Occasional Analysis Brief Series

KONRAD ADENAUER STIFTUNG
REGIONAL PROGRAMME AUSTRALIA AND THE PACIFIC

PERISCOPE

Analysis #2 August 2020

Analysis of the Australian Hydrogen Strategy

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The Australian National Hydrogen Strategy was developed to support the establishment of an Australian hydrogen industry. While there is mention of domestic uses of hydrogen and establishing hydrogen hubs, a key aim of the Strategy is to establish Australia as an exporter of hydrogen. For example, one measure of success for 2030 is that Australia has become one of the top three exporters of hydrogen to Asian markets.

The Strategy has been adopted by all Australian States and Territories (which are members of the Council of Australian Governments, now to be succeeded by the National Council[1]). It contains measures of success, but no key performance indicators (which has been stated to be the role of a 'roadmap')[2].

The Strategy is part of a broader focus on hydrogen by Australian organisations (as shown in Table 1). It builds on the Commonwealth Scientific and Industrial Research Organisation (CSIRO) National Hydrogen Roadmap. And the Technology Investment Roadmap that is being developed by the Department of Industry, Science, Energy and Resources (DISER). The Roadmap (a Discussion Paper of which was open for comment between 21 May and 21 June 2020) is currently being finalised and likely to include hydrogen as a key technology, which is reflected in the example stretch goal of producing hydrogen under $2/kg.

There are also sub-national hydrogen strategies and action plans. Examples include the Queensland Hydrogen Industrial Strategy[3], South Australia's Hydrogen Action Plan[4], the Western Australian Renewable Hydrogen Strategy[5], and the Tasmanian Renewable Hydrogen Action Plan[6].

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1 www.coag.gov.au/
2 Refer to slide 14 of 43 for the relevant statement. https://webcache.googleusercontent.com/search?q=cache:ySpeU3HXkOQJ:https://energy.anu.edu.au/files/NHS%2520ANU%2520presentation%25202019.pdf+&cd=1&hl=en&ct=clnk&gl=au
3 https://www.dsdmip.qld.gov.au/industry/priority-industries/advanced-manufacturing/hydrogen-industry-development.html
4 www.renewablessa.sa.gov.au/topic/hydrogen/hydrogen-action-plan
5 www.drd.wa.gov.au/projects/EnergyFutures/Pages/Renewable-Hydrogen-Industry.aspx
6 www.stategrowth.tas.gov.au/energy_and_resources/energy/hydrogen

A focus on 'clean' hydrogen not 'green' hydrogen

The Strategy uses the term 'clean' hydrogen. It refers to both clean 'renewable hydrogen' and clean 'CCS hydrogen'. This means that the Strategy classifies hydrogen produced using electrolysis and renewable electricity as 'clean' hydrogen rather than 'green' or zero-carbon hydrogen. This is also the case in the Technology Investment Roadmap Discussion Paper, which used the same statement on 'clean' hydrogen and technology neutrality (as shown in Table 1).

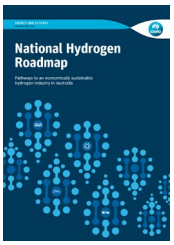
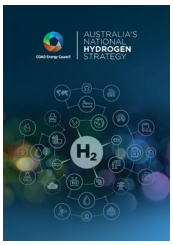
In relation to carbon capture and storage, it is noted that "if these emissions can be captured at a high level and permanently stored, clean 'CCS hydrogen' can be produced". Best-case capture rates of 90-95% are used, however, it is unclear whether facilities with lower capture rates will be prevented from operating or have to offset these emissions. For more detail on this issue refer to an article on the use of the term 'clean' published in The Conversation[7].

A measure of success for 2030 is that the "carbon intensity of Australian hydrogen production meets community, customer and consumer expectations and is decreasing over time". The Strategy presents the emissions intensity of hydrogen production, as shown in Table 2 below. But no target for the carbon intensity of hydrogen production is specified.

While less than 'best-case' capture rates are not mentioned, the Strategy does mention that "to produce hydrogen from natural gas or coal at acceptably low levels of carbon emissions, capture rates of 90% or more will likely be required".

Note that it is stated that the focus on 'clean' hydrogen "reflects a technology-neutral stance", which was one of the principles mentioned in Strategy's the terms of reference.

Table 1 – The position of the National Hydrogen Strategy in relation to other Australian reports

Document			
Org./ Year	**CSIRO** 2018	**COAG Energy Council** 2019	**DISER** 2020
Key statement of intent	The primary objective of this report is to provide a ***blueprint for the development of a hydrogen industry*** in Australia (i.e. market activation).	The National Hydrogen Strategy aims to ***lay the foundation for Australia to capture the hydrogen opportunity*** and become a leading player in a growing global market.	The Technology Investment Roadmap will ***help inform Australia's first Low Emissions Technology Statement*** and will be a ***critical input to Australia's Long Term Emissions Reduction Strategy***.
Key statement on clean H2	Further, if produced using low or zero emissions sources, ('clean') hydrogen can enable deep decarbonisation across the energy and industrial sectors. ***Clean hydrogen is the focus of this report.***	Unless otherwise indicated, ***references to hydrogen in this report refer to clean hydrogen.*** Clean hydrogen is produced using renewable energy or using fossil fuels with substantial carbon capture and storage (CCS). This definition reflects a technology-neutral stance.	Unless otherwise indicated, ***references to hydrogen in this report refer to clean hydrogen.*** Clean hydrogen is produced using renewable energy or using fossil fuels with substantial carbon capture and storage (CCS). This definition reflects a technology-neutral stance.

7 Jotzo, F., Beck, F. J., Longden, T. (2019) 'For hydrogen to be truly 'clean' it must be made with renewables, not coal', The Conversation. https://theconversation.com/for-hydrogen-to-be-truly-clean-it-must-be-made-with-renewables-not-coal-128053

Table 2 - Emissions intensity of production (as shown in the National Hydrogen Strategy)

Production technology	Emissions intensity (kg CO2-e/kg H2)
Electrolysis – 100% renewable electricity	0
Coal gasification, no CCS	12.7-16.8
Coal gasification + CCS – best case	0.71
Steam methane reforming (SMR), no CCS	8.5
SMR + CCS – best case	0.76

A pathway towards a hydrogen industry

The Strategy provides detail on activities that should occur before and after 2025. In the lead up to 2025 a key activity is to set-up demonstration projects. The activities for the period after 2025 are focused on large-scale market activation.

The activities before 2025 are:

- initiating pilots, trials and demonstration projects,
- assessing supply chain infrastructure needs,
- building demonstration scale hydrogen hubs, and
- developing supply chains for prospective hydrogen hubs.

The activities after 2025 are:

- identifying signals that large-scale hydrogen markets are emerging,
- scaling up projects to support export and domestic needs
- building Australian hydrogen supply chains and large-scale export industry infrastructure
- building and maintaining robust and sustainable export and domestic markets and supply chains, and
- enabling competitive domestic markets with explicit public benefits.

Potential uses and markets for hydrogen

The Strategy mentions five uses of hydrogen. These uses are heating, transport, grid electricity, chemical feedstock, and as an export good.

Building local demand depends on the establishment of hydrogen hubs and uses in transport and/or blending with natural gas. These hubs are defined as “regions where various users of hydrogen across industrial, transport and energy markets are co-located”. An aim of these hubs is to make the development of supply chain infrastructure more cost-effective. The Strategy mentions that these hubs could be in cities, remote locations or near ports for export. A separate report (which was commissioned by the COAG Energy Council) identifies over 30 potential export hydrogen hubs across Australia[8].

Using hydrogen in Australian gas networks

The use of hydrogen in existing gas networks is an avenue that the Strategy identifies as stimulating early domestic hydrogen demand. However, the Strategy notes that there are barriers to widespread hydrogen blending in gas distribution networks. Technical, economic and regulatory barriers are mentioned. This is especially the case for blends above 10%. And yet, the Strategy also mentions switching to 100% hydrogen in Australian gas networks.

8 www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/nhs-australian-hydrogen-hubs-study-report-2019.pdf

Using hydrogen for transport

The Strategy mentions hydrogen as a viable alternative for powering buses, trucks and ships. It is identified as a complement to battery electric vehicles by fulfilling the role of transporting heavy loads and travelling long distances.

The Strategy notes that industrial users, transport (including fleet vehicles and metropolitan public transport), and freight transport are the early opportunities for hydrogen vehicles.

Using hydrogen for industrial feed-stocks and heating

The Strategy mentions a role for hydrogen in industrial uses. This is as a chemical feedstock or as a fuel for heating and electricity generation applications. This is one case where notable details of end-uses are not provided.

A role for ammonia

Ammonia is mentioned as an important carrier and end-use for a hydrogen industry. The Strategy notes that while ammonia is commonly transported in tankers, there are no commercially available ships to transport liquefied hydrogen.

The Strategy mentions three uses of ammonia as a fuel. These are: - fuel for ships, - co-burning with coal in existing coal-fired power stations, and - use in fuel cells for electricity generation. These are supported as new areas of growth for ammonia in a relatively mature industry.

The role for government: regulation, certification and international outreach

An important part of the Strategy is providing detail on how Australian governments can help to establish a hydrogen industry. The main areas discussed are regulations focused on safety, establishing bilateral agreements with trading partners, and establishing hydrogen certification.

Regulation

One of the areas that governments agreed to coordinate are reviews of regulations. The aim is that a nationally consistent approach for hydrogen safety and industry development is established. Standards Australia and SafeWork Australia are identified as having roles in supporting this.

Standards Australia has formed a Hydrogen Technologies technical committee to facilitate developing national hydrogen standards. SafeWork Australia develops policy relating to work health and safety (WHS), however, it is up to Australian governments to regulate/enforce the WHS laws.

International outreach

Bilateral agreements with expected trading partners are raised as a way that the Australian Government can help support a global hydrogen market. These agreements should develop common standards and international regulations, as well as supporting research and pilot projects.

Hydrogen certification

The Strategy states that Australia wants to be a leader and help develop an international certification scheme. It notes that it is ideal for there to be a single global certification scheme. In relation to this, the Strategy states that "consideration will be given to the European CertifHy framework in developing a certification scheme".

To prevent disagreement on a certification scheme (and delays to investment), the Strategy proposes that one way to avoid disagreement is to "establish a minimal certification scheme that verifies and tracks production technology, scope 1 and scope 2 carbon emissions, and production location". And then the approach would "allow countries to set their own definitions of 'green' or 'low-emissions' hydrogen, with reference to agreed international standards".

Box 1 – The Hydrogen Energy Supply Chain pilot project

The Hydrogen Energy Supply Chain is provided as an example of Australia and Japan cooperating on a pilot project. The gasification plant is located in the Latrobe Valley and hydrogen will be shipped to Japan via the Port of Hastings in Victoria. This project will use brown coal gasification to produce up to 3 tonnes of gaseous hydrogen during a one-year pilot period during 2020/2021. Emissions are expected to be 100 tonnes of CO_2[9]. Offsets will occur in Queensland through native forest regeneration[10].

The project will utilise the world's first liquefied hydrogen carrier, which is the SUISO FRONTIER. It will transport liquefied hydrogen from Victoria to a terminal in Kobe Japan[11]. The ship has been launched, but without the storage tank, which was scheduled to be installed by late 2020[12].

Measuring success

The Strategy outlines 15 measures of success that should guide decision-making and the implementation of the Strategy. These measures are intended to be compared to a baseline. The Strategy states that in most cases, the baseline is effectively zero as the industry is yet to develop. In other cases, such as carbon intensity, there is no baseline measure provided.

A pathway towards a large-scale and low-carbon hydrogen industry?

The Strategy encourages that an adaptive and nationally coordinated approach is taken to support industry development. This is reflected by a 'review-revise-adapt' feedback loop shown in the Strategy. It is unclear when these reviews will take place.

The Technology Investment Roadmap is an important development related to the establishment of a hydrogen industry. For example, a stretch goal of producing hydrogen <$2/kg was proposed in the initial Discussion Paper[13]. It also mentions a possible goal for carbon capture use and storage.

The hydrogen futures scenarios presented in the Strategy were developed by Deloitte[14]. They assumed carbon prices were in place and rising over time. These were in place in Australia and internationally[15]. However, carbon pricing as a policy mechanism is not mentioned in the Strategy. So, the pathway towards a large-scale and low-carbon hydrogen industry in Australia is unclear.

9 https://hydrogenenergysupplychain.com/faqs/#latrobe-valley-faqs

10 https://hydrogenenergysupplychain.com/hesc-pilot-locks-in-carbon-offset-measures/
https://a.southpole.com/public/media/302610/2610.pdf

11 https://hydrogenenergysupplychain.com/construction-complete-at-hescs-kobe-hydrogen-terminal/

12 www.rechargenews.com/transition/worlds-first-liquefied-hydrogen-carrier-launched-in-japan/2-1-722155

13 https://consult.industry.gov.au/climate-change/technology-investment-roadmap/

14 https://www2.deloitte.com/content/dam/Deloitte/au/Documents/future-of-cities/deloitte-au-australian-global-hydrogen-demand-growth-scenario-analysis-091219.pdf

15 The Deloitte Australian and Global Hydrogen Demand Growth Scenario Analysis was commissioned by the COAG Energy Council. They developed the market growth scenarios presented in the Strategy. In these scenarios the 'implied Australian cost of decarbonisation' was $16.50/tCO2 in 2019 and increased to $41.25/tCO2 or $74.88/tCO2 in 2050 (depending on the scenario). The 'implied international cost of decarbonisation' was $16.84/tCO2 increasing to $39.89/tCO2 or $145.73/tCO2 in 2050 (depending on the scenario). When describing these scenarios, the Strategy does mention "deep decarbonisation" and "lower emissions electricity".

Table 3 – Measures of success for 2030

Theme of success	Element of success	Description of measure
A clean, innovative, safe and competitive industry	**Clean**	Carbon intensity of Australian hydrogen production meets community, customer and consumer expectations and is decreasing over time
		Australia has a robust certification scheme in place that is internationally accepted
	Innovative	Australia has a 'hydrogen-ready' workforce that is responsive to industry's needs
		The sustainability of water use for Australian hydrogen production continues to improve
	Safe	Australia has an excellent hydrogen-related safety track record
	Competitive	Australian hydrogen is cost-competitive domestically and internationally
		Australia has a 'hydrogen-ready' workforce that is responsive to industry's needs
Benefits all Australians	**Jobs and prosperity**	Hydrogen is providing economic benefits and jobs
	Supported communities	Benefits are flowing back to communities where hydrogen industries are located
	Domestic use	The cost of clean hydrogen continues to decrease in part due to technology developments and in part due to scale achieved in the development of a hydrogen export industry
		Hydrogen production and use is integrated into energy market structures
A major global player	**Hydrogen exports**	We are among the top three exporters of hydrogen to Asian markets
	Investor confidence	Australia is seen as a destination of choice for international investors in hydrogen
		We have major offtake or supply chain agreements in place with importing countries
	Hydrogen capability	We have demonstrated our hydrogen capability in all links of the supply chain

About the Author

Dr Thomas Longden is a Research Fellow working on the ANU Energy Change Institute's Grand Challenge – Zero-Carbon Energy for the Asia-Pacific. His work is focused on the economics of renewable energy and hydrogen.

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Before joining ANU in 2019, Dr Longden was based at UTS, Macquarie University, the University of Sydney and Fondazione Eni Enrico Mattei (FEEM) in Milan, Italy.

Thomas holds a PhD from the University of New South Wales (UNSW) and his main areas of research interest are applied econometrics, environmental economics, energy economics and health economics.

His work on energy, applied econometrics and technological change has been published in leading international journals (including Climatic Change, Energy, Technological Forecasting and Social Change, Energy Policy and Health Economics). He has also written correspondence articles for The Lancet Planetary Health.

Thomas was a Contributing Author on the AR5 WGIII Intergovernmental Panel on Climate Change (IPCC) report titled Mitigation of Climate Change.

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Periscope – Occasional Analysis Brief Series #2 (August 2020).
ISSN: 2652-7332 (Online)