SUBMISSION

Submission to the Department of Climate Change, Energy, the Environment and Water

Submission to Review of the National Hydrogen Strategy

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The Australian Academy of Technological Sciences and Engineering (ATSE) is a Learned Academy of independent, non-political experts helping Australians understand and use technology to solve complex problems. Bringing together Australia's leading thinkers in applied science, technology and engineering, ATSE provides impartial, practical and evidence-based advice on how to achieve sustainable solutions and advance prosperity.

A successful Australian hydrogen energy market strategy should couple economic goals with climate goals. Hydrogen production presents an opportunity to diversify the export economy and reach new markets as demand for Australia's traditional fossil fuel commodity exports declines. Australia's ambition to become a renewable energy superpower, decarbonise the economy and increase clean energy exports to contribute to global decarbonisation would benefit from the establishment of an efficient Australian-made hydrogen industry as a part of the solution. It is important to be objective and understand that not all options that are accompanied by early enthusiasm turn out to be winners (Gartner 2018), and to conduct independent and holistic assessments, bringing along all disciplines to achieve this energy sector ambition. ATSE recommends the following to the Department of Climate Change, Energy, the Environment and Water in its review of the National Hydrogen Strategy ("the Strategy"):

Recommendation 1: Conduct assessments to guide investment decisions on whether to invest in either: the development of hydrogen transport infrastructure and storage; on-site production co-located with hydrogen end-use; or a mix of both.

Recommendation 2: Invest and create incentives to help scale existing, successful hydrogen projects to realise the benefits of scale from hydrogen hubs.

Recommendation 3: Facilitate international cooperation across the value chain, to enable demand creation and secure Australian supply for hydrogen produced.

Recommendation 4: Develop regulations and standards to support the generation, transport, handling and utilisation of hydrogen and the management of associated waste streams that are safe for both communities and the atmospheric environment.

Recommendation 5: Establish a national skills taxonomy regarding workforce needs required by the hydrogen sector to facilitate consistent communication and appropriate training and recruitment.

Recommendation 6: Strengthen international cooperation to develop hydrogen technologies, and secure export markets for Australian hydrogen.

Planning for hydrogen infrastructure

Factors that must be considered for successful large-scale production of hydrogen include location and access to services, markets, and infrastructure. These factors should help inform the decision on where to locate future hydrogen plants. Current storage and transport solutions are commercially immature and site availability, capacity, and costs are highly uncertain (Wells et al. 2022). Australia must answer the question: what do we want to use hydrogen for? If we wish to make it primarily for industry uses such as steel, ammonia and chemical feedstock production, limited transport and storage would be required if plants are co-located with industry. If the goal is to work towards a hydrogen export industry, further development of storage and transport technology is a prerequisite. There is a growing consensus that technological and economic issues posed by storage and transport could shift the emphasis towards the co-location of hydrogen production with where it will be used (City of Townsville 2021). The Strategy should assess whether the development of hydrogen transport infrastructure and storage, on-site production co-located with hydrogen end-use, or a mix of both, would be the best way forward. The results of this assessment should be used to guide the formulation of incentives, investment and regulation.

Recommendation 1: Conduct assessments to guide investment decisions on whether to invest in either: the development of hydrogen transport infrastructure and storage; on-site production co-located with hydrogen end-use; or a mix of both.

Achieving economies of scale

ATSE's explainer 'Here and now: The state of low emissions technology in Australia' recommended that for Australia to realise the potential for sustainable hydrogen, further research, development, and demonstration of supporting technologies are needed (ATSE 2022a).

The intricacy of the links and relationships between production and supply in the hydrogen sector would most benefit from the use of industrial clusters, reaping the benefits that come when firms and people locate near one another (Edward L. Glaeser 2010)[1]. This is already seen in the Strategy's current emphasis on the development of regional hydrogen hubs. Hubs bring together multiple hydrogen inputs in one location and reduce the cost of achieving economies of scale in the production and delivery of hydrogen to end consumers. Given the massive expansion of renewable energy generation (and associated storage and transmission) that will be required for electrification, there will be competition for renewable electricity available for hydrogen production in the domestic electricity grid. The interplay between grid electricity prices and generator availability for hydrogen production may shift the competitive advantage towards off-grid hydrogen generation using dedicated renewable facilities. The Strategy can consider two options: building electrolysers in locations with excellent renewable resource conditions to enable ease of hydrogen supply, or co-locating hydrogen production with end-use.

State and territory governments are also promoting hydrogen as a future industry for Australia through their plans and strategies. These include South Australia's Hydrogen Action Plan, Western Australia's Renewable Hydrogen Strategy, Queensland's Hydrogen Industry Strategy and Tasmania's Renewable Hydrogen Action Plan. This is encouraging investment in hydrogen production, utilisation and the logistics of its movement. The National Strategy needs to interface with these different regional strategies and build on the work that is already underway in these strategies from early-stage research to deployment projects. This would help Australia achieve large-scale demonstrations of hydrogen production and use much more effectively (ARENA 2023).

Recommendation 2: Invest and develop incentives to help scale existing hydrogen projects that are performing well to realise the benefits of scale from hydrogen hubs.

Creating markets for downstream demand for hydrogen

Hydrogen holds promise to strengthen national energy security, conserve petroleum, and diversify transportation energy options for a more resilient system. Global hydrogen use is dominated by industrial applications (like ammonia production, methanol production and iron/steel production via the direct reduction of iron ore) (IEA 2019). Many countries are pushing to realise these benefits from hydrogen and make it an asset in their energy portfolio to meet decarbonisation targets and generate huge economic benefits (KPMG 2022).

Australian hydrogen can contribute to various supply chains, most notably in the steel production supply chain. This could be done through the export of hot briquetted iron (HBI), a type of premium direct reduced iron (DRI) that forms one of the most energy-intensive parts of green steel production (Parkes 2022). Future growth of the hydrogen industry depends on the evolution of demand for other downstream products, like refined fuels for transport, fertilisers for food production, and construction materials for buildings. The total addressable domestic market for hydrogen and hydrogen-embedded products in Australia is smaller relative to other comparable economies (KPMG 2021). As a result, ensuring that Australian hydrogen has access to demand from international markets is critical to assuring the supply of domestically produced hydrogen. The Strategy should aim to coordinate collaboration between a wide range of stakeholders to create markets that generate demand.

To realise market potential, Australia needs to attract investment and focus on translating research into commercial ventures. This must be done strategically, leveraging options such as co-investment to de-risk early ventures. Currently, the availability of hydrogen supply and the demand for hydrogen-based products

[1] This approach is referred to as agglomeration economies

are interdependent. The Strategy must decide the relative emphasis it wishes to place on the creation of demand for hydrogen and embedded hydrogen products (green iron/steel, for example), and the creation of hydrogen supply. Government can play an important role in influencing supply costs. Guided by the Strategy, the government can incentivise market entrants by introducing simplified licencing and permitting processes for production, transportation, and export logistics while maintaining high standards for safety. Long-term agreements would also be an important factor in lowering investment risk in hydrogen projects.

To satisfy increased demand from future downstream markets, the Strategy must plan for the development of pilot projects to produce industrial-scale capacity. If this is to be accomplished by delivering and storing hydrogen, bulk commodity ports that already handle gas and even cryogenic liquids must be compatible with transporting hydrogen. There are additional technical challenges for transporting hydrogen (such as the requirement to maintain a very low liquid temperature and the containment of such a small molecule), most of Australia's bulk commodities ports are capable of hosting hydrogen export facilities (AEMC 2022; PwC 2022). The Australian Government's priority regional hydrogen hubs also have direct access to deepwater port infrastructure, but maximising value-for-money and creating infrastructure that is fit for purpose to satisfy this increased demand will require collaboration from all stakeholders.

Recommendation 3: Facilitate international cooperation across the value chain, to enable demand creation and secure Australian supply for hydrogen produced.

Creating resilience in the supply chain

Several supply chain risks must be addressed in the Strategy. Hydrogen has unique features that make it complex to de-risk. Although it is widely recognised as a valuable energy carrier, it has not yet been used as a fuel at scale. Any leakage of hydrogen into the atmosphere has the potential to alter existing atmospheric chemistry (Warwick et al. 2022). De-risking this requires the establishment of engineering standards in the end-to-end processes of hydrogen production, storage, transportation, and utilisation.

As part of the risk mitigation strategy, the Strategy should also address the potential for global shortages in key input components (e.g., electrolysers): in this case, building domestic manufacturing capacity for these key components would be essential. It is important to note that inputs in the supply chain inevitably become ‘commodities’, with consequent boom and bust cycles that manufacturers must withstand for long-term sustainability. The Strategy can play a key role in the development of the hydrogen economy by providing risk management knowledge and risk transfer at selected points of the value chain.

Safety and environmental impacts should be a primary consideration when considering the manufacturing and utilisation of hydrogen. Standards that require efficient and safe processes that would reduce risk and increase resilience across the system. The Government should work with industry leaders to develop appropriate regulations and standards to support the complete supply chain of safe generation, transport, handling and utilisation of hydrogen and associated by-product streams. ATSE recommends that the Department focuses on developing appropriate regulations and standards.

Recommendation 4: Develop regulations and standards to support the generation, transport, handling and utilisation of hydrogen and the management of associated waste streams that are safe for both communities and the atmospheric environment.

Achieving a skilled workforce for the hydrogen industry

Central to establishing a domestic hydrogen industry is the availability of a skilled workforce. The availability of technical skills to support engineering, design, installation, operation, maintenance, and optimization of hydrogen technologies and systems will be vital – as will enabling and cross-cutting skills[2]. To develop

[2] Cross-cutting skills and competencies include safety, quality, environmental, regulatory, and economic aspects of green hydrogen production and use.

these skills and competencies, the workforce needs access to quality and relevant education and training programs, including for workers transitioning from fossil fuel industries.

Australia is already experiencing engineering and electrician workforce shortages, which threatens the progress of short and medium-term projects to bring down emissions. To address these gaps and establish a pathway into the clean energy workforce, collaboration and coordination among governments, the education sector, and industry are paramount. In ATSE's Our STEM Skilled Future report, the importance of establishing a National Skills Taxonomy (classification) was highlighted (ATSE 2022b). This taxonomy would facilitate consistent communication regarding workforce needs and pathways among various organizations and individuals in Australia, enabling better utilisation of our current skilled workforce.

Recommendation 5: Establish a national skills taxonomy regarding workforce needs required by the hydrogen sector to facilitate consistent communication and appropriate training and recruitment.

Fostering international cooperation

If the Australian hydrogen sector is to capture the global market share for hydrogen and hydrogen-embedded products and accelerate the creation of a domestic hydrogen industry for export markets, optimal international cooperation will be critical. The Australian Government is already working closely with international partners to advance practical action on climate change and build new clean energy industries (DCCEEW 2023). The Strategy should seek to leverage these partnerships and build an international appetite for Australian hydrogen technologies.

Government-to-government partnerships could facilitate hydrogen export, increasing demand in domestic hydrogen and hydrogen-embedded products areas and securing supply agreements, reducing uncertainty. International coordination can also help to spur investments in factories and other infrastructure that will bring down costs and enable the sharing of knowledge and best practices. It is important for Australia to collaborate with importing countries and their hydrogen supply-chain companies for offtake contracts[3] and co-investment. The development of a comprehensive international emissions certification system to support Australian exports (whether of hydrogen or embedded hydrogen products) will be crucial to help establish these linkages.

An example of international collaboration can be seen in ATSE and the National Academy of Engineering Korea (NAEK)'s joint workshop with experts who recognised how the components of the Australian and South Korean hydrogen value chains are complementary. This could be leveraged to form strong partnerships with clear production and consumption roles (ATSE 2022c). We need to utilise and build on the experience gained in the development of Australia's coal, iron ore and LNG industries to derive best practices for supporting and enabling the establishment of a new hydrogen export sector.

Recommendation 6: Strengthen international cooperation to develop hydrogen technologies, and secure export markets for Australian hydrogen.

ATSE thanks the Department of Climate Change, Energy, the Environment and Water for the opportunity to respond to the Consultation Paper for the Review of the National Hydrogen Strategy. For further information, please contact academypolicyteam@atse.org.au.

[3] An offtake agreement is an arrangement between a producer and a buyer to purchase or sell portions of the producer's upcoming goods.

References

AEMC (2022) *Hydrogen: the new Australian manufacturing export industry and the implications for the National Electricity Market (NEM)*, *Australian Energy Market Commission*, https://www.aemc.gov.au/hydrogen-new-australian-manufacturing-export-industry-and-implications-national-electricity-market, accessed 2 August 2023.

ARENA (2023) *$2 billion for scaling up green hydrogen production in Australia*, *Australian Renewable Energy Agency*, https://arena.gov.au/news/2-billion-for-scaling-up-green-hydrogen-production-in-australia/, accessed 2 August 2023.

ATSE (2022a) *Here and now: The state of low emissions technology in Australia*, https://www.atse.org.au/news-and-events/article/here-and-now-the-state-of-low-emissions-technology-in-australia/, accessed 21 June 2023.

ATSE (2022b) *Our STEM skilled future — An education roadmap for an innovative workforce*, https://www.atse.org.au/research-and-policy/publications/publication/our-stem-skilled-future-an-education-roadmap-for-an-innovative-workforce/, accessed 16 February 2023.

ATSE (2022c) *Hydrogen production, transport & distribution*, https://www.atse.org.au/research-and-policy/publications/publication/hydrogen-production-transport-distribution/, accessed 2 August 2023.

City of Townsville (2021) *Council, consortium to explore green hydrogen production* , https://www.townsville.qld.gov.au/about-council/news-and-publications/media-releases/2021/may/council-and-consortium-to-explore-green-hydrogen-production, accessed 9 August 2023.

DCCEEW (2023) *Australia's international clean energy partnerships*, *Department of Climate Change, Energy, the Environment and Water*, https://www.dcceew.gov.au/climate-change/international-commitments/international-partnerships, accessed 10 August 2023.

Edward L. Glaeser (2010) *Agglomeration Economics*, Edward L. Glaeser (ed), The University of Chicago Press, https://www.nber.org/system/files/chapters/c7977/c7977.pdf, accessed 31 July 2023.

Gartner (2018) *Understanding Gartner's Hype Cycles*, *Gartner Research*, https://www.gartner.com/en/documents/3887767, accessed 7 August 2023.

IEA (2019) *The Future of Hydrogen- Seizing today's opportunities*, https://iea.blob.core.windows.net/assets/9e3a3493-b9a6-4b7d-b499-7ca48e357561/The_Future_of_Hydrogen.pdf, accessed 31 July 2023.

KPMG (2021) *Geographic hydrogen hotspots*, https://kpmg.com/xx/en/home/insights/2021/01/geographic-hydrogen-hotspots.html, accessed 15 August 2023.

KPMG (2022) *National hydrogen strategies*, https://kpmg.com/xx/en/home/insights/2021/08/national-hydrogen-strategies.html, accessed 10 August 2023.

Parkes R (2022) *Green steel*, *Hydrogen Insight*, https://www.hydrogeninsight.com/industrial/green-steel-move-iron-production-to-places-where-green-hydrogen-will-be-cheap-and-abundant-says-shell/2-1-1359361, accessed 9 August 2023.

PwC (2022) *Getting H2 right Success factors for Australia's hydrogen export industry*, https://www.pwc.com.au/important-problems/integrated-infrastructure/PwCAU-Getting-H2-Right.pdf, accessed 2 August 2023.

Warwick N, Griffiths P, Keeble J, Archibald A, Pyle J and Shine K (2022) *Atmospheric implications of increased hydrogen use. Research into the atmospheric impacts of fugitive hydrogen emissions in a future UK hydrogen economy.*, https://www.gov.uk/government/publications/atmospheric-implications-of-increased-hydrogen-use, accessed 7 August 2023.

Wells C, Minunno R, Chong H-Y and Morrison GM (2022) 'Strategies for the Adoption of Hydrogen-Based Energy Storage Systems: An Exploratory Study in Australia', *Energies*, 15(16):6015, doi:10.3390/en15166015.

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