scale required for ports is significant and has not yet been achieved.

Existing natural gas pipelines can only transport hydrogen blended up to 10% by volume due to the limitations of steel pipeline materials that are subject to hydrogen embrittlement. This limits the potential for using existing infrastructure for hydrogen transport. Research is needed to develop new approaches for the pipeline transportation of 100% hydrogen, which could provide a less expensive transport option compared to building new pipelines (Australian Government 2023).

The high cost of storage and distribution (which accounts for the major cost of hydrogen's end-user cost) is another major barrier to the fast uptake of a hydrogen economy. To minimise costs, there should be a focus on shared infrastructure across the hydrogen supply chain. This includes optimising the use of compressed hydrogen and considering integrating infrastructure for different carriers (e.g., ammonia and liquid methylcyclohexane (MCH) to create a connected ecosystem).

Depending on the preferred carrier type (e.g., liquid hydrogen, ammonia), ports will need facilities such as liquefaction plants, loading facilities and specialised pipelines. While large-scale geological storage solutions, such as salt caverns or depleted gas fields, are essential to hydrogen storage (Muhammed et al. 2022), they remain expensive. The scale of hydrogen production and demand must justify these investments (Australian Government 2023).

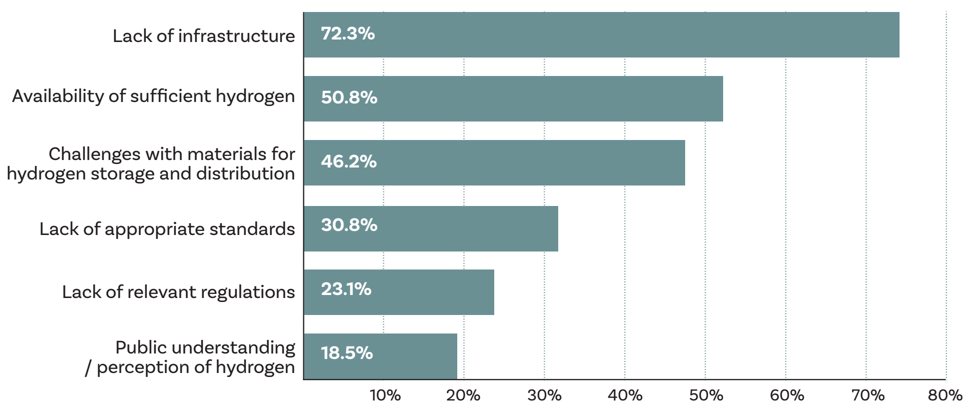


FIGURE 6 Leading challenges for hydrogen trade between Australia and Japan as highlighted by experts consulted

Transportation Infrastructure

When rating transportation infrastructure readiness, 74% of experts indicated that a key challenge identified by respondents is the considerable distance between optimal production resources, such as renewable energy zones, and hydrogen demand centres. Recent trends, as highlighted in the 2024 Australian National Hydrogen Strategy, favour deploying hydrogen applications at the point of production (Australian Government 2023). This shift reflects the persistent challenges in transporting hydrogen: shipping hydrogen over long distances continues to be a major technological and economic challenge. Additionally, when hydrogen is used as a feedstock, it is increasingly seen as more cost-effective and efficient to produce the final products (e.g., ammonia, direct reduced iron) at the production site, thereby bypassing the logistical hurdles associated with hydrogen transport.

The Hydrogen Energy Supply Chain (HESC) project is an example of a potential hydrogen transport solution, although it has not yet been scaled up (CSIRO 2022). The flagship project was designed to overcome the technical challenges in the maritime transport of liquified hydrogen between Australia and Japan. The initiative resulted in collaboration between both nations on the Suiso Frontier, a liquefied hydrogen carrier ship. With A$500 million in funding from the Japanese and Australian governments, the project resulted in the vessel departing from Kobe in Japan on 24 December 2021. After a month-long journey, it reached Victoria, Australia, before safely returning to Kobe on 25 February 2022. Despite these advancements, scaling such transportation projects to a commercial level remains costly.

Shipping berth capability & co-location

Ports need to be equipped with adequate shipping berth capabilities to handle the bulk storage and transportation of hydrogen carriers.

Marine terminal requirements

Essential features of marine terminals include deep seaports, suitable wharf structures, dedicated pipelines and marine loading arms.

FIGURE 7 Key areas to improve transportation infrastructure as noted by experts consulted. The slow progress in developing port and terminal infrastructure, essential for supporting hydrogen exports, highlights the readiness gap in this area.

Skills availability

Of those consulted, 60% indicated that the availability of the skilled workers required to develop the hydrogen supply chain in Australia and Japan is also an important consideration. Respondents highlighted that hydrogen-specific skills and training could be achieved by retraining personnel from traditional energy sectors. While there is potential to repurpose these existing skills and supplement them with expertise from pilot-scale hydrogen projects, some experts highlighted that there is still significant effort required to build a workforce capable of supporting the hydrogen economy at scale.

The skills gap poses a barrier not only to infrastructure development but also to the overall scalability and sustainability of the hydrogen value chain. Australia is investing in education and training programs to build a skilled workforce for the hydrogen industry through programs like the ARC Training Centre for the Global Hydrogen Economy (GlobH2E) (Australian Government 2022b). This includes partnerships between industry, government and educational institutions to develop specialised training courses and apprenticeships (Australian Government 2021).

Financing availability

Half (52%) of those consulted responded that innovative, low-carbon projects in Australia are not yet supported financially to the extent necessary, with limited government funding and a lack of clear regulatory frameworks for hydrogen projects. Additionally, the absence of a bankable offtake scheme further complicates financing efforts, as projects struggle to secure the financial backing needed to move from the feasibility stage to full-scale production.

Experts from ATSE and EAJ both highlighted the importance of strengthening the introduction and formation of a market for hydrogen through strategic frameworks aimed at economic benefits. This would enable the realisation of economies of scale and could aid in addressing the price challenge. A transition to a green and competitive energy structure will require cross-sector collaboration and stronger public-private partnerships to efficiently implement frameworks that support affordable hydrogen energy.

Recommendations for an Australia-Japan hydrogen partnership

The enactment of Japan's Hydrogen Society Promotion Act in October 2024, alongside Australia's revised 2024 National Hydrogen Strategy, reflects the mutual ambition to position hydrogen as a cornerstone of each nation's respective energy transition (Japan Organization for Metals and Energy Security 2024; Australian Government 2024a). These efforts are underpinned by a focus on low-carbon hydrogen, including "green hydrogen" derived from renewable energy sources. However, challenges such as high energy costs, regulatory delays and technological uncertainties have impeded progress in establishing a robust Australia-Japan hydrogen value chain.

Major hydrogen energy operators around the world have been confronted with the problem of rising energy costs and investment risks in the development of hydrogen and ammonia businesses, and the creation of hydrogen energy supply chains. Despite setbacks, including the withdrawal of key players like Kansai Electric Power and Origin Energy from Australian hydrogen projects, there is potential for revitalising bilateral collaboration through targeted policy initiatives (Daniel Mercer 2024; Yoshifumi Uesaka 2024; Nikkei 2024).

Stakeholders consulted in this project displayed cautious optimism about the market potential for renewable hydrogen between Australia and Japan over the next decade. Out of all the respondents consulted in ATSE interviews and surveys, 65% believe the market potential will fall short of current expectations, underscoring the need to address barriers such as cost, regulation, and infrastructure readiness. The LNG partnership model provides valuable lessons but cannot be entirely replicable for hydrogen due to evolving and different cost structures and market demands. New collaborative models must be developed to address these unique challenges. Given the complexity of certifying and ensuring the environmental integrity of hydrogen supply chains, policy and regulatory alignment, experts advise more dedicated research is needed to scale the value chain.

Partnerships between government, industry and research institutions are essential for creating sustainable business models. NGOs and not-for-profits also play a key role in managing land use, cultural heritage and environmental impacts, ensuring that hydrogen projects align with broader sustainability goals. By addressing regulatory gaps, optimising costs, advancing R&D, and fostering collaboration through targeted initiatives, the Australia-Japan hydrogen value chain can emerge as a global leader in the clean energy transition.

ATSE and EAJ experts identified the following policy proposals that could strengthen the Australia-Japan renewable hydrogen partnership:

Support for collaborative innovation

- Introduce incentives to encourage technological advancements and cost efficiencies in hydrogen production with the aim of improving cost competitiveness in global hydrogen markets.
- Establish support for collaborative resource and technology sharing initiatives between Australian and Japanese researchers and industry.
- Foster bilateral projects that integrate renewable resources and advanced hydrogen technologies to drive industry growth.

Policy and regulatory alignment

- Harmonise regulatory frameworks and certification standards to streamline trade and cooperation.
- Ensure mutual recognition between Japanese and Australian regulators of quality and safety standards in hydrogen production and distribution.

Skills development

- Launch joint training programs to leverage technological expertise and share best practices to address skill gaps in the hydrogen workforce.
- Invest in proven approaches to developing a skilled workforce to sustain industry growth and innovation.

Appendix

Steering Committee

- Dr Marlene Kanga AO FTSE (Chair), Rux Energy Pty Ltd
- Professor Yasushi Sekine FRSC, Waseda University
- Professor Yun Liu FTSE, The Australian National University (ANU)

Expert Review Group

- Professor Tetsuya Shishido, Tokyo Metropolitan University
- Professor Shigeo Satokawa, Seikei University
- Professor Jun Kubota, Fukuoka University
- Dr. Hiroshi Tsujigami, Iwatani Corporation
- Professor Ken Baldwin FTSE, The Australian National University (ANU)

Report team

- Suryodeep Mondal, ATSE Economics and Policy Specialist
- Nicola Smillie, Manager, ATSE Policy and International Projects

Design and production

- Elizabeth Geddes, ATSE Brand & Digital Design Manager
- Adam Huttner-Koros, ATSE Campaigns Manager

Methodology

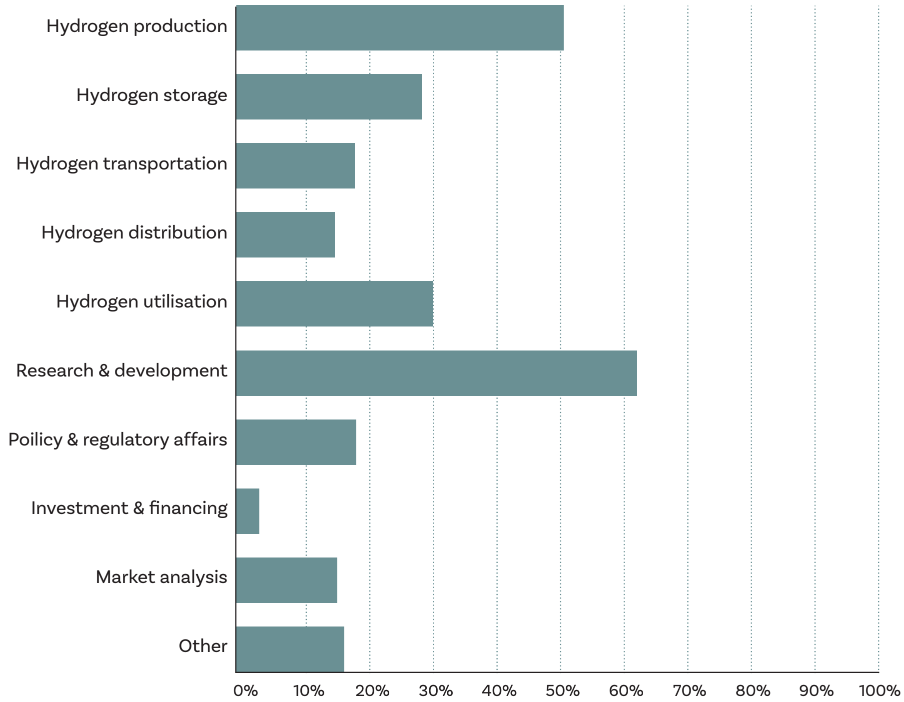
The methodology for this project began with the development of an overarching analysis framework, which included the identification of key issues within an industry sector and potential emerging or enabling technology solutions. Following this, consultation was undertaken with a diverse range of key stakeholders whose input guided the research and informed the development of a list of key recommendations and research priorities that could address the key sectoral issues that were identified. Finally, these recommendations were stress-tested through a final round of consultation with key stakeholders to ensure that the proposed recommendations are credible, impactful, and achievable.

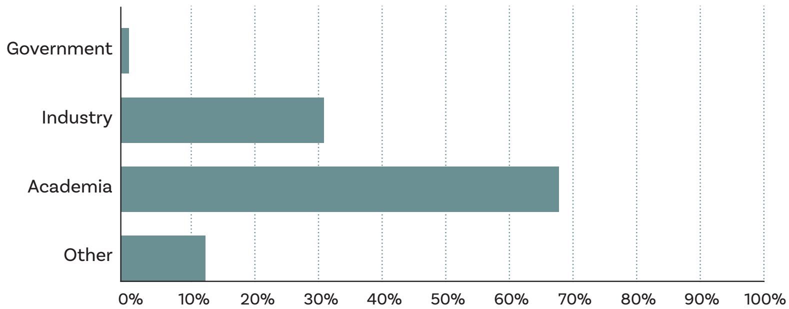
Desktop research analysed academic literature, industry reports and news articles, while data analysis from government reports, industry databases and investment platforms provided insights into intellectual property, investments, deals and workforce trends for the green hydrogen value chain between Australia and Japan.

Expert consultations were conducted with 5 experts representing green renewable hydrogen sector to help ATSE refine the scope of this report and gain key insights for the technology readiness assesment. Consultation and 1:1 interveiws were conducted in September 2024.

A survey of experts was administered in SurveyMonkey. The survey was open from 5 August to 1 September, 2024. The survey was distributed to all ATSE Fellows and EAJ fellows and their networks with a renewable hydorgen background or industry experience.

The following is the breakdown of all the respondents consulted for the report.





Acknowledgements

ATSE would like to thank the following experts who shared their insights to help shape this report.

Emeritus Professor Graham Town FTSE	Engineers Australia, Macquarie University
Adam Karl	AECOM
Emeritus Professor Akhtar Kalam	Victoria University
Dr John Wright FTSE	Wright Energy Consulting
Marius Bosch	Rux Energy
Professor Assaad Masri	The University of Sydney
Professor Takayuki Ichikawa	Hiroshima University
Dr Andrew Dicks	Australian Hydrogen Research Network
Professor Tetsuya Shishido	Tokyo Metropolitan University
Professor Simon Bartlett AM	University of Tasmania
Professor Jun Kubota	Fukuoka University
Professor Andrew Blakers FTSE	Australian National University
Dr John Söderbaum FTSE	ACIL Allen
Professor Rod Boswell	Australian National University and Boswell Technologies
Professor Huanting Wang FTSE	Monash University
Professor Mikihiro Nomura	Shibaura Institute of Technology
Dr Hiroshi Tsujigami	Iwatani Corporation
Professor Ken Baldwin FTSE	Australian National University
Dr Alexander Klimenko	The University of Queensland
Dr Yuanshen Lu	University of Queensland
Professor Gerhard Schenk	The University of Queensland
Professor Ian O'Hara	Queensland University of Technology
Paul Hodgson	CQUniversity
Professor Syed Islam	Federation University
Professor Iven Mareels FTSE	Federation University
Professor Michael Goodsite	The University of Adelaide
Dr Bruce Godfrey FTSE	Wyld Group Pty Ltd
Associate Professor Fiona Beck	Australian National University
Professor Paul Medwell	The University of Adelaide
Hassan Khalili	University of Adelaide
Dr Scott Groom	Powering Australia
Rachelle Doyle FTSE	Rio Tinto
Dr Steven Percy	Vireo Energy
Professor Eric May FTSE	Future Energy Exports CRC
Dr Changlong Wang	Monash University
Professor Hongwei Wu	Curtin University

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Acknowledgement of Country
We acknowledge Traditional Owners of Country across Australia and recognise their continuing connection to land, water and community. We pay respect to Aboriginal and Torres Strait Islander culture, and Elders past and present.

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