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M3Or1C-01: [Invited] Hydrogen generation, storage and utilisation in Australia: transition to a low emissions energy sector

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Australia's energy policy settings at Federal and State level offer opportunities for a power transformation unmatched in format and content since the impact of widespread electricity transmission more than 50 years ago. These settings are driven by regulation that links the energy sector network to low (or zero) emissions targets and by network decentralization that enables greater use of renewable energy sources. Projections for renewable energy generation in Australia by 2050–2060 suggest increases between 8- and 40-times existing network market capacity [1]. Uncertainty in this range of values depends on projected risk profiles and approaches taken to reduce Australia's scope 3 emissions from energy exports currently dominated by coal and liquefied natural gas (LNG).

Renewable energy capacity in Australia is currently ˜36% of total energy generation [2] with targets of ˜80% in many jurisdictions by 2030-35. These target(s) presage ambition by policymakers in Australia to become a Hydrogen Superpower for the global clean energy industry and, by implication, a critical source of green hydrogen. Thus, production, storage, distribution and use of hydrogen will play a significant role in the energy transformation to 2050 and beyond. All jurisdictions in Australia have developed strategic plans for R&D, infrastructure build or rebuild, skills training, funding incentives and investment in a hydrogen facilitated energy transformation. Liquefaction is well established in Australia with 21 LNG trains operating along the western, northern and eastern coastlines. However, liquefaction of hydrogen, while nascent at industrial scale, has only recently been facilitated by inter-governmental and corporate engagement using existing resources.

For example, the Hydrogen Energy Supply Chain (HESC) concept promulgated by Japanese companies more than a decade ago [3], achieved a key demonstration step in early 2022. This step involved commissioning of a small-scale liquefaction plant (250kg H2/day) at Port Hastings to transfer LH2 for sea-borne shipment to Japan. Hydrogen was produced via gasification from brown coal in the Latrobe Valley. The liquefaction plant and port transfer facilities are the first such technologies installed in Australia. More than five other hydrogen liquefaction projects of commercial scale have been announced in Australia to date. These projects include use of renewable energy to produce hydrogen and a combination of gas and liquid storage capacity to address emerging export markets (e.g., LH2 or NH3).

Two web portals are useful resources for current compilations of hydrogen-focused initiatives driving the transformation of Australia's energy industry: HyResource and HyResearch [4]. The former documents >110 active and 15 inactive industrial projects, while the latter lists over 280 hydrogen-related R&D projects currently active in Australia. R&D on liquefaction is focused on the ortho-para transition, distribution and/or modularity of storage options, value-chain modelling, materials for magneto-caloric refrigeration and energy storage systems integration. Examples of these R&D projects will be detailed in the context of a rapidly transforming policy, investment and operational environment.

[1] Net Zero Australia, Final Results Summary, April 19th, 2023; [2] Clean Energy Australia Report, Clean Energy Council, April 2023; [3] Yoshino et al., Energy Procedia 29, 701-709, 2012; [4] https://research.csiro.au/hyresource/about/ ; https://research.csiro.au/hyresearch/ .

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